

Teaching Research Practice on Fundamentals of Mechanical Manufacture Course for Materials Science Major

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Abstract—This paper elaborates on a systematic study on teaching mode of Fundamentals of Mechanical Manufacture course for students majoring in Materials Science. Based on education conception of students-centered, the teaching mode of integrating quality education, knowledge impartment, and ability cultivation is expounded. According to the current situation and existing problems, teaching research focuses on how to inspire the enthusiasm and initiative of students to promote students' knowledge construction and develop their thoughts and comprehensive abilities. Studies on improving the quality of teachers, optimizing the content of this course and exploring diversified teaching methods such as blended teaching methods and multi-element examination mode are discussed. Changing from the old teaching concepts, the teaching and learning combination mode can stimulate students' desire for knowledge and learning enthusiasm, and advocate learning autonomy, cooperation, and explore ways of learning. The teaching practice proves that the reform of the teaching pattern improves the teaching quality, broadens the breadth and depth of the course, and favors improving students' comprehensive quality and ability. It is worthy of continuing to do further research, application and promotion.

Keywords—teaching research, cultivation objectives, comprehensive quality, blended teaching method

I. INTRODUCTION

Fundamentals of Mechanical Manufacture course is a compulsory professional basic course for junior undergraduates majoring in Materials Science. This course has a close connection with the actual production and engineering, thus there is a high requirement of students' practice basis. For this reason, the students must finish the actual operations course engineering training in sophomore. This course aims to cultivate the preliminary ability of process analyzing and innovative awareness, and lays a necessary foundation for the study of related courses and for the future work in mechanical design [1, 2]. Its contents include not only the technological

processes, principles, methods and equipment of the cutting technology and the non-traditional machining technology, but also the cold working processes of spare parts from the choice of raw materials to semi-finished or finished products [3]. It covers the theories and methods of mechanics, materials science, and other disciplines, therefore, this course has a wide knowledge range, and close combination of theory with practice characteristics.

With the development of science and society, higher and newer demands will be placed on the knowledge structure of talents. The aims of the talent cultivation joint track with the certification standards of international engineering education also should be renewed. At the same time, because the applications of new engineering materials and new manufacturing technology increase in engineering, the original knowledge system of this course cannot meet the demands of professional training and knowledge constitution, and it is difficult to establish the necessary knowledge foundation for the subsequent study and engineering application. Therefore, establishing the system of curricular contents of this course and reforming the teaching mode are the keys to cultivating high-quality talents to meet the requirements of the times [4–6].

II. ANALYSIS OF THE CURRENT SITUATION AND PROBLEMS

A. Characteristic of Materials Science Specialty

Material Science specialty has stronger interdisciplinary and engineering characteristics. Over 70% of graduates of Materials Science in Harbin Institute of Technology go to graduate school or go abroad for advanced study. And graduates are deeply favored by aerospace, aviation, automobile, equipment manufacturing and other domestic industries and research institutions. The cultivation objectives of Material Science major in our school are that: With the talent cultivation idea of “thick foundation, strong practice, strict process, and exploring innovation”, we strive to cultivate outstanding talents with excellent quality, scientific spirit, innovative thinking, international vision and social responsibility, broad basic theory and

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systematic professional knowledge, ability to express, analyze and solve complex engineering problems, organizational coordination and lifelong learning ability, who can lead the future development of the profession and related fields.

It fully embodies the spirit of quality education, which aims to improve the comprehensive development of students with the integration of knowledge, ability, and quality.

B. Existing Problems in Fundamentals of Mechanical Manufacture course

It can't be denied that there exist some problems in the course teaching, and that have obviously an adverse effect on the original intention of ability cultivation and quality education.

- There are still some problems in the teaching content, such as outdated knowledge, insufficient engineering education. Because of failing to keep up with the development of science and technology, the depth of course content is not enough.
- There exists emphasizing imparting knowledge too much as to neglect comprehensive quality education. This teaching mode is not good for the cultivation of students' comprehensive capability, such as autonomy, competitiveness and creativity.
- There is a lack of scientific teaching methods. This course covers a large amount of knowledge points, but the class hours were reduced to 32. Within the relatively few hours, only depending on the teacher's classroom teaching cannot give full play to the initiatives and enthusiasm of students.
- Although the original assessment method includes the regular scores and the final scores, usually adopts a close-book test form. Some tests can even be surmised by students, which makes students learn without enthusiasm, some students even learn by rote and study only at the last time for opportunistic in passing tests.

III. THE MAIN RESEARCH CONTENTS OF TEACHING REFORM

According to the major's cultivation objects and the actual situation, the teaching reform and research is launched with teaching objectives, teaching content system, teaching methods, assessment methods and teacher's quality [7-9].

A. Course Teaching Objectives and Thoughts

High quality talent education should not just stop with the cultivation of professional and technical talents, and engineering, humanity and social education also need to be emphasized. The logical relationship of the course with other courses, the development of disciplines, economic development and international situation should pay attention to. At the same time, it is necessary to fully consider the characteristics of the students and their career development. Based on the trinity teaching concept of

value shaping, knowledge teaching and ability training, the teaching objectives of student-centered and focusing on improving students' comprehensive ability are clarified.

1) Knowledge and skills objectives

Through this course study, students should master the basic principles of main conventional technology, advanced manufacturing technology, and the manufacturing process system; have the preliminary ability to analyze technological processes and structural processability of spare parts; learn about new materials, new process and new technology and the development trend to establish the concepts of modern manufacturing engineering.

2) Ability objectives

Through synthesis, comparison, generalization, and other cognitive activities of part processing methods, process analysis, and typical engineering cases, develop students independent and critical thinking, serious scientific spirit, perfected craftsman spirit, and professional ethics; train students the ability to explore, analyze and solve complex engineering problems.

3) Emotion attitude and values objectives

Make students understand the science and technology development, the impact of engineering technology on environment, society and the world; cultivate the students to have loyalty, responsibility, environmental protection awareness and lifelong learning habit; train students international competitiveness to respond to the opportunities and challenges from globalization.

B. Improvement of Teachers' Quality

How to teach a course well? First of all, teachers should have a deep love for the educational cause and model moral characters for students. Teachers should try to integrate emotion into teaching and establish full trust between teachers and students. Secondly, a wide range of knowledge, practical ability, and the ability to integrate knowledge are required. Teachers are encouraged to be engaged in scientific research to keep updating their knowledge. Various academic and typical engineering cases are shown to students for broadening their horizons, and expanding knowledge to improve students' engineering quality. Teachers apply their professional quality and information-based teaching capability into teaching, and build a student-centered, multi-dimensional learning environment.

C. Teaching Content Optimization

Materials science specialty has advanced and leading characteristics for corresponding to the modern high-tech and many subjects, hence professional knowledge update becomes one focus of this study. It is necessary to make students know the current situation and the development trend about the discipline.

Teaching content should not only reflect knowledge, but also emphasize ability in order to lay a solid foundation for reinforcing students' comprehensive understanding and establishing a systematic basis of open-mindedness. The basic principles and important process methods in the traditional teaching content are retained, for these contents are the basis of this course. Cut old

content far from engineering reality and overlap with other courses' content. Increase knowledge about advanced manufacturing technologies, new material and new equipment, especially related to actual engineering. Focusing on links between the traditional content and the new content inspires students' passion for learning this course. For example, the content on the steel used in industry is minimized, and new materials and applications are introduced, such as the materials used in the engine which is the heart of the aviation aircraft. Ultra-precision machining technology and rapid prototyping manufacturing technology are joined in advanced manufacturing technology. In the meanwhile, pay attention to training students to have a sense of environmental protection, sustainable development, professional ethics, and social responsibility.

D. Research on the Teaching Methods

In order to achieve the teaching objectives and motivate students to study enthusiasm and interests, several teaching methods have been performed by means of continuous exploration and teaching practice. Explore the online and offline multi-dimensional blended teaching mode, as shown in Fig. 1.

1) Online and offline blended teaching practice

The blended teaching methods integrate into all aspects of teaching by the combination of network platform and classroom. According to the characteristics of different teaching contents, different teaching methods, such as MOOC, flipped classroom, discussion, typical case analysis, and problem-driven teaching are organically combined. Online and offline independent learning is the main method, like MOOC, test book and literature, and preparation for discussion and cooperative learning. Students receive learning tasks and teachers' guidance through the online curriculum space constructed by teachers, and submit learning results through the network. Offline in class, teachers lecture, guide students to discuss, and summarize the difficult and focus problems in learning. After class, students review, do homework, and view expended materials. Teachers and students can communicate with each other before, during, and after class.

2) Case and problem orientation teaching method

Using typical engineering cases, teachers put forward problems, encourage students to analyze problems and conduct in-depth learning through inquiry and integration theory with practice, and guide students to cooperation and interactive discussion. Questions can also be put forward by students. The combination of case study and self-study motivates students to participate in the course under the guidance of teachers, solidifies knowledge, and trains students' critical thinking and innovative ability.

3) Flipped Classroom

Teachers release tasks, and organize technology and culture discussion and presentation. For example, before teaching tool materials, the teacher assigns the task such as the development history of tools, materials as well as machining technology. The students work in groups to search for references, discuss, summarize, write reports

and at last select one student to present in class, others prepare to answer questions. Cooperative learning can stimulate students' passion and enthusiasm in learning, cultivate team spirit and self-directing learning ability. In this teaching process, students can easily get more information effectively, and teachers give the process assessment of students.

Under the blended teaching mode, each student's creativity was valued. Teachers are no longer the leader of the class, but teachers and students form a community facing problems and challenges in learning. Student-centered teaching methods give play to students' autonomy and participation, and cooperative learning, and stimulate students' passion and enthusiasm in learning, which can improve the comprehensive quality and innovation ability.

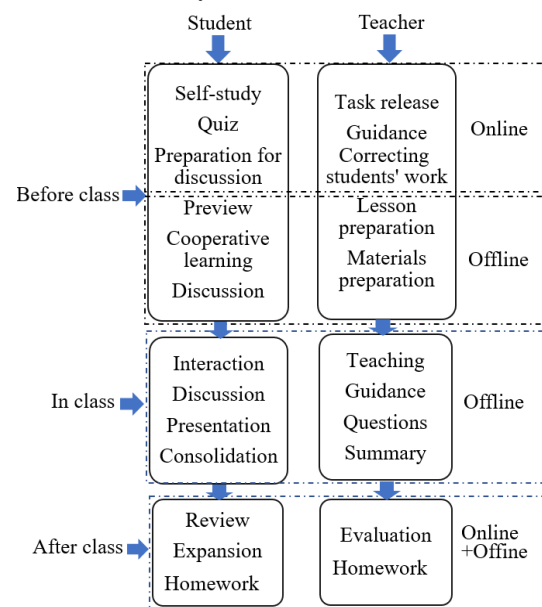


Figure 1. Design of blended teaching and learning mode.

E. Diversified Assessment

The assessment plays an important role in consolidating students' knowledge, guaranteeing the teaching quality and achieving the teaching goal. Scientific and reasonable assessment methods are the basis of promoting students' learning initiative and innovation consciousness.

We explore the process-based diversified course assessment, by online and offline, ideological indicators and knowledge indicators to comprehensively assess students. Online scores include interaction, homework, video learning, and quizzes. The online quiz plays a good role in promoting students to study. The quizzes are conducted on knowledge unit following the course schedule. Each quiz includes several test questions, and only lasts about several minutes. Offline scores include reports, case analysis, flipping, final exam and experiment. In case analysis, report, discussion, and flip, 40% scores are set for learning attitude, task completion ability, collaboration, and innovation awareness. The total scores comparison results before and after

implementation of the blended teaching are shown in Fig. 2. It can be seen that the excellent rate of the total scores increases from 5.5% to 6.5%, the good rate from 22.2% to 32.3%, and the failure rate decreases from 8.3% to 3.2% after implementing the blended teaching. The statistical data shows that the teaching reform is feasible and effective, that is worthy of continuing to do further research and implementation.

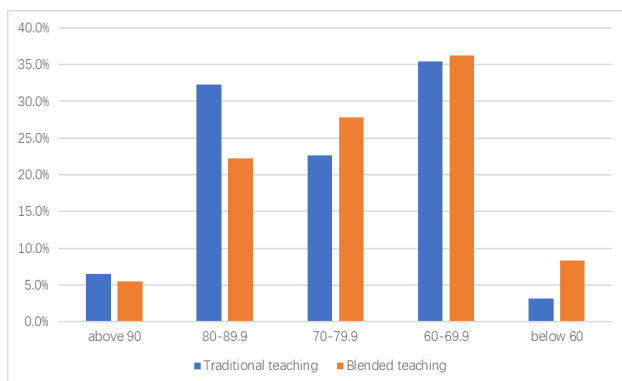


Figure 2. Comparison chart of total scores.

IV. CONCLUSION

By analyzing the characteristics of Fundamentals of Mechanical Manufacture course and problems in the teaching, the teaching mode adapting to the aim of talent cultivation for Materials Science major is discussed. Based on the trinity teaching concept of value shaping, knowledge teaching and ability training, the teaching objectives of student-centered and focusing on improving students' comprehensive ability is clarified. Revise the teaching content to construct students' systematic knowledge structure, emphasizing knowledge update and multi-subject combination. Blended teaching method and process-based diversified assessment system improve the teaching quality and promote students' learning initiative and innovation consciousness.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

C. Han mainly conducted the research and wrote the paper. X. Yang reviewed and finalized the paper. J. Song analyzed the data. All the authors had approved the final version.

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