Research on the Practical Path of Blended Teaching Mode of College Mathematics in the Perspective of Emerging Engineering Education

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Abstract. The Emerging Engineering Education concept further highlights and strengthens the supporting role of mathematical theory and methods for engineering majors, requiring students to enhance their mathematical abilities in terms of foundation, depth, and application, in order to achieve deep cross-border integration with engineering majors. This requires re-examining, rethinking, and constructing a new framework for engineering mathematics teaching, and emerging teaching models such as blended learning provide new ideas and approaches for engineering mathematics teaching to meet this requirement. Focusing on the goal of cultivating new engineering talents, this article mainly studies the construction of a three-dimensional university mathematics teaching resource library, the construction of a dual-subject multi-process blended teaching model, and the formation of a three-stage closed-loop evaluation feedback mechanism. It also analyzes and studies the advantages and problems of this model in practice. Practice has shown that the blended teaching model of engineering mathematics can effectively address some deficiencies in mathematics curriculum teaching and is an effective path to achieve cross-disciplinary integration. However, there are also problems such as imperfect evaluation systems.

Keywords: New engineering; Mixed teaching mode; Evaluation feedback mechanism

1. Introduction

New engineering is the sustainable driving force system for China's future technology and intelligent era. In recent years, the development of new engineering includes new major areas such as big data, cloud computing, artificial intelligence, blockchain, and the upgrading of traditional engineering majors driven by new technologies, which have diversified and pluralistic demands for the knowledge and abilities of professional talents. Emphasis is placed on the ability to use mathematical knowledge to establish models, analyze, and solve complex engineering problems [1,2]. University mathematics series courses are fundamental theoretical courses in higher education, occupy an important position in the entire disciplinary system, and carry the heavy responsibility of knowledge transmission, ability training, and value guidance. The content, ideas, and methods of university mathematics courses play a key supporting role in the comprehensive quality of various talents. Therefore, university mathematics courses are facing new opportunities and challenges to promote the accelerated development of engineering [3,4].

2. Application status of blended teaching mode in university mathematics teaching

The concept of "blended teaching" was first proposed in 1999, which combines the advantages of online teaching and traditional offline teaching. It can not only exert the guidance, inspiration, and assistance of teachers in traditional offline teaching, but also activate students' initiative, enthusiasm, and creativity as the main body of the learning process with the help of online classes on the internet, so that learning can be implemented effectively. Literature [5,6] has raised the issue of the applicability of blended teaching mode in different types of universities and different majors, providing new ideas for future research. Literature [7-10], and so on have discussed the optimal effect of blended teaching mode in university mathematics teaching, its influence on students' enthusiasm for learning and self-learning ability, and the repositioning of teachers' roles.

However, most of the above studies focus on theoretical models and application practices of blended teaching, with little attention to the integration of new engineering construction and

university mathematics teaching reform. This article explores the practical path of blended teaching mode in university mathematics teaching under the background of new engineering, which is of great significance for improving teaching quality and cultivating innovative talents.

3. Practical Path of Blended Teaching Mode in University Mathematics Course from the Perspective of New Engineering

University mathematics courses have high abstraction, logic, and comprehensiveness, In the follow-up professional course study, students need to have a deep mathematical foundation, and students lack a way to solve their own problems in mathematics learning, and their professional development needs cannot be fully met. At the same time, most mathematics teachers do not have research backgrounds in professional disciplines, and the phenomenon of "teaching mathematics as mathematics" is common, ignoring the differences in mathematical needs among different majors. The disconnect between mathematics learning and engineering applications has led to the teaching effect and quality of university mathematics courses being insufficient to support the training objectives of new engineering professionals.

Based on the above analysis, the teaching reform of university mathematics courses from the perspective of new engineering should focus on improving students' core competencies in three aspects: foundation, depth, and application. The foundation should be solid, the depth should be sufficient, and the application should be strong. Our school's mathematics teachers and engineering teachers have worked together to accumulate experience in teaching practice, carry out macro planning and top-level design to form a blended teaching mode for university mathematics courses, improve the courses' higher-order, innovation, and challenge levels, and cultivate students' comprehensive ability and scientific thinking for solving complex problems.

3.1 Three-Dimensional University Mathematics Teaching Resource Library will be Constructed to Optimize and Improve the Connection with Professional Courses

The first dimension is the micro-knowledge teaching resource library. Firstly, aiming at the problems of traditional teaching resources being too large and long, with weak targeted learning and inconvenient and inflexible use in blended teaching, each chapter of teaching content will be refined into several micro-knowledge units, and classified according to concept units, method units, and application units, to determine the teaching objectives of each micro-knowledge unit. Secondly, multiple resources such as conventional teaching resources, video resources, core knowledge point analysis, and other electronic resources will be used to construct each micro-knowledge unit, forming a teaching resource library with micro-knowledge units as the basic particles.

The second dimension is the application teaching case library. A virtual teaching and research section will be established to discuss and jointly sort out the development history of important concepts and methods in university mathematics and professional courses, as well as their sources in real life or scientific research, and build a literature database tracing back to its source. From complex engineering problems, we will extract sub-problems and transform them into application cases suitable for university mathematics teaching and students' extra-curricular inquiry and discussion, establishing an application teaching case library with engineering background.

The third dimension is the practical training task resource library. To fundamentally improve students' mathematical thinking, modeling, and problem-solving abilities, as well as train students' basic software operation skills, we will design a practical training task resource library that includes model learning, algorithm analysis, and operation practice tasks such as "point-line-surface" model learning tasks.

3.2 A Dual-subject, Multi-process Blended Learning Mode will be Constructed to Activate Independent Learning Abilities

"Dual-subject" refers to the student as the learning subject and the teacher as the guiding and controlling subject. "Multi-process" represents the diversity of learning progress in the same class. According to the different speeds of completing teaching tasks, the learning process can be divided into three types: ordinary process, fast process, and slow process. With the support of information technology, online and offline blended teaching is carried out, and students can simultaneously use

online learning resources and teacher guidance to complete differentiated learning processes, which meets the individualized learning needs of students. The flowchart of the dual-subject multi-process hybrid teaching model is shown in Figure 1.

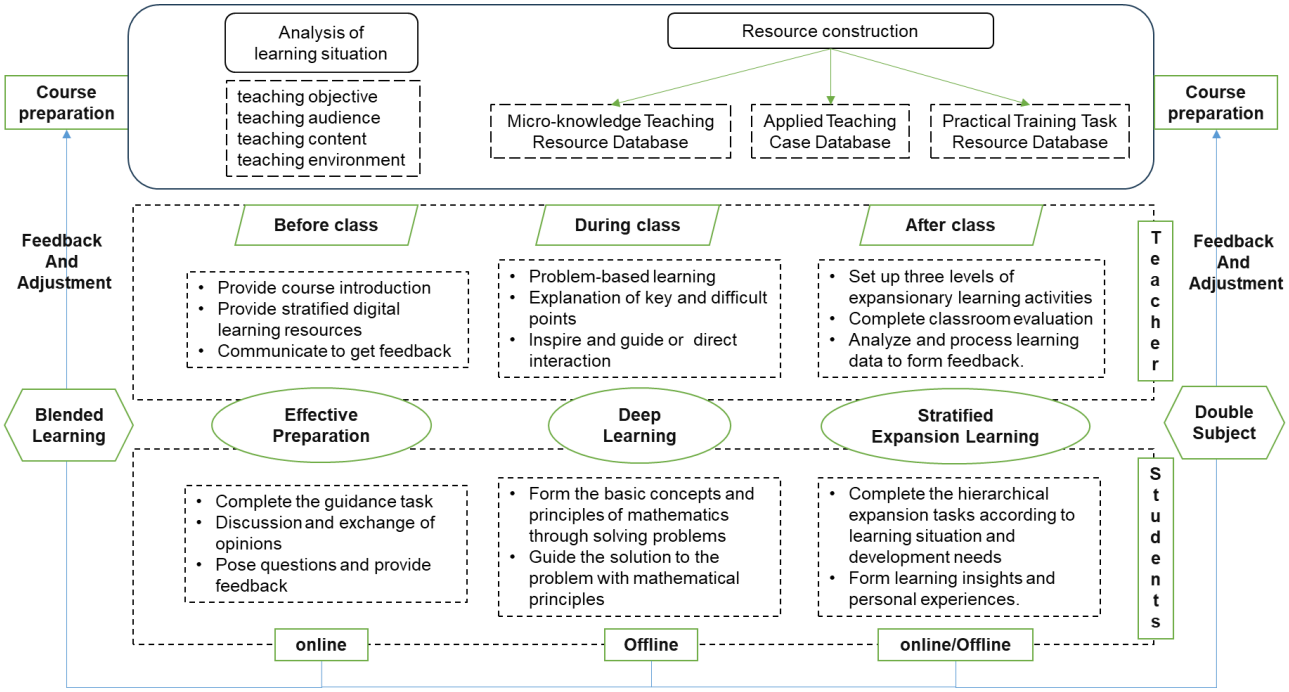

Figure 1. Dual-subject and multi-process blended learning mode

Before class, it is the online pre-learning stage. It mainly relies on the learning platform to carry out online autonomous learning to implement the concept of "learning before teaching and teaching based on learning". The pre-learning content is submitted in the form of text in the pre-learning form on the platform, and is divided into three modules: slow process, ordinary process, and fast process. Students can complete the corresponding process according to their own preview situation. For pre-learning related teaching videos, textbook materials, related induction content, etc., there will be clear prompts and explanations in the pre-learning form.

During class, it is the deep learning stage. This stage is controlled by teachers and can be completed online or offline. It covers three aspects: guide learning, mutual learning, and exploratory learning. This stage mainly plays the leading role of teachers, and based on students' pre-learning online, students carry out learning activities such as sharing, communication, and collision. At the same time, in key points, difficulties, and doubts, students initiate higher-order thinking such as analysis, synthesis, evaluation and creation in exploratory learning.

After class, it is the layered expansion learning stage. Based on teaching goals, three levels of expansion learning activities are set: "basic", "enhanced", and "improved", so that students can complete corresponding expansion learning activities according to their own learning situation. At the same time, with the help of the learning platform, students can repeatedly learn and complete corresponding tasks to promptly fill cognitive gaps and activate independent learning abilities, effectively improving their learning results.

3.3 Establish a "Three-stage" Closed-loop Evaluation and Feedback Mechanism to Track and Continuously Improve the Course

To provide timely feedback on student learning outcomes, establish a "three-stage" closed-loop evaluation and feedback mechanism (i.e., real-time evaluation and feedback in one class, stage-based evaluation and feedback in one course, and follow-up evaluation and feedback after the course).

In real-time evaluation and feedback in one class, five real-time evaluation observation points are set: "online objective problem assignment - offline subjective problem assignment - topic

discussion - classroom interaction - group task". Teachers obtain students' learning status through evaluation of pre-class tasks, classroom activities, and post-class assignments, and provide timely feedback to students.

In stage-based evaluation and feedback in one course, teachers obtain feedback on students' learning status through methods such as chapter tests, mind maps, time projects, stage exams, final exams, and other forms of stage-based learning effect evaluation. They analyze the achievement of teaching goals, adjust subsequent teaching plans, and issue timely academic alerts to students with suboptimal learning performance during the semester to supervise their subsequent learning.

In follow-up evaluation and feedback after the course, teachers obtain feedback from students on the teaching mode, teaching process settings, and achievement of knowledge, abilities, and qualities through a questionnaire survey after the end of the course. When students enter into advanced professional courses, engineering teachers evaluate students' mathematical knowledge and abilities, and provide feedback to mathematics teachers for continuous improvement of course teaching.

4. Conclusions

In the context of emerging engineering education, this study implemented a dual-subject, multi-process blended teaching model. This teaching model basically solved the teaching conflicts between students' uneven knowledge reserves, complex teaching content, limited class time, and the multi-objective teaching goals of outcome-oriented emerging engineering education. The teaching model fully motivates all types of students to study university mathematics courses and improves students' basic knowledge and abilities of mathematics, as well as their ability to obtain and solve problems independently. Additionally, it enhances students' awareness of challenges. This teaching model will also profoundly affect the professional positioning, academic accomplishment, and teaching skills of mathematics teachers.

However, how to fairly evaluate students' learning process requires refining more reasonable course assessment standards and considering more appropriate weights for each link to enable curriculum reform to not only reflect the requirements of cultivating students' abilities but also drive students to actively learn. The above issues will continue to be studied by our research group.

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