The Construction of a New Normal Classroom for Linear Algebra Under Hybrid Teaching

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Abstract. To address the problems in the traditional classroom of linear algebra, we make full use of self-built MOOC resources and propose a hybrid teaching model that combines online and offline learning suitable for applied undergraduate institutions. This mode of teaching meets students' needs for "fragmented" learning, not only stimulates students' enthusiasm for learning, but also increases students' motivation and initiative. Practice shows that this teaching mode emphasizes the "main" position of students and the "leading" role of teachers, which solves the problem of "difficult interaction" between teachers and students and improves the teaching effect of linear algebra courses.

Keywords: linear algebra · hybrid teaching · teaching reform · New Normal Classroom

1 Introduction

Linear algebra is a compulsory basic course for science and engineering students in colleges and universities. It is also a powerful tool to solve complex engineering problems. The course involves the knowledge of vector linear correlation, linear space, linear transformation, similar diagonalization of matrices, solving systems of linear equations, etc. are important means for future students to solve practical problems. Through the study of this course, it can make students have the ability of proficient matrix operations and comprehensive use of matrix methods to analyze and solve practical problems, with a large audience, coverage, benefit a wide range of characteristics.

Blended teaching model should closely link teachers, students and courses, and is a combination of online learning and traditional classroom teaching. Blended teaching reflects the main position of students in the learning process, but also emphasizes the guiding role of teachers. There are two typical types of blended instruction: activity-based blended instruction and resource-based blended instruction. "Activity-based blended instruction" refers to the teacher's flexible selection and design of teaching activities according to the teaching objectives, teaching contents and teaching contexts, allowing students to learn independently in the activities and combining different sequences of activities to form a blended teaching style [1]. Resource-based hybrid teaching focuses

more on the planning and support of resources in hybrid teaching and focuses on how to provide students with the required resources for their learning activities [2].

In the current context of information-based teaching, hybrid teaching has become the mainstream teaching mode. Universities have carried out MOOC, SPOC and various information-based teaching practices supported by online course platforms. Many teachers have also made a lot of attempts. In terms of design, the blended learning course design architecture proposed by Rong-Huai Huang et al. [3]. Divides blended learning course design into three main parts: front-end analysis, activities and resources, and instructional assessment. Li Liang et al. proposed to integrate computational thinking into the specific teaching process in order to enhance students' enthusiasm and interest in learning [4]. Zhao Donghong et al. enriched application cases for students' specialties, added cutting-edge and applied contents, and cultivated students' independent thinking ability and learning-to-apply ability [5]. Cao Hongju et al. proposed to combine the curriculum with application cases under the guidance of "first-class undergraduate curriculum" construction [6]. Li Shangzhi proposed to use the language of linear algebra to describe equation problems, and then use linear algebra to solve them, so as to deepen students' understanding and mastery of concepts in the process of mathematical modeling [7].

Based on the above research, this study redesigned and organized teaching activities and teaching resources, and carried out reform and practice in teaching objectives research, teaching content reconstruction, teaching forms and means diversification, teaching resources construction, examination forms and other aspects. The second section discusses the problems in linear algebra teaching. The third section puts forward the concrete measures to construct the new normal classroom based on mixed teaching. The fourth section is a comparison of teaching effectiveness and the fifth section is a conclusion.

2   Current Problems Facing the Teaching of Linear Algebra

The course team teachers combined with practical experience and after continuous summing up, they summarized several problems of the current course. Some students are not interested in mathematics, and the students' basic knowledge of mathematics is uneven. It is difficult to carry out practice among students again because the course content is large but the class time is gradually small. The examination results do not effectively reflect the true level of most students. In order to effectively solve the above problems, the course team decided to use the construction of a new regular classroom under the blended teaching model to solve the above problems. The core issue of this work is the ways and strategies to combine the advantages of online teaching and traditional teaching.

3   Specific Measures for Building a New Normal Class-room Based on Hybrid Teaching

3.1   Based on the Analysis of Learning Situation, Adopt Motivating Teaching Mode to Enhance Students' Learning Confidence

The course team responded to the low interest of students in the course. It was decided to adopt a motivational teaching model to increase students' interest in learning by applying what they have learned to solve practical problems by themselves. And in the teaching activities, we sincerely respect, care and understand the students and gain their trust. Let students go to trust the teacher and identify with the curriculum. This motivation can motivate students to learn with higher quality and efficiency.

3.2   Multi-method and Comprehensive Teaching Reform Based on Course Objectives

The knowledge, ability and literacy objectives of this course are constantly revised and determined according to the talent training objectives. In order to better achieve the teaching objectives, multi-method, all-round and ladder teaching innovation attempts have been made (Fig. 1).

The first measure is to integrate the teaching content and optimize the teaching design. The main contents of linear algebra can be grouped into three tools and two problems. The three tools refer to determinants, matrices and vector spaces, and the two problems refer to systems of linear equations and systems of quadratic equations. These five modules are very closely related to each other, and many knowledge points are interconnected. In the specific teaching process, students can be guided to connect the new knowledge with the old knowledge and discover the inner connection. Encourage students to use multiple methods to solve a topic. For example, the knowledge point of invertible matrix is the same in many chapters of the textbook, but described in different ways.

The second measure is the establishment of the principle that the course is a tool for solving practical problems. In the lectures, the theoretical depth is appropriately reduced and the principle of "application-oriented and adequate" is adopted. At any time during the learning process, students are made aware of what they are doing and why they are doing it. For example, when teaching the eigenvalue and eigenvector part, the order
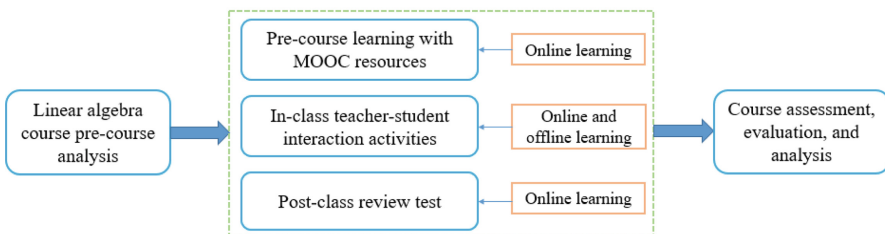

Fig. 1. Hybrid teaching model

of the course content is appropriately adjusted, starting from the example problem of finding the square power in Chapter 2, using the population migration problem as the introduction of this series of knowledge points, eventually leading to the diagonal matrix, and then introducing the concept of eigenvalue and eigenvector with the derived diagonal matrix. This enhances students' understanding of the basic course content and makes the introduction of problem solving methods more natural.

The third measure is to consider the levels of students at different levels and use a stepped approach in the lectures to fully motivate all students. After students meet the basic requirements of the course, some higher-order topics are given so that students can understand the extended form of the basic topics and build up their learning confidence. Finally, for higher level students, innovative and challenging reading material is also provided in a targeted manner. For example, popular techniques such as linear algebra in machine learning are supported, and they are guided to consult materials to extend their learning.

3.3   MOOC Construction and Hybrid Teaching

Currently, there are many well-known MOOC websites in China. Compared with traditional learning methods, MOOCs are more flexible, and students can enjoy the best teaching resources at home and abroad without the limitation of time and space. However, the teaching resources of these famous teachers are not necessarily suitable for all students. Students may not know how to choose when faced with numerous resources, which in turn leads to online learning becoming unfocused. Therefore, it is necessary to establish their own course catechism for their students' learning characteristics and professional characteristics. In 2016, the course team started to build the MOOC website. And at the end of 2018, a complete MOOC resource for the course was established. Immediately after that, the mixed online and offline teaching started, and achieved good teaching results.

According to the importance of the case problem base in developing and improving students' mathematical thinking as pointed out by Wenxia Yang et al. [8]. The course team teachers attach great importance to the construction of the problem bank. After several semesters of efforts, a more stable online test bank corresponding to each teaching chapter has been formed. At present, the online course "Linear Algebra" provides 54 video resources and 865 problems. It has been used on the MOOC platform for 7 cycles, involving 1200 students (Fig. 2). The construction of MOOC resources has provided an important guarantee for the subsequent construction of the new regular classroom, and the new normal classroom is gradually formed.

3.4   Reconstructing Integrated Assessment and Evaluation Methods

In the past, grades were mainly determined by final grades and supplemented by regular grades. The usual grades are mainly for attendance and classroom performance, etc. Due to the limitation of the number of students and class time, the usual grade gradually became a formality and could not effectively reflect the real learning situation of students in general.

Fig. 2. MOOC Course Statistics

In order to change this drawback, the course team adjusted the final grade ratio to 50%, the usual written assignments accounted for 10%, MOOC assignments accounted for 10%, class attendance and performance accounted for 10%, and the midterm exam accounted for 20%. The assessment time is full, the content is full and the methods are varied. Such assessment ratio more effectively mobilizes students' learning enthusiasm throughout the semester, thus improving learning efficiency. The examination pass rate and merit rate of the teaching classes have increased significantly.

4 Teaching Effect

The new normal classroom has had a significant effect on improving teaching effectiveness and enhancing the quality of student learning. Since the implementation of the project, students' learning has become significantly more purposeful and motivated. The number of winners in mathematics competitions and modeling contests has also increased year by year (Fig. 3). The various abilities of the course team teachers have also been improved, and they have won awards for teaching reform projects, teaching excellence awards and teaching quality awards. The course has also become a construction course of MOOC Alliance for Computer Education in Chinese Universities.
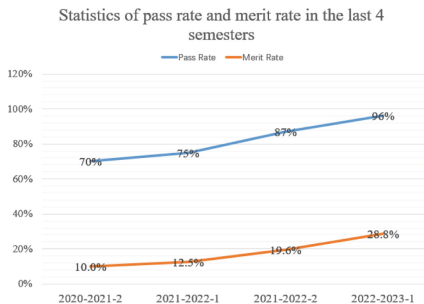

Fig. 3. Statistics of pass rate and merit rate in the last 4 semesters

5   Conclusion

Compared with the traditional linear algebra teaching mode, the new normal classroom mode has significantly improved students' learning initiative and the teaching effect has been significantly improved. This shows that the construction of this model is feasible and can provide teaching reform experience for applied undergraduate institutions. This model not only improves teachers' teaching efficiency in the classroom, but also improves students' learning status and cultivates their ability to think and solve problems. With the continuous iteration, updating and optimization of self-built MOOC resources, the teaching effect of the hybrid teaching mode in linear algebra courses will be significantly improved.

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