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# The Application of Flipped Classroom Based on MOOC in Linear Algebra Teaching

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## Abstract

With the development of internet technology in education, MOOC and Flipped Classroom, possessing abundant educational resources, have become indispensable teaching means. This paper presents the principle of organizing Flipped Classroom based on MOOC in linear algebra teaching and designs a new teaching mode from three stages: pre-class, in-class and post-class. The result of teaching practice indicates that, under MOOC environment, the application of Flipped Classroom in linear algebra teaching can significantly improve teaching effect.

## Keywords

MOOC, Linear algebra, Flipped Classroom.

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## 1. Introduction

Linear algebra is an important basic theoretical course in mathematics in higher education. It provides calculation methods and problem-solving tools for many disciplines such as engineering science and technology, agriculture and forestry, economic management and so on. With few practices and less class hours, the traditional teaching mode mainly focuses on theoretical knowledge transmission and the course is featured by its abstract and logical content which is difficult to understand and master for students, thus making them lose the interest in linear algebra learning. To improve students' efficiency, arouse their interest in learning, and yield good teaching results are the significant objectives of the current linear algebra teaching research and reform.

In recent years, the emerging teaching modes such as MOOC and Flipped Classroom have gained rapid development, which provide abundant teaching resources for the reform of linear algebra[1-2]. MOOC, namely massive open online courses, has several advantages [3]. First, with rich course resources, MOOC can accommodate a large number of students for online learning at the same time; second, the teaching content and process are open, and students are relatively free and flexible in time and place for learning; third, MOOC provides a great platform for the exchange between teachers and students as well as between students themselves. The Flipped Classroom converts teachers from classroom managers and knowledge delivers in traditional education into guides in learning, and students play a dominant role in classroom [4-5]. Two features of the Flipped Classroom are presented here. Firstly, before a class, the teacher would send the relevant material of new knowledge to be explained to students, and students are required to make preview; secondly, in the class, the teacher and students would discuss some questions encountered by students during the preview through interaction for the purpose of making students understand and master the knowledge.

Based on abundant teaching resources at home and abroad, this paper, by virtue of various communication means, explores and practices a new mode of linear algebra teaching--the Flipped Classroom of linear algebra teaching based on MOOC.

## **2. The Application of Flipped Classroom Based on MOOC in Linear Algebra Teaching**

### **2.1 The principles of organizing Flipped Classroom based on MOOC**

#### **Principle 1: Designing Flipped Classroom based on student-oriented principle**

The purpose of Flipped Classroom is to change the phenomenon of passive learning of students and encourage them to participate in learning activities actively, making them play the main role in classroom, thereby enhancing their autonomous learning capability and improving their learning efficiency [6]. It requires teachers to design their teaching process based on student-oriented principle as much as possible, creating opportunities for students to cultivate their problem-finding, thinking and independent problem-solving capability. Teachers shall prevent teaching videos from turning into another form of cramming education. In addition to a detailed presentation of the video, teachers shall design question asking, thinking and practicing activities to help students solve problems and digest new information through their positive thinking and actions instead of purely listening and recording in their extra-curricular learning. In classroom, teachers are no longer leaders delivering tedious preachment, but the organizers and coordinators of class activities. All learning tasks shall be accomplished through efforts of students themselves or group cooperation and teachers would provide guidance and assistance only when difficulties hinder the learning activity or students need help.

#### **Principle 2: Promoting the fulfillment of individualized teaching**

The fact is that students in a same class are different in their learning competence. Given this, making students at different levels keep up with a same learning schedule has been a big challenge that plagues many teachers. In Flipped Classroom, educators, on the one hand, would give students more freedom and impart knowledge out of class, thus making them receive new information in their most proper way, and on the other hand, would help students with their knowledge internalization in class, thus promoting communication between students themselves as well as between students and teachers [7]. To achieve individualized teaching in Flipped Classroom, teachers, first of all, shall supplement other relevant resources apart from providing basic teaching material. The relevant resources are given mainly to strengthen students with poor learning foundation. Secondly, teachers shall set up a network platform for online communication, so that students could exchange ideas about problems encountered in extra-curricular learning with classmates or teachers through the platform. Finally, teachers shall give students personalized guidance based on their characteristics. Students with excellent learning ability could determine their own learning content independently after finishing tasks assigned by teachers, thereby improving their learning efficiency; students with poor learning ability could adjust learning schedule according to their own learning competence, rather than ignoring or even giving up some knowledge for the sake of keeping a same pace with others.

#### **Principle 3: Attaching great importance with teaching feedback**

Teaching feedback is of great significance in a teaching process [8]. Teachers could analyze, evaluate, amend and adjust their entire teaching activities based on the feedback. According to the feedback of their own learning behaviors and results obtained from teachers, students could review and summarize their learning activities and timely modify and adjust their learning behaviors and methods, making themselves stay in a normal and positive learning status. There are more opportunities for teachers and students to communicate in the Flipped Classroom than in a traditional classroom, so that teachers may have more channels to get feedback in their teaching. Firstly, get feedback from network online communication. Students could present their questions or suggestions to teachers through a exchange

platform while teachers could instruct students’ learning behaviors and adjust their own teaching arrangement according to questions raised by students. Secondly, get feedback from face-to-face communication in classroom. Students could ask for teachers’ help at any time in the classroom during performing learning tasks while teachers could clear up their puzzles and learn about their learning status and progress. Finally, get feedback from homework correction, teachers could check and remark students’ homework while students could make up their deficiencies according to teachers’ comments.

**2.2.Establishing the teaching mode of Flipped Classroom based on MOOC**

The Flipped Classroom based on MOOC is a new teaching mode that adapts to the transformation of mobile Internet learning and that combines online video courses with traditional classroom Q & A [9-10]. According to the actual teaching, teachers shall find out the coherence point between MOOC and teaching content, appropriately select teaching content to carry out Flipped Classroom teaching, properly handle the key and difficult points in teaching, and finally finish teaching tasks. This study mainly concentrates on the establishment of Flipped Classroom of linear algebra teaching based on MOOC from pre-class, in-class and post-class three stages. The detailed implementation plan is shown in Figure1.

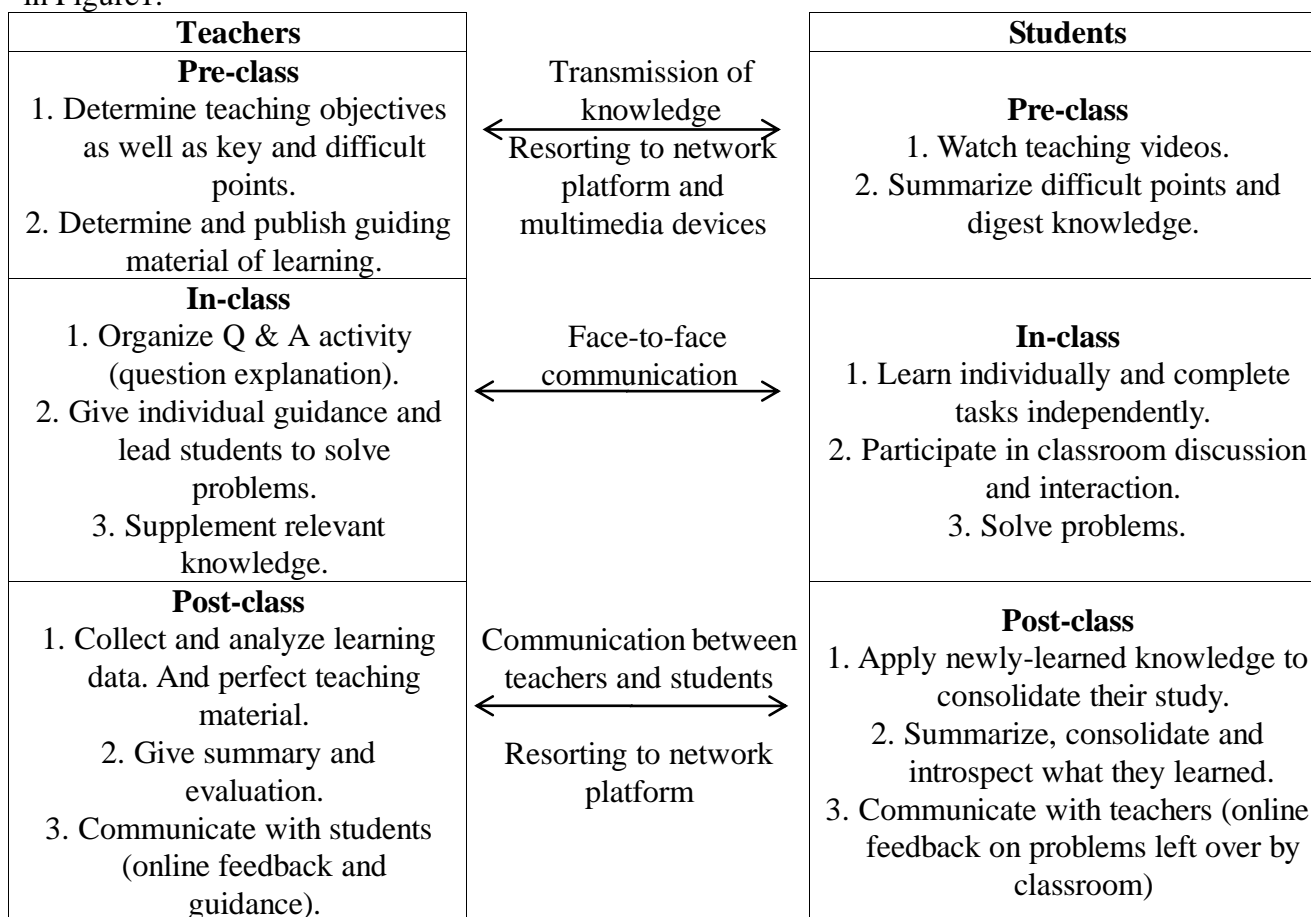


Figure 1. Implementation plan of Flipped Classroom teaching mode based on MOOC

**Pre-class: Construct the framework of linear algebra knowledge system and clarify the main line of the course so that students can sort out the relationship between knowledge points and their autonomous learning capability would be trained.**

In a traditional classroom, the teacher is mainly responsible for teaching, while the students are passive receivers of the entire knowledge without any target, which leads to a failure of arousing students’ learning interest. Meanwhile, their knowledge system may be fragmented after a chapter is finished, and they can not string what they have learned together. In view of this, the teacher could display the

knowledge structure of linear algebra to students through video before class. By visual learning, students, on the one hand, would have a general understanding of the knowledge framework, teaching objectives and teaching difficulties of linear algebra, and on the other hand, are able to classify and sort the knowledge points interlocked in the course. This not only significantly enhances students' autonomous learning capability, greatly improves their learning efficiency, but also provides a guarantee for teachers to carry out Flipped Classroom teaching mode.

Take the textbook used by undergraduates of our university [9] as an example. The main content of the first four chapters is designed to discuss two major topics of linear equations: existence and structure of solutions. Therefore, a series of concepts including matrix, determinant, vector, elementary transformation of matrix and several related operations are introduced in each chapter to demonstrate linear equations. The first chapter is designed to solve simple and special equations by determinant, that is, Cramer's Rule, thus the definition, property and calculation of determinant are studied; the second and third chapters are designed to solve general linear equations by the elementary row transformation of matrix and the Gauss elimination method, thus the basic content of the matrix theory (six algebraic operations, block and elementary row transformation) is introduced; the fourth chapter is designed to present the connection structure of linear equations, thus the definition and the linear dependence of vector are discussed. The fifth chapter deals with the comprehensive application of theory and methods of linear equations.

**In-class: Take the Flipped Classroom as an opportunity to form a student-centered teaching mode and to develop students' autonomous learning and thinking capability.**

Our teaching practices show that the traditional blackboards-writing is required to erase repeatedly and students are busy taking notes without enough time to think. In addition, the short duration of slides on which formulas and theory deduction are shown usually fails to impress students deeply. The implementation of Flipped Classroom would prevent teachers from teaching in a cramming way, make students receive information and learn knowledge actively, and prompt them take the initiative to participate in learning activities, so that students could play the dominant role in classroom and their capability and efficiency of self-learning would be improved.

For the Flipped Classroom teaching mode based on MOOC, students has made preparation for specific knowledge through videos before class, so in classroom, the teacher would take solving problems encountered by students in self-learning as a main teaching objective instead of a teacher-based knowledge transmission. In a Flipped Classroom, students may be asked to exchange and discuss their puzzles and problems encountered in self-learning within groups, and may seek teacher's help with the problems that can not be solved by themselves. After the puzzles are cleared up, the teacher then raise relevant questions for students to answer to examine their actual understanding of the content of MOOC. Regarding to the problems which appear frequently or which are difficult to solve, the teacher shall present students the detailed solution process, highlight the knowledge point involved in this problem and demonstrate its application. This not only strengthens the interaction between teachers and students as well as between students themselves, but also reflects the student-centered teaching purpose, enhancing students' learning initiative and improving their learning interest.

**Post-class: Teachers and students shall make summary and feedback; teachers shall learn about students' learning situation and provide corresponding guidance.**

Based on problems occurring in learning and homework finished by students, teachers shall evaluate students' performance and make retrospection and summary on the teaching process to provide references for the design and organization of the subsequent lessons, making their teaching process better and better. According to teachers' guidance and evaluation, students could conduct review with specific targets and make summary and feedback on their learning timely to gather self-experience for the follow-up effective learning and to promote the establishment of individual knowledge system.

### 3. Practice Effect of Flipped Classroom Based on MOOC in Linear Algebra Teaching

The author applies this mode to an Energy and Power Class of 2016 (the experimental class) in the Linear Algebra teaching. Throughout the teaching process, the teaching activities are designed according to the learning degree of students as well as the features and content of this course, and students are instructed to make full use of MOOC resources to carry out Flipped Classroom teaching mode. An Electrical Automation Class is set as the control class for the similar average scores in the College Entrance Examination and almost the same number of students. Using same textbook and outline, these two classes are taught by the same teacher (the author) with same class hours. After a semester of practice, the analysis and distribution of their final examination scores is shown in Table 1 and Figure 2.

Table 1. Analysis of examination scores of experimental class and control class

Class (class size)	examination scores			excellent scores (90 -100 points)		Passing scores (>60 points)	
	highest score	lowest score	average score	student numbers	percentage	student numbers	percentage
Experimental class (86)	98	46	86	16	19%	80	93%
Control class (90)	96	27	78	10	11%	74	82%

The analysis of final examination results shows that the average score of the experimental class is about 8 points higher than that of the control class, the excellent rate is about 8 percentage points greater than that of the control class, and the pass rate is about 11 percentage points greater than that of the control class. These data indicate that, under MOOC environment, the Flipped Classroom teaching mode is helpful in improving the overall learning effect. In addition, the examination results of these two classes are in a normal distribution with a similar proportion of both high mark range and low mark range. The scores of experimental class mainly fall in the range of 75-95, exceeding half number of the whole class. The scores of controlling class mainly distribute in the range of 70-85, nearly half number of the whole class. This shows that the Flipped Classroom teaching mode under MOOC environment is conducive to the progress of learners at the original stages.

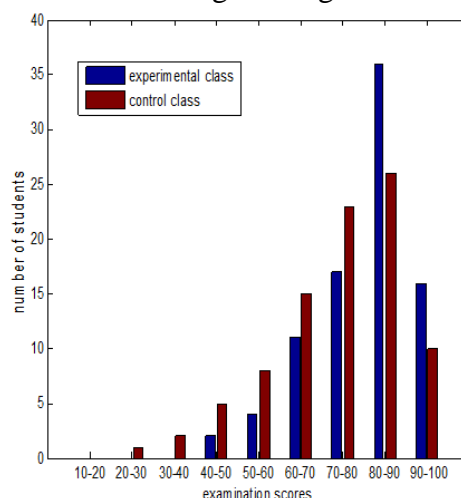


Figure 2. Distribution of examination scores of experimental class and control class

The result of a questionnaire survey conducted in the experimental class suggests that 94.5% of the students recognize Flipped Classroom teaching mode under MOOC environment because they can make preview before class through MOOC videos and questions raised in the preview can be recorded.

In the classroom, a face-to-face communication and discussion between students and teachers as well as between students themselves can be organized to answer these questions, enhancing students' autonomous learning capability and cultivating their learning interest. Students are also allowed to watch MOOC videos repeatedly after class according to their own needs for keeping their different schedules. By this, a personalized learning is truly achieved.

#### 4. Conclusion

Linear algebra is not only a basic course of other disciplines, but also a key course in developing students' logical thinking, innovation ability and comprehensive quality. MOOC and Flipped Classroom have changed the way and mode of traditional teaching. Under MOOC environment, the integration of Flipped Classroom into linear algebra teaching has following advantages. It makes students become the main role of teaching activity and trains students' autonomous learning capability; it promotes the fulfillment of individualized teaching and encourages teachers to teach students in accordance with their aptitude; it enhances the communication between teachers and students and allows teachers to acquire feedback timely, gradually improving their teaching process. In a word, the Flipped Classroom teaching mode based on MOOC promotes the reform of linear algebra teaching, optimizes the outcome of linear algebra teaching and increases teaching efficiency.

#### Acknowledgements

This paper was financially supported by the Fund of Teaching Reform Project of Northwest Agriculture and Forestry University in 2017 (No.GY1703119 and No.JY1703084).

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