Frontiers in Educational Research
ISSN 2522-6398 Vol. 3, Issue 1: 1-6, DOI: 10.25236/FER.2020.030101

"Student Centered" Teaching Reform and Practice for Linear Algebra

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ABSTRACT. *In order to improve the learning effect of students and effectively promote the long-term development of them, combined with the characteristics of linear algebra course and various problems of students in the past teaching process, adhering to the teaching concept of "student centered", we have carried out effective reform and practice in the whole teaching process from the aspects of knowledge reconstruction, individualized teaching, group teaching, process management, etc.*

KEYWORDS: *Student centered, linear algebra, individualized teaching, group teaching*

1. Introduction

As one of the three basic mathematics courses in colleges and universities, linear algebra is characterized by the abstractness of the theory, the wide range of applications, the complexity of calculations, and the dependence on computers. Because of its abstract theory and monotonous, mechanical, and boring operations, students often feel that linear algebra is difficult to understand and boring during the learning process. Although linear algebra is widely used, it is highly abstract in theory and highly dependent on computers. Therefore, in the actual teaching process, since there are less teaching hours, teachers tend to focus more on the rigor of logical reasoning and the integrity of the knowledge system, and ignore the application of the knowledge given in practice. This created a sense of fear in many students' learning process. Some students even said that "math is useless."

In our college, linear algebra was introduced in the first semester of sophomore year. During this period, students have adapted to the teaching methods of the university. Their logical thinking ability has been greatly improved. They desire to really understand mathematics, not only to acquire the mathematical knowledge needed for subsequent courses, but also to acquire the ability to solve problems independently. At the same time, when entering the second year of university, some students were not as serious as in the first year. They began to relax many courses, and their learning initiative declined.

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How to mobilize students' driving force in learning so that they can better grasp and understand the basic theories and methods of linear algebra, and then train and exercise their ability to analyze and solve problems is a problem we need to solve urgently. In the actual teaching, we uphold the "student-centered" teaching concept, and fully consider and design the entire teaching process.

2. Concept of "student-centered" reform

The so-called "student-centeredness" reform has three central concerns: student development, student learning and learning outcomes. This is different from the traditional teaching model centered on "textbooks, teachers, and classrooms"[1]. Students are the main body of teaching activities. The purpose of education is to learn, but not to teach. Therefore, we should aim to promote the comprehensive development of each student, explore the potential of students, make them responsible for their own learning, develop their ability to learn actively and autonomously, and then improve the learning effect effectively. For this reason, we have vigorously reformed and practiced the entire teaching process.

3. Reform and practice

3.1 Knowledge reconstruction

Linear algebra mainly includes determinants, matrices, systems of linear equations, vector theory, similar matrices, and quadratic forms, etc.[2]. The correlation between the contents of each part is not obvious, so students often feel that there are a lot of knowledge points in the learning process. For this reason, we reorganize the knowledge points, take the solving of the linear equations as the main line, and connect all the knowledge points in an orderly, rational, and well-documented manner (see Figure 1). At the beginning of the course, this figure is presented to the students, so that they can easily grasp the main line of knowledge during the learning process and better understand the mathematical ideas of each knowledge point. By the end of the lesson, this small figure can be perfected into a huge mind map by students, so that each knowledge point is better grasped.

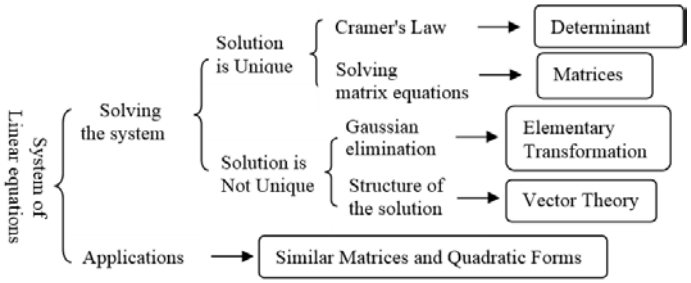

Figure. 1 Knowledge Restruction of Linear Algebra

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3.2 Teach by aptitude

In the actual teaching process, based on the principle of "student-centeredness", the course design starts from understanding the students. Based on the students' professional expertise and hobbies, find and design teaching cases suitable for students, and use this as a carrier to enhance students' learning interest, narrow the distance between classroom teaching and reality, and then change the students' view that "math is useless". Implement the principle of teaching students according to their aptitude into practical teaching.

Carefully designing application cases that the students' majors learn about or are closely related to, it is easier to mobilize the enthusiasm of class discussion and the initiative of students to think. By applying practice on professional issues, it can better show the application value of linear algebra. The necessity of learning ultimately leads to the autonomy of students' learning and the continuity of knowledge construction [3]. Application cases can be further complicated for extension assignments. Through discussions on extension issues, not only can they effectively consolidate students' knowledge of the curriculum, but they can also develop their ability to analyse and solve problems.

For example, when learning matrix multiplication, students with mechanical related majors can start with the control of robot arm movement: the definition of matrix multiplication is introduced from the motion control of a one-degree-of-freedom robotic arm; through calculation of special examples, operation law of matrix multiplication are found; using MATLAB to demonstrate the control effect of the matrix multiplication on the manipulator; leave the control of the two-degree-of-freedom manipulator as an extended topic. Students can give the control matrix in the class and use MATLAB to implement it. Starting from simple application cases, deepening layer by layer, gradually deepening students' understanding, and guiding students to establish a "practical problem-building model-analytical model-solving problem" thinking mode. Through this way of teaching, students' ability to use existing knowledge to solve practical problems is cultivated in the subtle way.

3.3 Application of group discussion

The group discussion method is used in the completion of case analysis and expansion. First of all, students form groups voluntarily with 4-6 members each group, find out the commonality of problems through the common analysis of cases, and then refine the important mathematical ideas to obtain the theoretical knowledge of this course. Second, complete the expansion work in groups. Due to class time constraints, the content of this section is mainly completed after class, and the teacher is responsible for supervision. Through the division of labor and collaboration between group members, group work can be completed efficiently and on time, and students' teamwork awareness can also be strengthened.

Based on past practical experience, the following points need to be paid special attention to during the implementation of the group discussion method. First, as the

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designer and organizer of the group activities, the teacher need to pay more attention on the choice of cases. How to find application cases that match the majors and make the basic course more effectively support the development of new engineering disciplines is the challenge we face. In this regard, we have strengthened the dialogue and exchanges with teachers of professional courses, so as to understand the application cases that are closely related to the content of our courses in professional development, so that students can better understand the supporting role of the course of linear algebra on subsequent professional courses, and inspire their internal driving force for learning. Secondly, in order to prevent students from “loaf on the job” and “free-riding” in group activities, we asked group members to divide their labors and submit a detailed list of division of labor. We also require the team members to take turns to report. When asking questions, we can also be targeted according to the division of labor and strive to take into account each classmate. Finally, in order for the group activities to proceed smoothly and to effectively ensure the quality of the job completion, team building is essential. A simple group activity, such as naming a group, can quickly establish students' team awareness, enhance cohesion, and lay a good start for the subsequent group activities.

3.4 Use mobile teaching methods to assist teaching

In the teaching process, using the Cloud Class and Maple T.A. online assessment system to assist teaching.

(1) Cloud Class is a free mobile teaching platform for teachers and students. You can easily manage and learn your class on PC and any mobile device such as mobile phones and tablets. Teachers can sign in through this platform, send notifications, share resources, arrange modification assignments, organize discussions and answer questions, and carry out teaching interactions. In normal teaching, we especially pay attention to the interactive function of teaching. Interactive teaching activities such as voting questionnaires, brainstorming, and timed answering are used to investigate students' learning results.

(2) Online test and scoring system Maple T.A. is an internet-based online test and scoring system. Maple T.A. provides tools such as user database, WYSIWYG test question creation environment, different types of test task settings, proctor browser, automatic scoring engine, student performance statistics analysis, system management, and distributed post-processing engine, provide users with the ideal online examination platform. We use Maple T.A.'s powerful functions to arrange assignments for students every day. Specifically, each question is set with parameters. Different students see the same question types with different parameters, which achieves different questions for different students and is very conducive to detecting the real learning situation of students.

The Cloud Class and Maple T.A. online assessment system are new interactive modes of instant teaching in a mobile environment that our school strongly supports. For teaching activities, immediate feedback and immediate comments can be made. It is not only conducive to students 'self-evaluation, but also to teachers' timely

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teaching evaluation and teaching reflection. Contemporary college students as electronic natives have a strong interest in online activities. Online quizzes and online assignments can quickly attract their attention, and more importantly, allow teachers to quickly and timely understand the students' grasp of the knowledge they have learned.

3.5 Strict and transparent process management

On the premise that the final exams account for 60% and the usual grades account for 40%, we evaluate the usual grades according to classroom performance, offline assignments, online assignments, extended assignments, and MATLAB laboratory assignments. The classroom performance is assessed by the cloud class classroom test; offline assignments are reviewed by teachers to focus on correcting students' writing and logical specifications; online assignments are Maple T.A. online assignments, which are automatically graded by the system and give detailed feedback; Assignments are group assignments; MATLAB lab assignments are completed through the MATLAB grader system, with automatic grading and support for multiple modifications.

In the actual teaching process, regardless of classroom exercises, classroom tests, or after-class assignments, experimental assignments, group assignments (extended assignments), etc., all grades are reported in a timely manner, and students can learn about their usual grades in time, which is conducive to students self-restraint, complete assignments in a timely and earnest manner.

4. Effect feedback

By implementing the "student-centric" teaching paradigm reform in linear algebra classrooms, students' enthusiasm for learning has been greatly enhanced. Through a questionnaire survey of students, more than 85% of students support this teaching method; 78% of students expressed that they can appreciate some important ideas and methods of linear algebra, and 83% of students said they recognized the importance of linear algebra in their professional courses.

5. Conclusion

In the teaching process, we must actively learn advanced teaching concepts, integrate advanced teaching ideas into each lesson, and continue to summarize teaching experience and modify teaching methods and teaching content in order to bring continuous growth and progress, keeping pace with the times , and adapt to modern university education, so as to effectively ensure teaching results and improve teaching quality.

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Acknowledgments

This work was supported by Student-centered Teaching Paradigm Reform Project of Beijing Institute of Petrochemical Technology (No. ZDFSGG20190803).

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