The Development and Application of an Intelligent PAD Class for Linear Algebra Teaching in Universities

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Abstract
PAD (Presentation-Assimilation-Discussion) Class is an innovative teaching mode, and *Mosotech* is an intelligent teaching tool adapted to mobile Internet and big data. This paper integrates the two to construct an intelligent PAD Class that injects vitality into linear algebra teaching and arouses students' initiative and autonomy, thereby improving the efficiency of both learning and teaching.
Keywords: Intelligent Teaching, Linear Algebra, *Mosotech*, PAD Class

1. Introduction

Linear algebra is an important basic course for science and engineering majors in universities in China and abroad. It not only provides necessary mathematical knowledge and tools, but also helps improve students' core mathematical qualities, such as abstract thinking, logical reasoning and calculation. Current linear algebra classroom teaching, however, still adopts the traditional teaching mode, dominated by blackboard writing and PowerPoint presentations, with teachers imparting knowledge that students passively accept. This mode does not address students' understanding and absorption of the material; lacks teacher-student interaction; and makes the classroom atmosphere dull and uninspiring. In the long term, this may mean that students gradually lose their interest in learning, and fail to meet developmental requirements(Wang & Han 2022). To improve teaching quality, the author introduced the PAD class teaching mode to linear algebra teaching in universities. The presentation of the concept was highly condensed, and the class was quickly returned to the students. The *Mosotech* intelligent teaching platform was used to organize and manage the class, stimulate and enhance the students' learning enthusiasm and autonomy, and improve the efficiency and effect of teaching and learning.

2. PAD Class and *Mosotech* Platform

2.1 PAD Class

PAD Class is a new mode of classroom teaching, proposed by Professor Zhang Xuexin of Fudan University in 2014(Zhang 2014). Its core concept is to allocate half the class time to teacher presentation and the other half to students, for free discussion and sharing. Presentation and discussion times are staggered, so students can learn independently in the interval between the two presentation stages; internalize and absorb the information they receive; and prepare fully for class discussions. The implementation of PAD Class is therefore divided into three processes: presentation, assimilation and discussion. In the former, the teacher explains units of knowledge according to a framework, clarifies the key points, and breaks down the difficulties, laying a foundation for students to learn independently and internalize the knowledge they receive. In assimilation, students engage in personalized independent learning, which is the key to successful realization of the PAD class method. At this stage, they deeply absorb and refine knowledge points, complete homework and discussion topics assigned by teachers, and prepare for class discussion. Students are then divided into groups, in which they share and exchange learning content and discussion topics from the last class, and form group opinions. Representatives of each group take turns to elaborate conclusions, and have a second discussion. In this way, PAD Class gives full play to students' autonomy and spirit of exploration, and improves learning enthusiasm and teaching outputs (Yang et al, 2015). In recent years, college professors in China have favored this method, and increasing numbers of teachers have applied its educational concept to undertake educational reforms(Liu 2020).

2.2 The Mosotech intelligent teaching tool

Intelligent teaching tools are cloud service platforms that use devices such as smart phones and tablets to carry out timely feedback-driven interactive teaching inside and outside the classroom, via mobile Internet networks(Qiu et al, 2018). They include *Mosotech*, *Rain classroom*, and *MOOC*. The author of the present paper often uses *Mosotech* to conduct daily teaching activities. With it, teachers can distribute course information, learning requirements, courseware, micro-videos and other learning resources before class; use interactive teaching functions such as hand-raising, quick answer, screen display, brainstorming, and tests during class; and

post-teaching tasks, such as homework, discussion topics, and online testing. *Mosotech* can track each student's progress and evaluate individual learning effects, and allows students to develop independent thinking, learning, communication, sharing and self-management skills.

Both PAD Class and *Mosotech* adhere to the "student-centered" teaching concept; cultivate students' learning, research and thinking abilities; and improve the learning effect. The results of this paper are an important contribution to the practical application of PAD Class to the teaching of linear algebra, and can be referenced to improve the quality of talent training.

3. Applying intelligent PAD Class to linear algebra teaching

This study combined the *Mosotech* platform with the PAD class educational concept, and applied it to the linear algebra teaching of several classes in the Spring semester of 2023 at our school. Linear algebra is taught for 3 class hours once a week, in a face-to-face classroom session. Its Matrix Concept and Basic Operation unit is usually completed in 3 class hours. Because it contains many new definitions and symbols that are easily confused, students need time to absorb and organize this information before they can deeply understand the concept and calculation method. This unit could therefore be designed for separated PAD Class teaching. In the second half of the first lesson, the teacher presented the new PAD Class material, which occupied one and a half class hour. Students then internalized and absorbed the knowledge they learned, and completed the homework and discussion questions independently over the course of a week. In the first half of the second lesson, they discussed the materials within and among their groups, and the teachers commented on their findings, summarized the information imparted, and answered questions. The specific implementation of the PAD class is described in the remainder of the section.

3.1 Presentation

Because their classroom presentation time was halved, teachers needed to design the teaching content carefully, and use intelligent teaching tools to improve efficiency. They needed to give students a general idea of the body of knowledge to be learned, by concentrating on the syllabus, framework and key points, but also address known areas of difficulty. Specifically, because the class was Matrix Concepts and Basic Operations, teachers focused on the concept of the matrix; and the definition and operational properties of matrix addition, number multiplication, matrix multiplication, matrix power and matrix transposition. They selected typical examples that illustrated the essence of matrix operation, and its similarities and differences to real number operations. These examples were few and precise, and fundamentally explained or derived ideas. The explanation of theorems focused on the elaboration of ideas, and the process of proof was not specifically taught; this left space for students to learn and think independently; made the classroom teaching content more compact, coherent and easy to understand; and helped students form a mind map of the unit's knowledge system.

Teachers used the *Mosotech* platform for efficient class planning. Before teaching, they released a 3–5-minute mind map animation, to help students preview the content before class. During teaching, a fast-paced system was used—including raising hands, answering quickly and brainstorming—to interact with students effectively, and improve their enthusiasm for classroom learning. At the end of the class, teachers published homework and discussion questions quickly, and were open to receiving student feedback at any time.

3.2 Assimilation

The teacher's presentation gave students a basic idea and framework of knowledge for the concepts being taught, and raised problems to be solved. Since the speed and method of internalization is different for each student, sufficient time was set aside between presentation and discussion for students to absorb and digest knowledge.

Students added details to the broad knowledge framework presented by their teachers. This included obtaining a more detailed and in-depth understanding and analysis of matrix concepts and operational property theorems, and practicing matrix multiplication and other operational methods and skills to master the algorithm rules. First, students deeply studied and thought about what they learned, by, for example, reading their textbooks independently, studying micro-lesson videos, and consulting internet resources. Second, they completed their homework independently, to deepen their understanding of concepts and theorems and master their learning methods. Unlike the traditional teaching mode, PAD Class requires students to answer discussion questions assigned by the teacher. In this case, these were: (1) How can the traffic routines among four cities with a matrix be described and compared? (2) Can matrix multiplication satisfy commutative and elimination laws? (3) How can any n-order matrix be expressed as the sum of symmetric and antisymmetric matrices? The design of these discussion questions was based on the teachers' own professional knowledge and teaching experience.

To help students learn more effectively after class, teachers uploaded learning resources (such as courseware and micro-lesson videos in the resource pool; appropriate homework or exercises in the homework area; and relevant topics in the discussion area) and opened the live broadcast and comments functions to

facilitate student feedback. Through the *Mosotech* platform, teachers were able to guide students, and help them learn independently in a timely and effective manner. They could also monitor and evaluate students' homework completion, and promote the quality of their after-school learning.

3.3 Discussion

PAD Class' innovation is in its separated class discussions; after their preparation in the assimilation stage, students are able to participate in these discussions as protagonists. In such an interactive atmosphere, they can express their opinions and help each other stimulate the reorganization and construction of knowledge; cultivate critical thinking; and develop their teamwork and communication skills.

In the first round of discussions, students addressed the teacher-assigned questions in their groups. They took it in turns to share their answers and then discussed them with the group, thereby inspiring each other. At this stage, students raised the issues they had, and questioned and answered each other to find their shortcomings, share the learning experience, and improve together. A group representative was chosen to make a summary statement and ask the teacher for comments. The teacher then set the common problems proposed by each group as the topic of the second inter-group (whole class) discussion; selected several students at random to present the results of the discussion; answered questions and summarized results; corrected students' thinking biases; and pointed out the correct solution methods. Each group was then asked to give complete written answers to all the questions discussed, and upload them to *Mosotech* for review before the next class.

Teachers can use the *Mosotech* platform to strengthen the organization and guidance of classroom discussion activities, by, for example, using the group plan to divide the class into smaller groups of 4–8 students, each of which selects a representative who can upload group discussion opinions, and use the screen projection function to display the group work. The hand-raising or quick-answering function can be used to encourage students to initiate inter-group discussion, and to collect and comment on the final written answers to the discussion questions. Students' participation in interactive activities such as class check-in, speeches, quizzes and homework results are stored in the *Mosotech* system in the form of experience values, which is convenient for teachers in the processes of assessing individual students' work, and obtaining average grades.

4.Teaching feedback

The intelligent PAD Class for linear algebra greatly stimulated students' learning interest and autonomy. The Intelligent PAD Class Teaching Satisfaction Survey showed that more than 85 percent of students in this study found that the content presented by the teacher helped them understand key points and areas of difficulty, and build a basic knowledge framework; more than 83 percent found the assimilation process helpful in improving independent thinking, problem solving and generalization; 78 percent found that classroom discussions helped stimulate the reorganization and construction of knowledge, strengthened understanding, and improved learning efficiency; and 85 percent were able to use *Mosotech* skillfully and believed that intelligent teaching tools could improve classroom organization and assessment, and therefore teaching efficiency. The results of the survey show that the teaching experiment was fundamentally effective, and achieved the goal of teaching reform.

5.Conclusions

The Intelligent PAD Class is a new innovation in the reform of teaching methods. Based on the traditional teaching mode, it improves student participation by adding peer-to-peer discussion; addresses the deficiencies of the traditional teacher-centered educational mode; and introduces an intelligent teaching tool to efficiently organize teaching activities and build an independent learning environment. The study's realization of process assessment reflects the student-oriented teaching concept, and its application shows that the Intelligent PAD Class is conducive to improving the effect and quality of teaching, and can stimulate and mobilize students' learning enthusiasm. It should be explored further through bold research and timely summaries, to provide continuous innovation and gradual improvement.

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