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Application Research of SPS Case Sandbox Teaching Method in Linear Algebra Teaching

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Abstract: The paper introduces the sandbox SPS case teaching method and the necessity of using in classroom teaching in linear algebra, and in the case of classroom teaching practice, to verify the sandbox SPS case teaching method can not only effectively enhance the teaching effect in linear algebra class, also greatly improve the students' team cooperation ability and the ability to solve the problem.

1. Introduction

The application of SPS case sandbox teaching in engineering management and engineering technology has been many, but the application in mathematics course teaching process is rare. Linear algebra is a mathematics course with strong applicability, and it is essential to solve practical problems and the application of discipline competition -- mathematical modeling competition. Since the SPS case sandbox teaching method can effectively combine classroom teaching and case practice together, and can effectively improve students' hands-on ability, it is necessary for us to apply it in the teaching process of linear algebra, and then generalize.

SPS is a general term of Structured, Pragmatic and Situational. Case is the form, sandbox is the environment, teaching is the goal, SPS is the principle and concrete operation, specifically, SPS case sandbox teaching will be teaching and concrete practice, experiment or social practical problems together, through solving practical problems to achieve the purpose of cultivating students' ability.

2. Main Contents of the Study

From the practical operation level of linear algebra course, let students use the knowledge to solve practical problems, so as to bridge the gap between universities, students and society. According to the characteristics, objectives and basic needs of the specific chapter content of linear algebra course, appropriate practical cases are selected, a brief case guide is prepared, the core needs are decomposed into specific key thinking points, as the implementation link to guide students to practice; Group the students into groups. Group members form associations with the background, current situation, core themes, key thinking points and relevant reference data of the case, face and solve practical problems, and make plans; The implementation and implementation of specific solutions may involve the application of multidisciplinary and interdisciplinary knowledge, and often the results of different student groups will be different, which is the significance of teaching, ability training and innovative pre-research. Summarize the problems and shortcomings of each group in the whole case practice, and give specific guidance for these problems to help students grow.

3. Implementation of SPS Case Sandbox Teaching Method in Linear Algebra Course

3.1. Chapter Selection

This paper introduces the application of linear equations in the textbook Linear Algebra published by Beijing Institute of Technology.

3.2. Instructional Design

3.2.1. Status and Role

This section is the continuation and deepening of linear equations, which lays a foundation for mathematical modeling and serves as a link between the preceding and the following. This lecture will explore further the application of systems of linear equations, which are very important in this chapter and in linear algebra as a whole.

3.2.2. Analysis of Learning Situation

There are two levels of differentiation in the basis of students, their thinking level is uneven, and their ability to understand and apply knowledge is slightly inadequate. In teaching, it is necessary to consider the learning feelings of students at different levels, divide students into groups, make more students participate in learning and stimulate their interest in learning through question guidance and inquiry teaching.

3.2.3. Teaching Key and Difficult Points

Teaching focus: the application of linear equations.

Teaching difficulties: list reasonable linear equations and solve them according to practical problems.

3.2.4. Teaching Objectives

Knowledge objective: Application of linear systems of equations.

Ability objective: the solution of linear equations.

Emotional goal: to cultivate students' spirit of in-depth and meticulous research.

3.2.5. Teaching Process

a) Create a situation and introduce a new lesson;

b) Organize students to explore independently and list reasonable equations;

c) Through examples and exercises, improve students' grasp of the application of linear equations.

3.2.6. Teaching Effect

In the teaching process, we pay attention to students' learning situation, organize classroom teaching reasonably, students actively participate in, master effective learning methods, and achieve the teaching objectives in knowledge, ability and emotion.

3.3. Review

Solution of inhomogeneous linear equations.

3.4. Introduction of New Lessons

A manufacturer produces three different chemical products A, B, and C. Each product must be produced by two machines M and N, which can be used for A maximum of 80 hours per week and N for A maximum of 60 hours per week. However, it takes two different machines different time to produce each meal, as shown in the following table

Table1: Product time table

machine	Product A	Product B	Product C
M	2	3	4
N	2	2	3

Analysis: Assume that the manufacturer can sell all the products it makes in a week. Operators do not want to idle expensive machines, so they want to know how much each product needs to be made in a week to make the machines fully utilized. We can set x_1、 x_2 and x_3 respectively to represent the tonnage of product A, B and C produced in A week.

Teacher: In order to make full use of the machine, how much time can machine M be used in a week?

Group discussion results:

$$2x_1 + 3x_2 + 4x_3 = 80$$

Similarly, students discussed that the actual time of machine N being used in a week can be expressed as

$$2x_1 + 2x_2 + 3x_3 = 60$$

Students list the required equations for this production planning problem

$$\begin{cases} 2x_1 + 3x_2 + 4x_3 = 80 \\ 2x_1 + 2x_2 + 3x_3 = 60 \end{cases}$$

The augmented matrix of the equations is transformed into the simplest form of the row

$$\tilde{A} = (Ab) \to \begin{pmatrix} 1 & 0 & \frac{1}{2} & 10 \\ 0 & 1 & 1 & 20 \end{pmatrix}$$

The original system of equations is equivalent to

$$\begin{cases} x_1 + 0.5x_3 = 10 \\ x_2 + x_3 = 20 \end{cases}$$

The solution to the system is

$$\begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} 10 \\ 20 \\ 0 \end{pmatrix} + k \begin{pmatrix} -1 \\ -2 \\ 2 \end{pmatrix}.$$

Teacher: Is the value of k unique in order for the variable to be a positive integer?
Student: The value of k is not unique.
Teacher : if take k=5 can get what result?
The students calculated:

$$x_1 = 5, x_2 = 10, x_3 = 10$$

This results in A production plan that produces 5 tons of product A, 10 tons of product B, and 10 tons of product C within A week.

3.5. New lesson

Suppose you are an architect, and an apartment is to be built in a community. Now you need to design a modular construction plan. According to the basic floor area, each floor can have three plans for setting the apartment type, as shown in the table below. Is it feasible to design 136 one-bedroom units, 74 two-bedroom units and 66 three-bedroom units? Is the design unique?

Table2: Plan table

plan	one-bedroom unit	two-bedroom unit	three-bedroom unit
A	8	7	3
B	8	4	4
C	9	3	5

Each floor of the apartment adopts the same plan.x_1 floor adopts plan A,x_2 floor adopts plan B, and x_3 floor adopts plan C

$$\begin{cases} 8x_1 + 8x_2 + 9x_3 = 136 \\ 7x_1 + 4x_2 + 3x_3 = 74 \\ 3x_1 + 4x_2 + 5x_3 = 66 \end{cases}.$$

The rank of coefficient matrixAand augmented matrix $B = (Ab)$ can be obtained by elementary row transformation of the augmented matrix:

$$r(A) = r(B) = 2 < 3$$

The equations corresponding to the matrix are:

$$\begin{cases} x_1 = 2 + \frac{1}{2} x_3 \\ x_2 = 15 - \frac{3}{8} x_3 \end{cases},$$

Take x_3=c (c is an integer), then all the solutions of the equations are:

$$\begin{cases} x_1 = 2 + \frac{1}{2} c \\ x_2 = 15 - \frac{13}{8} c \\ x_3 = c \end{cases}$$

x_1, x_2, x_3 is a positive integer, so the system of equations has a unique solution

Therefore, the design scheme is feasible and unique. The design scheme is as follows: plan A is adopted for 6 floors, plan B is adopted for 2 floors and Plan C is adopted for 8 floors.

3.6. Classroom exercises

A pharmaceutical factory produces 3 kinds of proprietary Chinese medicine, and the production of each proprietary Chinese medicine goes through 3 workshops. The weekly working hours of the three workshops and the number of working hours required by each Chinese patent medicine in each workshop are shown in the table below. What is the weekly output of each of the three Chinese patent medicine?

Table 3: Chinese medicine time table

	Chinese medicine1	Chinese medicine2	Chinese medicine3	weekly working hours
workshop1	1	1	2	40
workshop2	3	2	3	75
workshop3	1	1	1	28

Results: Set the weekly output of 3 kinds of Chinese patent medicine as x_1、x_2、x_3 respectively,we get

$$\begin{cases} x_1 + x_2 + 2x_3 = 40 \\ 3x_1 + 2x_2 + 3x_3 = 75 \\ x_1 + x_2 + x_3 = 28 \end{cases}$$

The elementary row transformation of the augmented matrix is transformed into a simplified row ladder matrix, and

$$(Ab) \to \begin{pmatrix} 1 & 0 & 0 & 7 \\ 0 & 1 & 0 & 9 \\ 0 & 0 & 1 & 12 \end{pmatrix}$$

It follows from this that

$$\begin{cases} x_1 = 7 \\ x_2 = 9 \\ x_3 = 12 \end{cases}$$

So the weekly output of the three kinds of Chinese patent medicines is 7, 9 and 12 pieces respectively.

3.7. Homework

Questions 10 and 13 on page 54.

4. Conclusion

The application of SPS case sandbox teaching method in linear algebra teaching, first of all, changes the role of educator and educated, teachers guide students through knowledge exploration and application practice, and then organically combine students' curriculum learning, social needs and technology development; Secondly, the education "teacher center, book center, classroom center" into "student center, experience center, activity center". Moreover, let more people feel the charm of SPS case sandbox teaching method, and successfully use this teaching method in teaching practice, so that the education and management of human resources can not only quickly adapt to changes, but also be proactive to meet the future.

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