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Exploration of Integrating Mathematical Culture into the Teaching of Linear Algebra

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Abstract: ***Linear algebra is an important foundational course in universities. This article integrates mathematical culture into the teaching of linear algebra, some attempts are made from four aspects: mathematical thoughts and methods, the history of mathematics, mathematics and other disciplines, and mathematical aesthetics, it enhances students' interest in learning, and then cultivates their mathematical thinking ability and problem-solving ability.***

Keywords: Linear Algebra, Mathematics Methods, Mathematical thought and Methods, the History of Mathematics**.**

1. Introduction

Linear algebra is an important foundational course in science and engineering colleges. The teaching of linear algebra is taught in large classes, with a few class hours, abstract and difficult to understand, and complex calculations. Students have low interest in learning and poor self-discipline. The traditional teaching model is teacher directed, focusing on teaching knowledge and neglecting the integration of mathematical thinking methods. Emphasis is placed on teaching of theory, while neglecting the practical application of theory and the connection between mathematics and other disciplines. Students are unable to master the concepts, theories, and methods of linear algebra systematically. We integrate mathematical culture into the teaching of linear algebra to improve students' interest in learning and enhance their comprehensive ability.

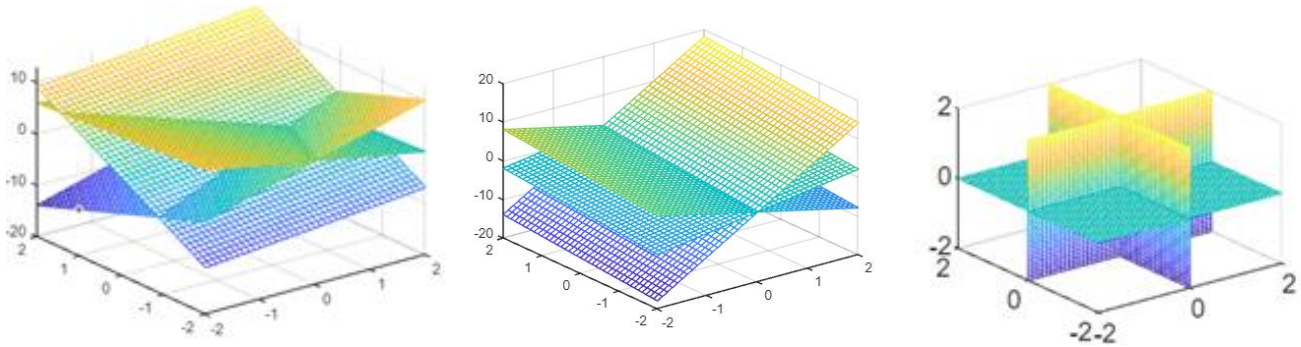
The concept of mathematical culture was first introduced by R. L. Wilder, while M. Kline pushed mathematical culture to a climax, followed by rapid development of mathematical culture. In recent years, Professor Gu Pei of China has conducted more than a decade of research and practice on mathematical culture, pointing out that "the connotation of mathematical culture, in simple terms, refers to the ideas, spirit, methods, viewpoints, and their formation and development of mathematics. Broadly speaking, in addition to the above connotations, it also includes mathematicians, the history of mathematics, beauty of mathematics, mathematical education, the humanistic components of mathematical development, the connection between mathematics and society, and the relationship between mathematics and various cultures [1]." This article discusses the integration of mathematical culture into the teaching of linear algebra, which help students understand the cultural background of knowledge, understand and master the knowledge systematically, and understand the application of linear algebra in other disciplines, then it can improve comprehensive abilities of students. We will explore mainly from the following aspects.

2. The Integration of Mathematical Thoughts and Methods

Linear algebra is very abstract and there is more logical thinking. Not only concepts of linear algebra are abstract, but their thoughts and methods are also abstract, and their logic is also very rigorous. Students who starting to learn this subject will fell fear and lose interesting in this subject. In the teaching process, we permeate the mathematical ideas involved, allowing students to go from understanding to application, so we help them better understand the knowledge system of linear algebra and improve their mathematical thinking ability. Such as reduction, analogy, deduction, classification, and the combination of numbers and shapes and so on.

The idea of reduction is the most basic way of thinking in mathematics, which is used to convert complex problems into simple problems. By reducing, higher-order is reduced to lower order, and abstraction is reduced to concrete. For example, we can transform the linear representation of vector set into a solution to a non-homogeneous linear equations, we can transform the solution to a linear equation into an elementary row transformation of a matrix, and we can transform the calculation of a determinant into an upper triangular determinant, and the problem of transforming a quadratic form into a standard form is transformed into a diagonalization of a symmetric matrix. By infiltrating mathematical ideas, students can grasp the essence of problems through phenomena, and their creative thinking is also inspired.

The combination of numbers and shapes is a method of combining algebra and geometry. For example, the concept of linear algebra is relatively abstract. By introducing the geometric meanings of concepts such as determinants and eigenvectors, students can be better to understand the concepts. For example, linear equation systems are the core content of the course. When learning the criteria for determining the solution of a system of linear equations, we can take a system of three variable linear equations as an example. From a geometric perspective, a system of three variable non-homogeneous linear equations can be considered as the intersection of three planes. Through geometric demonstrations of three scenarios (see figure below), students can grasp this conclusion.



3. The Integration of Mathematical History

The history of mathematics studies the origin and development of mathematical concepts, methods, and ideas. Learning the history of mathematics can help students understand the background knowledge of linear algebra and the real process of creation. Inspiration can be gained from learning, which is of great significance for our future learning. Integrating the history of mathematical into teaching not only enhances learning interest and promotes students' understanding of mathematical knowledge, but also helps students have a macro understanding of this course, develops mathematical thinking of students, and shapes correct values of students [2].

For example, determinants are the most basic content in linear algebra, first proposed by Japanese mathematician Guan Xiao and German mathematician Leibniz respectively [3]. In 1750, Swiss mathematician Kramer obtained the Kramer's rule for solving linear equations using determinants. In 1771, French mathematician Vandermonde studied determinants and expanded them using second-order and cofactors. Later, Laplace extended VanderMonde's method, which is still used today as the Laplace theorem. By introducing the origin and development of determinants, students' interest in learning has been enhanced, and they have gained a clear understanding of determinants. In addition, it is also possible to intersperse the stories and biographies of mathematicians, and adapt problems based on the history of mathematics, reconstruct and reproduce the natural process of knowledge, hence we can cultivate students' spirit of courage. The integration of mathematical history has greatly improved learning effectiveness and deepened understanding of knowledge. We can widen field of vision and cultivate students with a persistent scientific attitude through the power of role models.

4. Mathematics and Other Disciplines

Linear algebra has strong applicability and has penetrated into various disciplines and fields of life. It is necessary to apply the knowledge of linear algebra to other disciplines. This can not only help students better understand the knowledge they have learned and cultivate their comprehensive practical abilities, but also promote the development of the discipline and cultivate outstanding interdisciplinary talents. For example, we can introduce concepts through the introduction of cases. For example, matrix linear operations are introduced through digital image processing, linear equation systems are introduced through balancing chemical equation, and the concept of eigenvalues is introduced through spotted owls and dynamical systems. After class, group assignments can also be left for students to experience the application value through group cooperation and project-based learning, and enhance their comprehensive application and innovation abilities.

5. The Integration of Mathematical Aesthetics

Mathematics is both a science and an art. In addition to its logical rigor, there is also unique beauty. The beauty of mathematics is not only the beauty of form, but also the beauty of the realm of thinking. The beauty of mathematics includes the beauty of simplicity, unity, symmetry, singularity, and other aspects. For example, when learning determinant, we must pay attention to the beauty of unity, symmetry, and conciseness in the form of determinant. When learning the Vandermonde determinant, experience the beauty of unity and simplicity. It is necessary to incorporate mathematical beauty into the teaching of linear algebra. It can enable students to experience the unique charm of mathematics, enhance their aesthetic ability, and cultivate their thinking ability.

In short, integrating mathematical culture into linear algebra teaching can enhance students' learning enthusiasm, better understand concepts, and apply them to practice. Cultivate Students' comprehensive abilities can be cultivated.

Acknowledgments

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