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Research and Case Analysis of Ideological Education in Linear Algebra Courses under the OBE Concept

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Abstract: ***With the gradual development and penetration of contemporary information technology in the field of education, the teaching mode of linear algebra courses is changing rapidly. In recent years, Outcome Based Education (OBE), as an advanced teaching model, has been increasingly accepted by many universities and implemented in the teaching reform and practice of linear algebra courses. This paper, based on the OBE educational concept and combined with the current teaching situation of linear algebra, proposes innovative teaching suggestions for ideological education in the linear algebra course group, aiming to improve the ideological education teaching system of Linear Algebra course groups under the OBE educational concept.***

Keywords: Linear Algebra, Curriculum Ideology and Political Education, Outcome-Based Education (OBE) Concept**.**

1. Introduction

The university period is likened to a golden age for the germination of life and value perspectives, where nurturing students' positive value orientation is particularly crucial. While traditional ideological and political courses form the cornerstone of moral education, their singular mode struggles to meet the diverse growth needs of contemporary university students. Consequently, curriculum ideological and political education has emerged as a fresh approach, quietly integrating into professional courses with the reforming breeze in higher education. It allows for the parallel advancement of professional knowledge and ideological and political education. Professional courses are no longer merely transmitters of knowledge but also shapers of values. They work alongside ideological and political theory courses, collectively weaving an all-encompassing, full-time educational network to ensure the comprehensive implementation of the educational purpose of fostering virtue through education. This transformation not only enriches educational methods but also deepens the educational connotation, blazing new trails for cultivating well-rounded future leaders.

Linear Algebra, as a foundational requirement for students in science, engineering, economics, and management fields, is undeniably important. It not only hones students' logical reasoning and abstract thinking but also nurtures spatial perception and innovative imagination, serving as a whetstone for thought. Constructing a mature curriculum ideological and political system in the teaching of "Linear Algebra" is a critical move. This not only transforms the concept of curriculum ideological and political education into practice but also subtly guides students to establish correct value orientations. Additionally, it carries the dissemination of mathematical culture and the promotion of the mathematical spirit, holding profound practical significance.

The OBE (Outcomes-based Education) concept, advocated by Spady, emphasizes an outcome-oriented education model. It has evolved into a complete theoretical system and serves as an educational guide for many countries worldwide to cultivate high-quality talents and stimulate innovative potential. Its core lies in being student-centered, with learning outcomes leading the way. Through reverse design, it constructs a curriculum system that focuses more on the process of achieving goals and rigorous evaluation of outcomes. Curriculum ideological and political education and the OBE concept complement each other highly, working together with talent cultivation as the target and achievement of outcomes as the navigation mark, forming a dual-drive mechanism for educational philosophy [1]. They not only align in goal positioning but also complement each other in implementation paths, jointly committed to enhancing educational quality and effectiveness.

Regarding the research on curriculum ideological and political education in "Linear Algebra," there have been fruitful results. Many documents explore the implementation paths of curriculum ideological and political education from multiple dimensions such as teacher training, integration of ideological elements, analysis of teaching content, and design of teaching processes [2-4]. To keep pace with university teaching reforms and achieve the educational goals of curriculum ideological and political education, it is particularly important to continuously explore innovative strategies for seamlessly embedding ideological and political education into professional classrooms under the guidance of the OBE concept. Innovating the teaching evaluation model and dynamically adjusting the ideological and political content in the classroom under the "evaluation – feedback - optimization" mechanism ensures its dynamic match with professional knowledge points. Achieving the parallel progress of professional education and ideological and political education is our ultimate pursuit.

2. The Necessity and Significance of Integrating Ideological and Political Education into "Linear Algebra"

2.1 The Necessity of Integrating Ideological and Political Education into "Linear Algebra"

From the perspective of disciplinary foundations, Linear Algebra primarily deals with linear relationships, expressing various mathematical objects in a first-order form. To date, linearity is one of the few fundamental frameworks in mathematics that humans can thoroughly study. Most real-world problems can be transformed into linear issues through certain processing for calculation. Therefore, Linear Algebra thinking and its knowledge system are important disciplinary foundations in fields such as computer science, communications, economics, management, agriculture, forestry, and more. From a practical application standpoint, Linear Algebra provides basic theories and methods for data processing. Using vector and matrix representations allows for flexible and convenient linear transformations of data, enabling researchers to grasp the main characteristics of data and the information required by different dimensions more intuitively and clearly [5-6]. In recent years, as computing storage capacity has increased and data volumes have grown, big data has been widely applied in various fields such as local government governance; it also plays an important role in the evaluation and analysis of intelligent ecological resource monitoring systems and the planning of ecological conservation construction. As one of the basic tools for big data analysis and numerical computation, Linear Algebra has become a fundamental mathematical theory that technology managers must master. Especially with the rapid development of information technology, using algebraic methods to solve practical problems has permeated various fields such as physics, chemistry, biology, aerospace, economics, engineering, etc [7-9].

"Linear Algebra," known for its highly abstract knowledge system and profound theoretical foundation, constitutes a challenging ladder in academic pursuits. Constrained by traditional scientific training frameworks and students' inherent rational thinking patterns, this undoubtedly sets numerous obstacles for the implementation of ideological and political education in "Linear Algebra." How to ingeniously implant ideological and political education into this professional field intertwined with theoretical denseness and abstract concepts, allowing the light of thought to reflect off professional wisdom, has become an urgent topic for us to explore and cultivate meticulously.

2.2 The Significance of Integrating Ideological and Political Education into "Linear Algebra"

The integration of ideological and political education into "Linear Algebra" adheres to three principles: knowledge transmission, value shaping, and capability cultivation. Its content includes anecdotes about mathematicians, explanations of worldviews, life philosophies, and value systems, as well as diverse materials such as philosophical insights, cultural heritage from China and the world, and social focal issues. It aims to nurture students' commitment to truth, rigorous pursuit of knowledge, courage in innovation, and striving for excellence in scientific attitude; at the same time, it focuses on forging their sense of social responsibility, deep affection for the motherland, confident mentality, and outstanding professional ethics.

The symbiotic integration between disciplines makes "Linear Algebra" and ideological and political education complement each other perfectly. In mathematics classrooms, the enthusiasm for innovation, creativity, and practice is highlighted; the spirit of technological innovation and sincere patriotism in ideological and political elements also shine brilliantly in the realm of mathematics. Especially when studying the abstract and complex concepts of "Linear Algebra," it further hones students' qualities of seeking truth from facts and persisting in their endeavors—the essence of ideological and political education.

Long-term dedication to this not only cultivates students' strong sense of responsibility and tenacious will for scientific research but also lays a solid foundation for training top technical experts.

3. The Integration Path of "Linear Algebra" and Ideological and Political Education

3.1 Leveraging Disciplinary Features and Synergizing Knowledge Systems to Deepen the Ideological and Political Efficacy of "Linear Algebra"

Given that "Linear Algebra" covers extensive knowledge areas such as science, philosophy, economics, etc., its disciplinary advantages are evident, which can enhance the effectiveness of ideological and political education. Studying this course not only exercises college students' logical thinking, enhances analytical ability, cultivates a dialectical perspective, but various problem-solving strategies can also expand their thinking boundaries, aligning seamlessly with the goals of ideological and political education.

Guided by the OBE concept and oriented towards learning outcomes, teaching content and disciplinary knowledge become key to instruction. Although "Linear Algebra" has formed a complete system, ideological and political content is relatively scarce. To fill this gap, we should start from professional knowledge and excavate ideological and political connotations for specific knowledge points, achieving a seamless connection between ideological and political education and knowledge transmission.

Specific integration strategies are as follows:

1) Excavating Ideological and Political Elements from the Perspective of Mathematical Philosophy: The precision of mathematics complements the profundity of philosophy. "Linear Algebra" contains rich philosophical thoughts, such as the dialectics of quantity and quality change, the relationship between the whole and the parts, the finite and the infinite. Delving into its philosophical core helps students build rigorous dialectical thinking and master materialist worldviews and methodologies.

2) Exploring Ideological and Political Elements in Mathematical Culture: Reviewing the history of mathematics reveals readily available materials for patriotic education. Through the lens of mathematical history and culture, introducing Chinese elements can stimulate students' national pride and cultivate a deep sense of patriotism.

3) Refining Ideological and Political Elements Focused on Educational Outcomes: Based on future professional

competencies, taking comprehensive scientific literacy, innovation awareness, team spirit, and social responsibility as core ideological and political goals. Delve into the ideological and political values within "Linear Algebra" professional knowledge, organically integrating them into daily teaching to achieve a deep integration of ideological and political education with disciplinary knowledge.

3.2 Constructing a Course Knowledge System, Integrating Ideological and Political Education into Course Design and Teaching

Taking the determinant in linear algebra as an example, since determinants and square matrices appear very similar, students often confuse them when they first learn about these concepts. As teachers, we must emphasize their differences both in form and essence; a determinant is essentially a value, whereas a matrix is essentially a table of numbers. When explaining the product of two vectors, the left multiplication of a row vector by a column vector seems superficially similar to the left multiplication of a column vector by a row vector, but the former results in a value while the latter results in a square matrix, which are completely different. Starting with second-order and third-order determinants, we can explore the definition of n-order determinants. We should proceed from simple to complex, from easy to difficult, from special to general, in a step- by-step manner. This cultivates students' ability to recognize and analyze problems using a progressive approach. It establishes the concept that one should be down-to-earth, start from the basics, draw inferences about other cases from one instance, and accumulate small steps to achieve great distances. Teachers can continue to introduce ideological and political examples: for instance, after two students graduate with PhDs, one works at Huawei and the other at a foreign company. Although it may seem similar on the surface, the essence is quite different. This fosters the noble thought among students to "serve the motherland and bring glory to the country." In the calculation of determinants, methods such as determinant transformations, calculations of different types of determinants, simplifying using properties of determinants, Vandermonde determinant, Laplace's theorem, etc., can be applied. However, the final result of the determinant remains the same. Students are taught that there are no shortcuts in life, but every step we take counts. "All roads lead to Rome"—through the relationships and transformation processes between different types of determinants, we cultivate students' rigorous scientific view and their spirit of continuous advancement and research.

In light of the unique knowledge structure of the "Linear Algebra" course and its disciplinary characteristics, we are committed to skillfully integrating professional knowledge with ideological and political education, deeply excavating the ideological and political elements within, to achieve the educational purpose of fostering virtue through education. Moral education is naturally integrated into daily teaching, identifying students' interests, adding fun to learning, and igniting their thirst for knowledge.

The implementation of ideological and political education in the curriculum is not only reflected in meticulously planned teaching content and design but is also permeated throughout every aspect of teaching. To maximize the efficacy of ideological and political education, choosing appropriate teaching methods is particularly crucial. The blended learning model provides an innovative platform for this, facilitating an efficient integration of professional education with ideological and political education and opening up new pathways for their organic combination.

1) Integration of Ideological and Political Elements into Classroom Teaching: In classroom teaching, carefully selected issues that align with ideological and political education are used as carriers. Problem-oriented teaching methods are adopted, flexibly using interactive approaches such as heuristic instruction, case analysis, and group discussions to stimulate active student participation. When studying systems of linear equations, matrices, and their elementary transformations, introduce the famous Chinese mathematical work "Nine Chapters on the Mathematical Art": Around the first century AD, China's "Nine Chapters" was already using matrix forms (essentially elementary transformations) to solve systems of equations, which is the earliest method for solving systems of equations in the world. In the West, it was not until the 17th century that Leibniz proposed a complete set of rules for solving linear equations. This introduction promotes Chinese culture, enhances students' national pride and cultural confidence, stirs their patriotic sentiments, and boosts their enthusiasm for learning.

2) Mixed Teaching and Flipped Classrooms: Utilize an online-offline blended teaching model to create an open classroom centered around students. With platforms like Zhihuishu, Yuke, Chaoxing Learning Pass, MOOC, etc., teaching resources are distributed, and classroom quizzes, thematic discussions, and surveys are conducted to encourage active student interaction. Teachers can quickly grasp students' status based on learning data, timely adjust teaching strategies, and ensure the realization of comprehensive and whole-process educational goals.

3) Combination of Theory and Practice in Ideological and Political Education: Extend course-based ideological and political education from the classroom to practice by establishing a "second classroom." Guide students to participate in various practical activities to enhance their academic literacy and professional responsibility, cultivate teamwork spirit and professional ethics. Create an atmosphere for innovation and entrepreneurship, encourage students to participate in competitions, improve theoretical level and innovation ability, and develop habits of being meticulous and pursuing excellence.

4. Developing and Perfecting Assessment Methods to Ensure the Implementation of Course-based Ideological and Political Education

The course evaluation and assessment system, as the core link in value judgment, is crucial for achieving teaching objectives. The OBE (Outcome-Based Education) concept emphasizes the transformation of students' attitudes and behaviors, focusing on process evaluation and individual differences. It aims to reverse the "utilitarian" learning tendency, guiding students to set lofty goals of "aspiration, virtue, and talent,"

and ultimately to shoulder the social mission of "taking on significant responsibilities." It strives to deepen knowledge foundation in value dissemination and lead value orientation in knowledge imparting.

Based on this, course assessment should balance the periodic evaluation of professional knowledge with long-term considerations of moral sentiment, knowledge skills, and academic literacy. Specifically, periodic evaluation can adopt various methods such as process assessment, daily learning performance, and practical outcome evaluation, breaking through the limitations of traditional written exams by introducing diverse forms like short essays, learning summary reports, and team presentation defenses. Through a variety of evaluation means, students are encouraged to comprehend the philosophical thinking of seeing through appearances to essence, master strategies for simplifying complexity, stimulate the spirit of innovation and exploration, enhance practical operation ability, broaden knowledge horizons, and strengthen social responsibility.

In the dimension of long-term evaluation, feedback and summary analysis can be conducted by tracking students' progress in subsequent courses of "Advanced Mathematics" and their performance in practice platforms such as the National College Student Mathematical Contest in Modeling and the National College Students Innovation and Entrepreneurship Project. Additionally, methods such as questionnaire surveys, in-depth interviews, and data analysis can be used to revisit graduates, collecting employers' evaluations of graduates' comprehensive abilities. This provides a comprehensive understanding of students' mastery of professional knowledge and practical skills level, offering empirical evidence for the optimization of subsequent course-based ideological and political education and the improvement of teaching quality, ensuring precise alignment between educational goals and societal needs.

5. Analysis of Case Studies in Ideological and Political Education for Linear Algebra Courses under the OBE Educational Concept

5.1 The Teaching Design for "Linear Combinations of Vector Groups" based on Facial Recognition Issues.

The teaching is structured around four key points: problem introduction, exploration of new knowledge, in-depth excavation, and summary extension, combining problem-based teaching methods with inquiry-based teaching methods. It emphasizes the extensive connection between mathematics and computer/information majors, introducing visual thinking within abstract reasoning, clarifying motivation and background, ensuring each knowledge point is naturally introduced.

1) Problem Introduction. Through a scene from the movie "Mission: Impossible IV" familiar to students, where agents use facial recognition glasses to pursue targets, the question is raised: How can linear algebra knowledge be used to explain this scenario?

2) Exploration of New Knowledge. By explaining the basic knowledge of image processing and analyzing how to represent images with matrices, and extending to how images can be represented with vectors for storage and computation, it is concluded that facial recognition is essentially about the relationship between one vector group and another vector. This leads to the new content of this lesson, focusing on clarifying basic definitions and the meaning of linearity, using examples to deepen understanding of the definitions, thereby preliminarily understanding the facial recognition issue. From definitions and examples, it explains how the linear representation of vector groups can be used to illustrate facial recognition issues.

3) In-Depth Excavation. In the practical application of facial recognition, due to different shooting angles and human emotions, each photograph may not be the same. This leads to the need for further in-depth consideration of the problem of solving vector equations.

4) Summary and Extension. Centered around the real-world problem of facial recognition, summarizing the content learned in this lesson and extending to issues that need further consideration in practical problems, leading to the content of the next lesson: linear representation between vector groups.

5.2 Integration of Ideological and Political Education in The Nine Chapters on the Mathematical Art and Matrix Concepts

1) Problem Introduction. The "Equations" chapter of The Nine Chapters on the Mathematical Art (a classical Chinese mathematical text) includes the "Five Families Sharing a Well" problem. The original problem states: Five families share a well. Family A's rope is two lengths short, Family B's rope is three lengths short... What is the depth of the well?

Accompanied by a modern translation, this example highlights the practicality and systematic nature of ancient Chinese mathematics. By emphasizing that such problems were solved using matrix-like arrangements of counting rods over 1,600 years before Western mathematicians formalized linear algebra, students are inspired to respect historical wisdom and recognize China's early contributions to mathematics.

2) Mathematical Modeling. The counting rods used in ancient China were arranged horizontally as rows and vertically as columns, with colors distinguishing positive and negative numbers — a system aligned with modern "row-first" matrix conventions. The "Five Families Sharing a Well" problem is translated into a system of linear equations and represented as an augmented matrix:

$$\left[\begin{array}{ccc|c} 2 & 1 & -1 & 8 \\ 3 & 2 & 1 & 14 \\ 2 & -1 & 3 & 9 \end{array}\right]$$

By comparing ancient elimination methods (e.g., zhichu fa) with modern Gaussian elimination, students explore how traditional mathematical insights can drive contemporary technological advancements.

3) Programming Practice. Using Python, students replicate

the ancient solution. The code outputs the well depth as 7 rope lengths, consistent with the original answer in The Nine Chapters. This exercise underscores China's modern contributions to mathematics and technology, such as Huawei's Ascend AI chips, which utilize matrix acceleration techniques. For example:

```
import numpy as np
A = np.array( [ [2, 1, -1], [3, 2, 1], [2, -1, 3]])
b = np.array( [8, 14, 9]) solution = np.linalg.solve(A, b)
print("Well depth:", solution [0], "rope lengths")
```

This exercise underscores China's modern contributions to mathematics and technology, such as Huawei's Ascend AI chips, which utilize matrix acceleration techniques.

4) Extended Discussion. Guided discussions connect historical mathematics to contemporary applications:

Topic 1: How do matrix concepts from The Nine Chapters inspire modern artificial intelligence (e.g., neural networks)?

Topic 2: How can ancient Chinese mathematical wisdom support technological collaboration in the Belt and Road Initiative?

These discussions encourage students to reflect on the societal role of mathematicians and align their expertise with national strategic needs.

6. Conclusion

In summary, under the guidance of the OBE educational concept, the teaching of linear algebra courses should deeply integrate ideological and political education. However, the goal is not to turn all mathematics courses into appendages of ideological and political classes but to fully explore and leverage the educational value of advanced mathematics courses and expand their educational functions. Relying solely on the impartation of professional knowledge is insufficient to meet educational challenges, and an excessive focus on professional education may turn students into mere repositories of knowledge, hindering their overall development. Teachers need to deeply understand the core of the OBE concept, skillfully implement ideological and political education in advanced mathematics course groups, and guide students to integrate mathematical knowledge comprehensively for practical application. At the same time, teachers must pay attention to students' overall learning outcomes, optimize the content and strategies of ideological and political education, ensure that students internalize the ideological and political content and externalize it in their actions, integrating it throughout the study of advanced mathematics courses and all aspects of daily life.

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