

ZIBELINE INTERNATIONAL  
PUBLISHING

ISSN: 2521-0831 (Print)

ISSN: 2521-084X(Online)

CODEN: MSMAD

## Matrix Science Mathematic (MSMK)

DOI: <http://doi.org/10.26480/msmk.01.2024.04.08>

## REVIEW ARTICLE

## LINEAR ALGEBRA COURSE ON THE IDEOLOGICAL AND POLITICAL DIMENSION BASED ON BOPPPS TEACHING MODEL-TAKING "EIGENVALUES AND EIGENVECTORS" AS AN EXAMPLE

Bo Sun<sup>a</sup>, Yimeng Lei<sup>a</sup>, Yuyao Ji<sup>b</sup><sup>a</sup> School of Statistics and Mathematics, Central University of Finance and Economics, Beijing, P.R.China 100081<sup>b</sup> Chinese Academy of Finance and Development, Central University of Finance and Economics, Beijing, P.R.China 100081.\*Corresponding Author Email: [sunbo19830328@163.com](mailto:sunbo19830328@163.com)

This is an open access article distributed under the Creative Commons Attribution License CC BY 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

## ARTICLE DETAILS

## Article History:

Received 20 January 2024

Revised 15 February 2024

Accepted 27 March 2024

Available online 29 March 2024

## ABSTRACT

The main teaching pain points of the course Linear Algebra include "students' fear of difficulty", "difficulty in igniting enthusiasm for learning", "uneven levels of student proficiency", "the political construction of basic course remaining a uphill battle" and so on. Aiming at facing the pain points of the course teaching and improving the effect of students' learning, this paper designs the teaching program. Taking "eigenvalues and eigenvectors" as an example, based on the BOPPPS teaching model, multiple teaching methods are adopted such as flipped classroom, case study, hierarchical design. At the same time, the design combines the application of information technology, and integrates the ideology and political elements into the course.

## KEYWORDS

Linear algebra; Eigenvalues; Eigenvectors; Political construction; Teaching program.

## 1. INTRODUCTION

Linear algebra is a branch of mathematics that studies vectors, vector spaces, linear transformations, and systems of linear equations in finite dimensions, with strong abstraction and logic. In real life, it is one of the important research strategies to transform nonlinear problems into linear problems to solve them, therefore, linear algebra has important applications in natural sciences, social sciences, technical sciences and so on.

However, in the actual teaching process, the classroom generally pays more attention to the abstract concepts and problem-solving strategies, instead of introducing the context of practical application of concepts, and ignores the cultivation of students' algebraic thinking and application skills, which makes students passively accept the abstract knowledge, and couldn't establish a clear framework for thinking, and sap the students' interest in learning. In this way, "won't learn, can't learn, can't use" constitutes the status quo of student learning, and the teaching effect is unsatisfactory (Wang, 2023).

Since The 18th National Congress of the Communist Party of China, the government attaches great importance to the task of ideological education in colleges and universities, and the integration of ideologic and politic in the curriculum is an important measure for colleges and universities to implement the fundamental task of ideological education and also an important way for colleges and universities to better cultivate high-quality talents (Zhu et al., 2023; Zhou and Zhou, 2023; Wang et al., 2022). This course will start from all aspects of teaching, focusing on students, and effectively integrating the elements of politics and offline teaching, which is of great significance to cultivate students' socialist core values of seeking truth from facts, and is also in line with the educational philosophy of "all-member, all-directional, and all-process" (Li, 2023; Zhang, 2022).

In order to face the above teaching pain points and key issues, this paper introduces the "BOPPPS" teaching mode into the classroom, adopts teaching methods such as flipped classroom, case study, and hierarchical design, and integrates the elements of Politics and information technology into Linear Algebra, and designs the teaching program (Li, 2023; Zhang, 2022). The teaching program was designed (Zhou et al., 2021; Liu and Gao, 2019). The program is designed to stimulate students' interest, stimulate students' thinking, connect theory with practice, make students actively participate in the classroom, and become the main body of knowledge learning.

## 2. ANALYSIS OF THE ACADEMIC SITUATION

The target audience of Linear Algebra is relatively wide, covering almost all majors of various disciplines, and it is offered to freshmen and sophomore undergraduates, who have their own learning characteristics. In terms of knowledge base, students have a certain degree of information technology literacy, good use of information technology, and can quickly adapt to the "Internet +" learning environment, so they have a better grasp of the basic concepts and principles of the course. However, they are relatively deficient in understanding the breadth, width and depth of the course content.

In terms of cognitive characteristics, university mathematics courses require a high level of logical and analytical skills due to their inherent attribute of high knowledge. In the current information technology environment, although students have a strong acceptance of new things, but lack of patience, in-depth analysis of the problem and the ability to think logically. As a result, students show a certain degree of intimidation and are prone to give up or seek shortcuts when encountering difficulties.

In terms of learning motivation, as a university public basic compulsory course, students showed certain course interest on the one hand, and on

## Quick Response Code



## Access this article online

## Website:

[www.matrixsmathematic.com](http://www.matrixsmathematic.com)

## DOI:

10.26480/msmk.01.2024.04.08

the other hand, students were less motivated to learn mathematics, and their learning behaviors were more purposeful and utilitarian. As a result, the phenomenon of score-only and the lack of practical innovation prevailed.

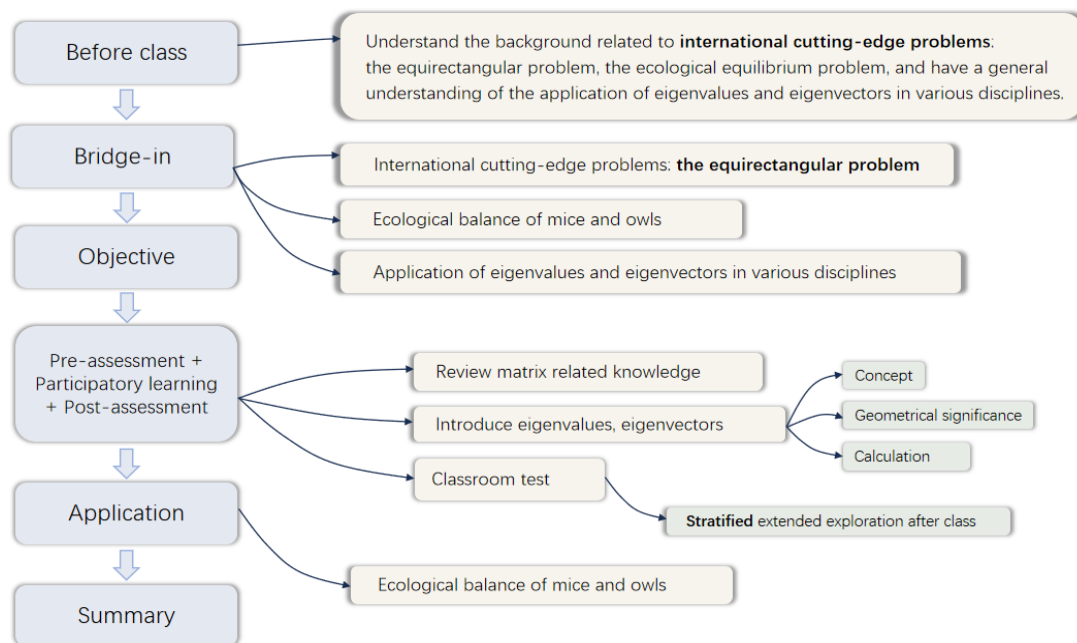
### 3. TEACHING PAIN POINTS

This course as a public basic course in mathematics, the main teaching pain points are focused on: the course content is too theoretical, students are intimidated by difficulties; the course itself is hardly enough to ignite the enthusiasm of the students to learn; the course is usually taught in large classes, The number of students taught at each podium is usually over a hundred, with varying levels of student acceptance, with uneven learning outcomes such as "Not enough" and "can't handle"; as a public basic course, the subtle influence of curriculum-based politics on student needs to be further emphasized and strengthened.

Therefore, the design of university mathematics courses should pay more attention to the following aspects:

- By adopting diversified teaching methods, such as case study, problem solving interactive discussion, etc., in order to stimulate students' learning interest and motivation. At the same time, mathematical problems related to real life can be introduced to let students feel the value and significance of mathematics in practical applications.
- By strengthening basic training in order to improve students' math skills and problem-solving abilities. Teachers can make targeted training programs according to the actual situation and needs of students, and give timely feedback and guidance.
- Through inspirational teaching methods, students are guided to utilize information technology tools for problem solving in order to develop their independent learning ability and sense of innovation. At the same time, a wealth of learning resources and materials can be provided to encourage students to expand their understanding and investigations, focusing on thinking training.
- Promote the all-round development of students at all levels by formulating personalized teaching plans and counselling measures so as to pay attention to students' individual learning differences and learning needs.

### 6. TEACHING DESIGN OF THE LECTURE "EIGENVALUES AND EIGENVECTORS"



#### 6.1 Before class (flipped classroom)

By assigning learning tasks to guide students to understand in advance the relevant background of international frontier mathematical problems: the equirectangular problem, the ecological balance problem,

### 4. BACKGROUND OF THE BOPPPS TEACHING MODEL

BOPPPS is a teaching model originated from Canada, which is trained by ISW (Instructional Skills Workshop) (Jin and Xiao, 2023; Cao and Yin, 2016). The BOPPPS teaching model focuses on student participation and feedback and is a closed-loop teaching process that embodies the educational philosophy of "teacher-guided and student-centered". The duration of human attention is about 15 minutes, according to this law, the BOPPPS teaching model divides the teaching process into six teaching links, and emphasizes the rational application of these six links, which are Bridge-in, Objective, Pre-assessment, Participatory learning, Post-assessment and Summary (Sun et al., 2023). Each link is basically an independent module, but the links before and after each link are related to each other and connect with each other, which together constitute a complete teaching process. The model starts from the students' cognitive law, improves the students' participation in the classroom enthusiasm, cultivates the students' active learning, enables the students to understand what they have learned more deeply, and thus better improves the classroom efficiency, teaching effect and teaching benefit (Yu et al., 2023; Chen et al., 2014; Li and Fu, 2020).

### 5. TEACHING OBJECTIVES OF THE LECTURE "EIGENVALUES AND EIGENVECTORS"

The knowledge learning objectives mainly include, gain a deep understanding of the concepts of eigenvalues and eigenvectors; be able to clearly describe the geometrical significance of eigenvalues and eigenvectors; and be proficient in performing calculations of eigenvalues and eigenvectors.

The objectives of capacity development mainly include, cultivating students' ability of abstract thinking and logical thinking, and seeing the world from the perspective of mathematics; cultivating students' comprehensive analytical ability and improving their mathematical accomplishment; cultivating students' ability in mathematical modeling and computational application; and cultivating students' ability to apply mathematical knowledge and connect theory to practice.

Ideological and political education goals mainly include, stimulating students' national sentiment and historical mission, from the perspective of mathematics; establishing national confidence and ambition to strengthen the country, based on mathematics; cultivating students' rigorous scientific attitude, the scientific spirit of scaling the heights; cultivating students' sense of national pride, scientific concept of development, dialectical methodology and so on.

and roughly understand the application of eigenvalues and eigenvectors in various disciplines, as well as to watch related videos on MOOC to understand the content of this lesson, in order to prepare for the course (Changdong et al., 2019).

### 6.2 Bridge-in

Class starts with explaining the literal meanings of eigenvalues and eigenvectors in the form of Chinese characters in Tazigraphy, incorporating Chinese elements, and guiding students not to neglect the "writing" and "meaning" of Chinese characters in today's information era. Introducing Case 1: With the help of the equirectangular problem solved

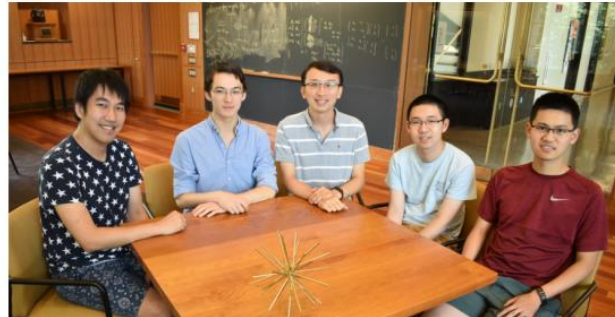
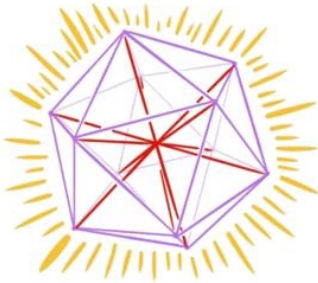
by Associate Professor Yufei Zhao and his undergraduates at the Massachusetts Institute of Technology (MIT), a problem that has been troubling mathematicians for 70 years, we emphasize the importance of eigenvalues by discussing their key role in cutting-edge international mathematical problems. While enhancing the students' sense of national pride, it inspired them to explore, defy difficulties, and to climb the peak of scientific research.

### Mathematicians solve an old geometry problem on equiangular lines

How many lines can be pairwise separated by the same angle in high dimensions? Geometry breakthrough gives new insights into spectral graph theory.

Sandi Miller | Department of Mathematics  
October 4, 2021

PRESS INQUIRIES



"The proof worked out cleanly and beautifully," says Yufei Zhao (center). "We had so much fun working on this problem together." Left to right: Zilin Jiang, Jonathan Tidor, Zhao, Yuan Yao, and Shengtong Zhang  
Photo: Sandi Miller

Introducing Case 2: Using the owl-mouse ecological balance problem, students are guided to think in terms of eigenvalues and eigenvectors to build a dynamical model based on existing data. In the process of building an ecological dynamical system, eigenvalues and eigenvectors are emphasized as scientific and effective tools in the process of solving practical problems, enhancing the cultivation of students' mathematical modeling ability and the establishment of innovative ideas. In the process of exploring ecological problems, students' awareness of the big picture and responsibility is cultivated.

### 6.3 Objectives, set specific, clear and reasonable teaching objectives in a hierarchical manner.

Basic goal: to be able to deeply understand the concepts of eigenvalues and eigenvectors, and able to calculate the eigenvalues and eigenvectors of matrices.

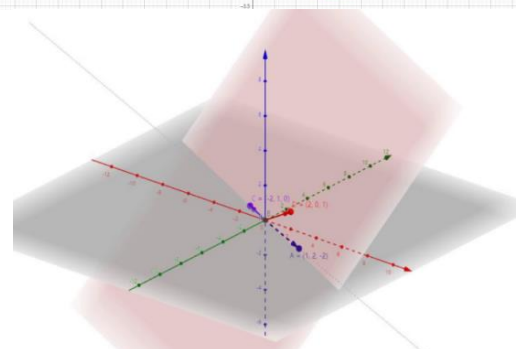
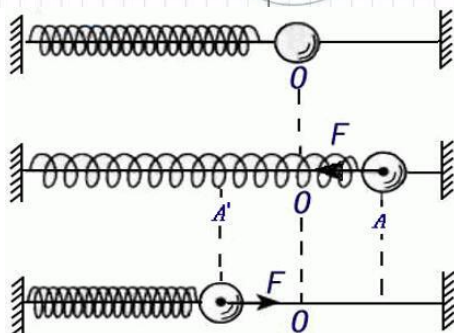
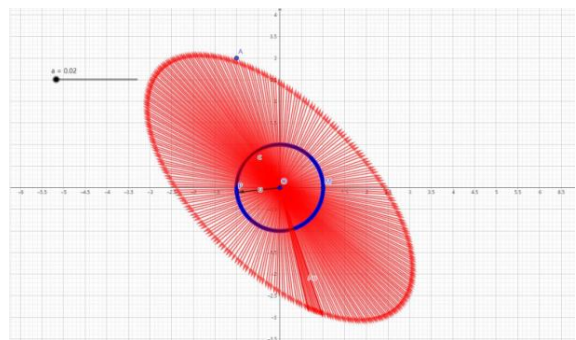
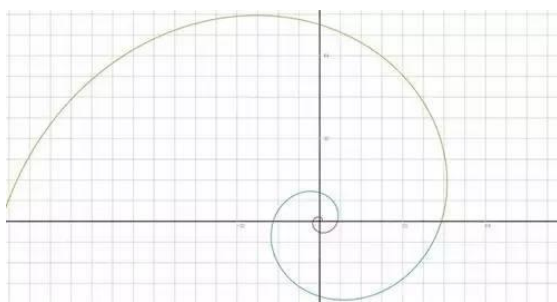
Advanced goal: to be able to clearly describe the geometric significance of eigenvalues and eigenvectors of matrices.



Introducing Case 3: Introducing the application of eigenvalues and eigenvectors in various disciplines such as medicine and physics by means of static diagrams and dynamic diagrams, which can cultivate students' innovative spirit and broaden their horizons.

### 6.4 P+P+P: Pre-assessment + Participatory learning + Post-assessment

In the pre-assessment session, by reviewing the knowledge of image processing with matrices, we review the simple transformations of vectors in the two-dimensional plane to pave the way for introducing the concepts of eigenvalues and eigenvectors. In this process, the method of combining numbers and shapes is utilized to enhance students' ability to discover principles through phenomena and to develop their mathematical thinking skills. In the Participatory learning session, the concept of eigenvalue eigenvector is introduced in detail, and its geometric significance is illustrated by drawing dynamic simulated graphs, and then specific examples are given to sort out its calculation method.



In the post-assessment session, through exercises and upgraded practice, students deepen their mastery of calculation methods and cultivate the habit of thinking attentively and practicing frequently.

### 6.5 Practical Application

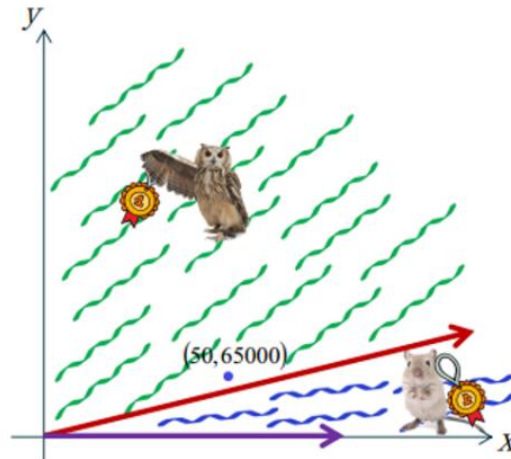
Responding to the ecological balance problem in the bridge-in section,

$$\begin{cases} y' = 0.4y \\ x' = 1.2x - 1000y \end{cases}$$

$$\begin{pmatrix} y' \\ x' \end{pmatrix} = \begin{pmatrix} 0.4 & 0 \\ -1000 & 1.2 \end{pmatrix} \begin{pmatrix} y \\ x \end{pmatrix}$$

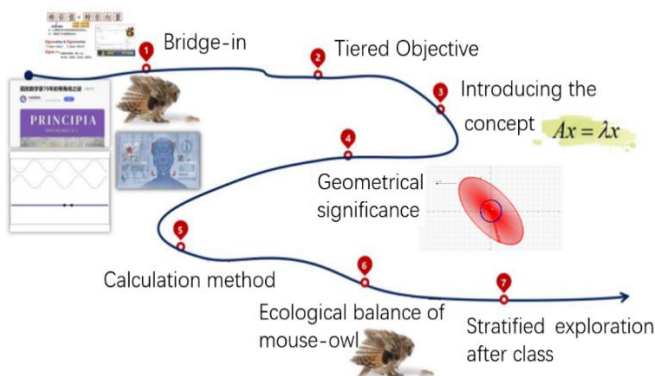
$$\lambda_1 = 0.4, \lambda_2 = 1.2$$

$$\alpha_1 = \begin{pmatrix} 1 \\ 1250 \end{pmatrix}, \alpha_2 = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$$



### 6.6 Summary

Sorting out the logic of the lecture, reviewing the knowledge of the section, deepening students' understanding of the content of this lecture, in order to achieve the auxiliary effect of after-school review and deeper exploration, and encouraging students to be keen to observe, diligent in summarizing, good at thinking and courageous in exploring.



## 7. TEACHING EFFECTIVENESS

The bridge-in section of the lecture consists of several practical cases, mainly including the international cutting-edge academic issues and real cases around us, so as to mobilize the students' enthusiasm. In turn, it stimulates students' interest in understanding and paying attention to the latest international research hotspots and their habit of active exploration; stimulates students' awareness of the big picture and sense of responsibility in caring for the ecological environment; and encourages students to explore the integrated application of mathematical knowledge in various subject areas.

The theoretical part integrates information technology, combining drawing, animation and video to demonstrate and explain the difficult parts of this lecture. It mainly introduces the concepts of eigenvalues and eigenvectors, analyzes the geometrical significance by using specific arithmetic examples, and finally comprehends the principles and main steps of the calculation method. Students are trained to look at the problem from multiple perspectives and in a holistic way, and the method of thinking from individual to general, as well as the dialectical relationship between abstraction and concreteness are emphasized.

In the part of theoretical application, the ecosystem problem in the imported cases are solved with what is learned in this lecture, which really makes students feel where the content of this lecture is used and cultivates the scientific attitude of making study serve the practical purpose. Throughout the course, the elements of Ideologic and Politics are deeply integrated with the teaching content, cultivating the students'

students are guided to apply the theoretical knowledge of eigenvalues and eigenvectors in real-life scenarios, students are guided to apply the theoretical knowledge of eigenvalues and eigenvectors in real-life scenarios, which cultivates the scientific attitude of connecting theory with practice and establishes the scientific development concept of "coming from and going to real problems".

dialectical thinking ability, inductive deduction and logical reasoning ability, mathematical modeling ability and innovative thinking ability, scientific concept of sustainable development, and the ability to combine theory with practice. The effect of Politics is deeply rooted in students' hearts, educating students in an invisible way, and motivating students to contribute their youth and blood to the prosperity of our motherland. Hopefully, after studying this lecture, students will be impressed by the beauty of math, and how the applications of linear algebra are just around the corner.

### FUNDING

This work was supported by Mathematics Research Branch Institute of Beijing Association of Higher Education & Beijing Interdisciplinary Science Society(SXJC-2022-009); Emerging Interdisciplinary Project of Central University of Finance and Economics; Disciplinary Funding of Central University of Finance and Economics; "SiZheng +" Teacher Support Fund of Central University of Finance and Economics ; Education and Teaching Reform Fund of Central University of Finance and Economics.

### REFERENCES

- Cao, D., Yin, X., 2016. The BOPPPS Teaching Mode in Canada and Its Implications for Higher Education Reform [J]. Research and Exploration in Laboratory, 35 (02), Pp. 196-200+249. (in Chinese)
- Changdong, W., Hua, J., Yongqiang, C., 2019. Research and application of BOPPPS teaching method in MOOC teaching design [J]. Experimental Technology and Management, 36 (02), Pp. 218-222. (in Chinese)
- Chen, W.W., Bao, A.H., Li, Q., 2014. Instructional design for cultivating computational thinking based on BOPPPS model and problem-driven pedagogy [J]. Industry and Information Technology Education, (06), Pp. 8-11+18. (in Chinese)
- Jin, G., Xiao, L., 2023. Design and Exploration of Civic and Political Teaching of Linear Algebra Course in Applied Colleges and Universities under the Mode of "Online and Offline + BOPPPS" [J]. China Internet Week, 2023 (21), Pp. 62-64. (in Chinese)
- Li, S., Fu, L., 2020. A Review on Development of BOPPPs Teaching Model in Domestic Colleges and Universities [J]. Teaching of Forestry Region, (02), Pp. 19-22. (in Chinese)
- Li, Z., 2023. Research on the Teaching Design of Civics in University Mathematics Courses [J]. Modern Business Trade Industry, 44 (19), Pp. 239-241. (in Chinese)
- Liu, Y., Gao, P., 2019. The Integration of Information Technology and Ideological and Political Theory Courses in the New Era [J]. Studies on Marxist Theory in Higher Education, 5 (04), Pp. 148-155. (in Chinese)

- Sun, Y., Jiang, Z., Bi, X., 2023. Practical Research on BOPPPS Teaching Mode in Linear Algebra Course [J]. Journal of North China Institute of Aerospace Engineering, 33 (05), Pp. 31-33. (in Chinese)
- Wang, H., 2023. Research on the Path of Improving the Quality and Efficiency of Ideological and Political Courses in Colleges and Universities from the Perspective of Moral Education [J]. Journal of Heilongjiang Institute of Teacher Development, 42 (11), Pp. 56-59. (in Chinese)
- Wang, Y., Li, H., Wang, Y., 2022. On the Problems and Countermeasures of the Course-based Ideological and Political Education in Practice for Postgraduates [J]. Journal of Graduate Education, (03), Pp. 57-60+82. (in Chinese)
- Yu, R., Hui, X., Zhang, P., 2023. Innovative Research and Practice of Teaching Methods in Linear Algebra Course Based on BOPPPS Teaching Module [J]. Kejifeng, (01), Pp. 136-138. (in Chinese)
- Zhang, Y., 2022. The Construction of the Development Mode of "Six Characteristics and Six Forces" Curriculum Ideology and Politics Based on the Basic Requirements of Moral Education [J]. Journal of Hubei Open Vocational College, 35 (21), Pp. 104-105+108. (in Chinese)
- Zhou, J., Zhou, S., 2023. Four-dimensional Construction of "Ideology and Politics Education Curriculum" in Colleges and Universities [J/OL]. Journal of Wuhan University of Technology (Social Science Edition), (11), Pp. 1-6. (in Chinese)
- Zhou, S., Deng, S., Chen, X., 2021. Courses in Universities Four Dimensions of Information Technology Integration into Ideological and Political Education [J]. Heilongjiang Researches on Higher Education, 39 (08), Pp. 125-130. (in Chinese)
- Zhu, Z., Zhu, L., Jiang, L., 2023. The Construction of Experimental Course-Based Ideological and Political Education System for Undergraduate and Graduate Students [J]. The Food Industry, 44 (11), Pp. 207-212.

