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SIMPLIFYING THE COMPLEX WITH SUBTLE INFLUENCE——CURRICULUM IDEOLOGICAL AND POLITICAL TEACHING CASE DESIGN AND PRACTICE OF THE LAW OF TOTAL PROBABILITY

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Abstract: The Law of Total Probability is a core tool for simplifying the complex in Probability Theory and Mathematical Statistics, and its ideological connotation of dividing and conquering is highly consistent with the wisdom in the excellent traditional Chinese culture. Taking the Law of Total Probability as a teaching case and based on the BOPPPS teaching model, this paper designs a six-link teaching process of Domestic Large Aircraft Airworthiness Certification-Goal Guidance-Pre-test Diagnosis-Participatory Learning-Post-test Feedback-Summary and Sublimation in light of the characteristics of economics and management students, integrating the philosophical thought of simplifying the complex into the knowledge imparting process in a natural way. Teaching practice shows that this design effectively improves students' classroom participation and thinking quality, and realizes the organic unity of knowledge imparting and value guidance.
Keywords: Law of total probability; Curriculum ideological and politics; BOPPPS teaching model; Simplifying the complex; Teaching design

1 INTRODUCTION

Probability Theory and Mathematical Statistics is a core basic course for economics and management majors, providing quantitative analysis tools for subsequent professional courses such as Microeconomics, Macroeconomics, Management, and Finance [1]. This course is closely connected with practical problems, and its content contains rich ideological and political elements. The Law of Total Probability is a core tool for simplifying the complex in probability theory, whose basic idea is as follows: when it is difficult to directly calculate the probability of a complex event B, the sample space is divided into several mutually exclusive simple subspaces, and the probabilities are calculated separately and then summed up. This idea is highly consistent with the systematic thinking in management and structural analysis in economics which provides a natural entry point for the integration of curriculum ideological and politics.

However, the current curriculum ideological and political teaching of Probability Theory and Mathematical Statistics is faced with problems such as rigid grafting and superficialization. Ideological and political elements are often attached to the knowledge teaching in a label-like manner, making it difficult to achieve the educational effect of subtle influence [2-3]. How to naturally integrate value guidance into knowledge imparting is an important subject of the current teaching reform [4-5].

The BOPPPS teaching model divides classroom teaching into six links: Bridge-in, Objective, Pre-assessment, Participatory Learning, Post-assessment and Summary [6-8]. It emphasizes student-centeredness, real-time feedback and participatory learning. The structured design of this model provides a possible path for the natural integration of curriculum ideological and politics, where ideological and political elements can be infiltrated in different ways in different links to avoid rigid grafting.

Taking the Law of Total Probability as a teaching case, this paper designs a complete curriculum ideological and political teaching process based on the BOPPPS teaching model in view of the characteristics of economics and management majors, and explores the organic integration of the thought of simplifying the complex and the imparting of mathematical knowledge.

2 TEACHING CONTENT AND IDEOLOGICAL AND POLITICAL ELEMENTS

2.1 Knowledge Connotation of the Law of Total Probability

The Law of Total Probability is a basic tool for calculating the probability of complex events in Probability Theory and Mathematical Statistics:

$$P(B)=\sum_{i=1}^{n}P(A_i)P(B\mid A_i), \tag{1}$$

where A_i is a complete event group of the sample space.

The core idea of the formula is to decompose the probability of a complex event B into a weighted sum of the probabilities of several simple sub-events to achieve the goal of simplifying the complex. This idea enlightens students that when facing complex problems, they should not shrink back for fear of difficulties, but stay calm and analyze things systematically, break down big problems into small ones and solve them one by one.

2.2 Excavation of Ideological and Political Elements

In light of the characteristics of economics and management students, the ideological and political elements contained in the Law of Total Probability can be excavated from the following dimensions:

Table 1 The Ideological and Political Mapping of the Law of Total Probability

Connotation of the Formula	Mapping in Economics and Management	Educational Value
Division of sample space	Market segmentation, customer stratification	Precise service, user orientation
Discussion by cases	Scenario analysis, risk management	Scientific decision-making, foresight
Weighted summation	Weight distribution, resource allocation	Equity and efficiency, system optimization
From simplicity to complexity	Modular thinking, system integration	Craftsman spirit, systematic concept

These ideological and political elements are not labels attached to knowledge, but the inherent value implication of mathematical thought itself. In teaching, teachers only need to guide students to deeply understand the ideological essence of the Law of Total Probability, and they can naturally touch these value levels.

3 TEACHING DESIGN BASED ON BOPPPS

Based on the BOPPPS teaching model, a six-link teaching process is designed, with differentiated ideological and political elements integrated into each link, as shown in Table 2.

Table 2 The Design of Ideological and Political Integration in the Six BOPPPS Links

Link	Teaching Content	Ideological and Political Integration Point	Time
Bridge-in	Domestic large aircraft airworthiness certification	Stimulating a sense of responsibility and patriotism	5 minutes
Objective	Clarifying knowledge objectives and ideological and political objectives	Goal guidance and value orientation	2 minutes
Pre-assessment	Step-by-step probability problems	Diagnosing the tendency of problem-solving	5 minutes
Participatory Learning	Formula derivation, fault probability decomposition, migration of economics and management cases	Practical wisdom of dividing and conquering	20 minutes
Post-assessment	Basic questions + extended questions	Real-time inspection of knowledge mastery	8 minutes
Summary	Knowledge summary + ideological sublimation	Unity of systematic thinking and patriotism	5 minutes

3.1 Bridge-in: Domestic Large Aircraft Airworthiness Certification (5 Minutes)

3.1.1 Situational introduction

The C919 domestic large aircraft has undergone more than ten years of airworthiness certification. In a complex system with millions of parts and more than 200 suppliers, how do managers ensure the reliability of the whole aircraft? The answer is: divide the whole into parts and conquer by dividing.

3.1.2 Data introduction

To simplify the problem, we decompose the aircraft system into three key subsystems:

Power system (engine, etc.): accounting for 40% of the system importance, the probability of mission failure caused by its fault is 0.01%

Avionics system (navigation, communication, etc.): accounting for 30%, the probability of mission failure caused by its fault is 0.02%

Structural system (fuselage, landing gear, etc.): accounting for 30%, the probability of mission failure caused by its fault is 0.005%

Question: What is the probability of mission failure of the entire aircraft system caused by the faults of these key subsystems?

3.1.3 Ideological and Political Infiltration

The airworthiness certification of the C919 embodies the painstaking efforts of numerous aviation personnel and managers. Behind every test report is the sense of responsibility of putting people and lives first; behind every management decision is the craftsman spirit of striving for perfection and excellence. As future managers, you shoulder the mission of promoting Made-in-China to the world. The Law of Total Probability we learn today is exactly a thinking

tool for you to manage complex projects and undertake social responsibilities in the future.

3.2 Objective (2 Minutes)

Knowledge objective: Understand the structure of the Law of Total Probability, correctly divide the complete event group, and apply the formula to solve practical problems.
Ability objective: Cultivate the ability to decompose complex management problems into simple sub-problems.
Ideological and political objective: Comprehend the practical wisdom of simplifying the complex, establish systematic thinking and overall concept, and stimulate the patriotism of serving the national strategy.

3.3 Pre-Assessment (5 Minutes)

Example: A company has two suppliers, Supplier A and Supplier B. Supplier A supplies 60% of the parts with a defective rate of 2%; Supplier B supplies 40% of the parts with a defective rate of 3%. Now a part is randomly selected from the warehouse, find the probability that it is a defective part.
Through the above simple problem of supplier defective rate, students' existing cognition of case-based discussion is awakened, building a scaffold for the formal learning of the Law of Total Probability. This problem is in the same vein as the C919 case in the bridge-in part, both calculating the overall probability from the perspective of weighted summation from multiple sources, only replacing the aircraft subsystems with suppliers and the fault rate with the defective rate, reducing the cognitive threshold.

3.4 Participatory Learning (20 Minutes)

Activity 1: Deriving the Formula from the C919 Case (8 minutes)
Return to the C919 case in the bridge-in part, set four events: Power system fault (A_1), Avionics system fault (A_2), Structural system fault (A_3) and Aircraft mission failure (B). Based on the assumption of approximate mutual exclusivity of subsystems in system reliability engineering, organize students to conduct a 2-minute group discussion to explore the logical relationship between B and A_1, A_2, A_3 . In the discussion, students find that the fault of any subsystem will lead to mission failure, thus independently deriving the set expression of B , and then abstracting the Law of Total Probability under the teacher's guidance. Subsequently, the teacher makes an ideological and political key point with the management wisdom of dividing the whole into parts and conquering one by one in *The Art of War by Sun Tzu*, elevating the mathematical principle to a thinking paradigm for dealing with complex systems.
Activity 2: Fault Probability Decomposition-Group Inquiry (7 minutes)
Question: A flagship model is facing launch testing, with risks coming from three suppliers of screens, chips and batteries. Their fault probabilities are 5%, 2% and 4% respectively, and the conditional probabilities of delayed delivery of the whole machine caused by faults are 80%, 90% and 70% respectively.
For the above problem, students complete four tasks in groups: 1. Identify the complete event group composed of the three suppliers; 2. Write the standard form of the Law of Total Probability; 3. Calculate the total probability of delayed delivery of the whole machine; 4. Discuss risk reduction strategies as a supply chain manager. In the roaming guidance, the teacher guides students to pay attention to which link is the bottleneck, and carries out ideological and political sublimation after the calculation is completed, emphasizing that every link of the supply chain affects the final result, and guiding students to establish systematic thinking and awareness of industrial chain security.
Activity 3: Migration of Economics and Management Cases - Brainstorming (5 minutes)
The teacher puts forward an open question: In the field of economics and management, what other problems can be solved by the idea of classifying first and then summing up? Students carry out brainstorming in groups and associate with multiple application scenarios such as market segmentation, credit rating, investment decision-making and policy risk assessment. Finally, the teacher makes a summary and sublimation with Lao Tzu's famous saying "The difficult things in the world must be done from the easy; the great things in the world must be done from the trivial", pointing out that the thinking mode of simplifying the complex and decomposing layer by layer contained in the Law of Total Probability is not only a mathematical tool, but also a core literacy of economics and management talents.
The three teaching activities form a logically rigorous and progressive teaching closed loop: starting from situational abstraction, enabling students to complete the cognitive leap from specific experience to mathematical symbols in the C919 case; then promoting the in-depth transformation from formula principles to practical application through the inquiry of supply chain cases; finally, realizing the thinking expansion from classroom learning to the professional field of economics and management with brainstorming as the carrier. In this process, students are fully involved through discussion, calculation and speculation, and teachers integrate knowledge imparting and value shaping into one through inspiration, doubt-solving and enlightenment.

3.5 Post-Assessment (8 Minutes)

Basic Questions (5 minutes)
An e-commerce platform divides users into three categories: highly active users (accounting for 20%, with an 8%

probability of clicking on ads), moderately active users (accounting for 50%, with a 4% probability of clicking), and low active users (accounting for 30%, with a 1% probability of clicking). Find the probability that a randomly selected user will click on an ad.
Requirement: Write the complete event group and calculate by applying the formula.
Extended Questions (3 minutes, optional)
If it is known that a user has clicked on an ad, how to find the probability that he is a highly active user? (Laying the groundwork for the Bayes' formula in the next section)
Real-time Feedback: Release the answers on the learning platform, display the accuracy rate in real time, and give targeted explanations.

3.6 Summary (5 Minutes)

At the end of the course, the teacher invites a student to share the core gain in one sentence. If the student answers: When facing complex problems, we should first classify and then calculate, divide the whole into parts and conquer one by one, the teacher affirms it and writes simplify the complex, classify and sum up on the blackboard, guides students to supplement it, and then quickly reviews the classroom context with the blackboard writing as a clue to complete knowledge construction. The value of this link lies in: letting students express knowledge in their own words, which marks the transformation of knowledge from hearing to internalization; forcing thinking processing through summary to deepen cognitive understanding; stimulating students' self-identity and learning confidence through affirmation; realizing the classroom transformation from teacher's monologue to teacher-student interaction; enabling students to naturally internalize ideological and political elements in expression and achieve value guidance. Letting students speak out knowledge is to return the initiative of learning to students, and transform knowledge from cold symbols into warm wisdom that accompanies them for a lifetime.

4 TEACHING REFLECTION AND IMPROVEMENT

With the Law of Total Probability as the carrier, this teaching design realizes the organic integration of mathematical thinking and ideological and political education through three progressive cases of C919 Domestic Large Aircraft-Supply Chain Risk Management-Migration in Economics and Management Field. Post-class student reflections show that the vast majority of students mention ideological and political gains such as systematic thinking, problem decomposition and a sense of responsibility in their reflection assignments, and believe that the ideological and political content is integrated naturally and closely combined with the major. Typical reflections such as "The C919 case made me understand the management wisdom behind the major-country heavy equipment" and "Lao Tzu's saying 'The difficult things in the world must be done from the easy' will become my thinking tool for facing complex problems" confirm the initial achievement of the curriculum ideological and political objectives.
The core experience is that the entry point of ideological and political education must be in line with the characteristics of the major and isomorphic with mathematical thought. Simplifying the complex is not only the mathematical essence of the Law of Total Probability, but also the basic methodology of management. The high consistency between the two makes the integration of ideological and political education as natural as salt dissolving in water.
Existing deficiencies: The time control of the group discussion link needs to be optimized, and the discussion of the supply chain case is slightly overtime; individual students have the phenomenon of free-riding, resulting in uneven participation; after the simplification of case data, the challenge is insufficient for students with spare capacity.
Improvement directions: Release preview videos to create situations before class, use AI tools to generate case data in real time and information means to improve interaction efficiency in class, and establish a case library of economics and management applications to extend learning after class; at the same time, strengthen the division of group roles to ensure the participation of all students, and cooperate with subsequent professional courses to form a joint force of ideological and political education, so that mathematical thinking can be continuously deepened and benefit students for a lifetime in professional learning.
The teaching design of the Law of Total Probability takes the mathematical thought of simplifying the complex as the core, takes the airworthiness certification of domestic large aircraft as the entry point, and builds a teaching path of deep integration of knowledge imparting and value guidance with the help of the BOPPPS teaching model. From situational introduction to participatory inquiry, from case migration to ideological sublimation, students not only master the mathematical structure of the Law of Total Probability in the progressive learning activities, but also subtly comprehend systematic thinking, a sense of responsibility and patriotism. The practice of this case shows that curriculum ideological and political education is not an ornament of knowledge, but an awakening of thought. When mathematical tools meet the propositions of the times and logical deduction blends with value inquiry, the classroom is no longer a cold formula deduction, but a fertile ground for the growth of thinking and the cultivation of spirit. In the future, we will continue to promote the transformation of curriculum ideological and political education from integration to internalization in a subtle way, so that mathematics education can truly serve students' lifelong development and social responsibility.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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REFERENCES

[1] Wu Ganchang. Probability Theory and Mathematical Statistics (Fifth Edition). China Renmin University Press, 2017: 21.
[2] Wang Yun, Wang Qian. Research on Online and Offline Blended Classroom Teaching of Probability Theory and Mathematical Statistics—Taking Guizhou University of Commerce as an Example. Industrial & Science Tribune, 2025, 24(17): 177-180.
[3] Jin Aiyun, Zhou Yongwei. Teaching Practice of Probability Theory and Mathematical Statistics Based on the Blended Teaching Mode Combining BOPPPS and PAD Class. The Science Education Article Collects, 2022, (24): 72-75.
[4] Wang Yongjuan, Jiang Xichun, Fan Yingbing. Teaching Practice of Probability Theory and Mathematical Statistics Course for Big Data Majors Based on the BOPPPS Model. Electronic Technology, 2023, 52(12): 220-221.
[5] Sun Yuefang, Guo Zhaozhuang, Bi Xiaohua, et al. Exploration and Practice of Probability Theory and Mathematical Statistics Course Teaching Based on BOPPPS Teaching Mode. Journal of North China Institute of Aerospace Engineering, 2023, 33(04): 30-32.
[6] Wang Zheng, Gong Yi. Research On Blended Teaching Of Advanced Mathematics Courses Based On BOPPPS Teaching Mode. World Journal of Mathematics and Physics, 2024, 2(2): 46-49.
[7] Lü Ning. Teaching Reform Practice of Probability Theory and Mathematical Statistics Based on BOPPPS Model Using Chaoxing Learning Platform . Science & Technology Vision, 2021, 14: 49-53.
[8] Shi Qiuhong, Tang Maoning. Effective Classroom Teaching Design of Probability Theory and Mathematical Statistics Based on BOPPPS Teaching Model—Taking Hypothesis Testing Teaching Design as an Example. University Education, 2022, 11: 100-102.