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# TEACHING DESIGN AND PRACTICE OF IDEOLOGICAL AND POLITICAL EDUCATION IN THE COURSE OF PROBABILITY THEORY AND MATHEMATICAL STATISTICS

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**Abstract:** In the context of the comprehensive promotion of ideological and political education in courses, the course "Probability Theory and Mathematical Statistics" in higher vocational colleges, relying on its materialist dialectics thought, scientific methodology and wide application, has a natural advantage in ideological and political education. In view of the problems existing in the current teaching, such as the superficial integration of ideological and political elements, the single teaching mode, and the insufficient coordination of the evaluation system, this paper takes Shenzhen Polytechnic as an example and proposes a systematic reform path: construct a modular knowledge system of "probability basis - statistical inference - applied modeling", and design a three-level ideological and political education route of "me - family - country" in a hierarchical manner; Innovate digital teaching resources and interdisciplinary projects to achieve contextualized teaching; Establish a multi-faceted evaluation mechanism covering technology application and ideological and political literacy. Practice has shown that this model effectively promotes the organic unity of knowledge, ability and value, provides a reference for the construction of ideological and political education in higher vocational mathematics courses in higher vocational colleges, and is of great significance for cultivating high-quality technical and skilled talents with both moral integrity and professional skills.
**Keywords:** Curriculum-based ideological and political education; Probability Theory and Mathematical Statistics; Instructional design

## 1 INTRODUCTION

At present, China is in a crucial period of fully building a modern socialist country and advancing towards the second centenary goal, and the demand for high-quality technical and skilled personnel is more urgent than ever. Higher vocational education, as the main front for cultivating great craftsmen and skilled workers, shoulders the fundamental task of "cultivating virtue and nurturing talent". The Ministry of Education's "Guidelines for the Construction of Ideological and Political Education in Higher Education Courses" clearly states that we should comprehensively promote the construction of ideological and political education in courses, incorporate value guidance into knowledge imparting and ability cultivation, and make all kinds of courses move in the same direction as ideological and political theory courses to form a synergy effect.

In this context, as an important public basic course commonly offered for science and engineering and economics and management majors in higher vocational colleges, Probability Theory and Mathematical Statistics, due to its unique disciplinary attributes - rich materialist dialectics ideas (such as necessity and contingency, quantitative change and qualitative change), rigorous scientific thinking methods (such as induction and deduction, hypothesis testing), and extensive application scenarios (such as risk assessment, quality control, data analysis), It naturally has deep soil and significant advantages for implementing ideological and political education in the curriculum[1].

However, looking at the current teaching practice of this course in higher vocational colleges, there are still some urgent problems that need to be solved: First, the teaching content is overly focused on theoretical derivation and problem-solving skills, and is not deeply related to professional practical application and professional quality, and the ideological and political elements contained in the course have not been fully explored; Second, the teaching methods are rather traditional and monotonous, making it difficult to effectively stimulate students' interest in learning and internalize value guidance. Third, there is a tendency for the integration of ideological and political education to be "labeled" and "student-hardened", and it fails to achieve an organic integration with professional knowledge and ability goals in a subtle way[2]. Therefore, deeply exploring how to systematically, naturally and effectively integrate ideological and political elements into the course of Probability Theory and Mathematical Statistics, construct a scientific teaching design model and put it into practice, is an inevitable requirement and an urgent issue for implementing the fundamental task of fostering virtue and nurturing talent and improving the quality of talent cultivation in higher vocational education[3]. This paper takes Shenzhen Polytechnic as an example, based on the practical teaching experience of the course of Probability Theory and Mathematical Statistics, systematically summarizes and refines effective ideological and political teaching strategies, providing a reference for the reform of ideological and political education in similar courses.

## 2 THE NECESSITY OF BUILDING IDEOLOGICAL AND POLITICAL EDUCATION IN PROBABILITY THEORY AND MATHEMATICAL STATISTICS COURSES

### 2.1 The Urgent Need to Implement the Fundamental Task of Fostering Virtue and Nurturing Talent and to Lay a Solid Ideological Foundation for Students

The core mission of higher vocational education is to cultivate high-quality technical and skilled talents with both moral integrity and professional skills. Probability theory and mathematical statistics, as a science that studies the laws of random phenomena and emphasizes data-driven decision-making, naturally incorporate rich elements of ideological and political education in its teaching process, such as dialectical materialist worldview, methodology, scientific spirit, professional ethics, etc. In higher vocational colleges, some students may focus more on the acquisition of skills and pay less attention to the shaping of worldviews, outlooks on life and values. Integrating ideological and political education into teaching can go beyond mere knowledge imparting and skills training. When explaining the contingency and necessity of random events and the inductive logic of statistical inference, it can guide students to understand the objective laws of the development of things and cultivate a scientific attitude of seeking truth from facts and being rigorous and realistic. When analyzing data and interpreting results, incorporate the awareness of integrity, responsibility and the rule of law to help students establish correct values and professional ethics[4]. This is an inherent requirement to incorporate the fundamental task of fostering virtue and nurturing talent throughout the entire teaching process of basic courses and to ensure the correct political direction and value orientation of talent cultivation in higher vocational education. It is a key measure to lay a solid ideological foundation for students' future development.

### 2.2 In line with the Cognitive Characteristics and Career Development Needs of Higher Vocational Students, it is an Effective Way to Enhance the Intrinsic Motivation for Learning

Higher vocational students have active minds and strong hands-on abilities, but they may have a certain fear of understanding abstract theories. If traditional probability and statistics teaching focuses too much on formula derivation and calculation skills, it may make students feel bored and unable to appreciate its practical value and intellectual charm. Integrate ideological and political education into the curriculum by carefully designing ideological and political teaching cases that are close to students' lives, professional backgrounds and social hotspots[5]. For example, the Bayesian formula is used to analyze the mechanism of online rumor dissemination and to cultivate the ability to distinguish information; Use hypothesis testing to interpret product quality control standards and understand the rigor of the "craftsman spirit"; Using descriptive statistics to show the country's achievements in poverty alleviation and enhance national pride can effectively bridge the gap between theory and reality and stimulate learning interest and intrinsic motivation. At the same time, the integration of ideological and political elements leads students to recognize that probability and statistics are not only problem-solving tools, but also essential qualities for understanding the complex world, making scientific decisions, and fulfilling social responsibilities. This value guidance can significantly enhance students' recognition of the importance of the course, shift their learning goals from "passive test-taking" to "active knowledge acquisition" and "ability improvement", and better meet their needs for analyzing, solving problems and undertaking social responsibilities in their future careers.

### 2.3 The Inevitable Choice for Cultivating Students' Core Literacy and Risk Awareness in Response to the Challenges of the Information Age

In today's society, which has entered the era of big data and artificial intelligence, probability and statistical thinking have become essential core competencies for citizens. While the information explosion brings convenience, it is also fraught with the risks of data traps, algorithmic bias, false advertising and over-interpretation. Vocational college students, as future builders and important participants in cyberspace, must have the ability to think rationally, evaluate information critically, and resist false thoughts. Incorporating ideological and political elements into probability and statistics teaching focuses on cultivating students' data literacy and statistical thinking: for example, by explaining sampling bias, the difference between correlation and causality, etc., teach students to identify data traps and misleading conclusions, not to follow blindly and not to believe easily; Use concepts such as expected value, variance, and confidence interval to analyze investment risks, production safety, public health events, etc., and develop the ability to assess risks and make rational decisions based on data and probability; Establish correct data ethics and legal awareness by emphasizing the legality of data collection, the importance of privacy protection, the objectivity of analysis results, and the social responsibility of release. The cultivation of these qualities is a key to helping students withstand the risks of the information age and become responsible digital citizens, with a strong sense of urgency in reality.

### 2.4 A Key Link in Deepening the Reform of Higher Vocational Mathematics Teaching to Achieve the Synergy of "All-Round Education"

For a long time, there have been problems in higher vocational mathematics courses, such as emphasizing knowledge over ability, theory over application, and skills over value. The integration with professional education and ideological and political education has been insufficient. Integrating ideological and political elements deeply into probability and statistics courses is an important breakthrough to promote the transformation of higher vocational mathematics teaching

from "knowledge-oriented" to "equal emphasis on ability and value"[6]. It requires teachers to restructure teaching content, innovate teaching methods and reform the evaluation system. The process itself can strongly promote the improvement of teachers' awareness and ability to educate students and drive the overall leap in the quality of curriculum teaching. More importantly, it breaks down the barriers between basic mathematics courses and ideological and political education, making the mathematics classroom an important front for "all-round education", moving in the same direction as ideological and political courses, responding and enhancing synergy with ideological and political elements in professional courses, jointly building a more complete and effective ideological and political education system in higher vocational colleges, and comprehensively improving the quality of talent cultivation, It serves the demand for high-quality technical and skilled talents in national strategies and regional economic and social development[7].

## 3 PROBLEMS IN THE TEACHING OF PROBABILITY AND MATHEMATICAL STATISTICS

### 3.1 The Superficial Integration of Ideological and Political Elements with Professional Content

At present, there is a widespread phenomenon of "hard integration" in the construction of ideological and political education in courses, and some teachers fail to deeply explore the dialectical materialist thought and scientific ethics connotations contained in the discipline of probability theory and mathematical statistics. The ideological and political materials mostly remain at the level of anecdotes or slogan-like value advocacy of mathematicians, and fail to establish a deep connection between the hypothesis testing methodology in statistical inference and the scientific spirit of seeking truth from facts, and the correlation and causality analysis in big data analysis and the cultivation of critical thinking. This kind of "tagging" ideological and political embedding leads to a "two-skin" state of professional knowledge and value education, weakening the persuasiveness and appeal of ideological and political education.

### 3.2 Inadequate Fit between Teaching Models and Cognitive Patterns

Traditional lecture-based teaching still dominates, lacking inquiry-based instructional designs based on real-world problems. The probabilistic models involved in the course could effectively relate to social hotspots such as public health decision-making and financial risk management, but the teaching cases are often confined to closed mathematical contexts. At the same time, the lack of information technology empowerment and the failure to use visualization tools such as Monte Carlo simulation to reveal the philosophical essence behind statistical laws have weakened the construction of meaning between abstract theories and the real world. This one-way indoctrination model is difficult to inspire students to think deeply about statistical ethics and hinders the internalization process of value recognition.

### 3.3 There is a Lack of Synergy between the Evaluation System and Educational Goals

The current assessment mechanism overly focuses on the technical ability assessment of probability calculation and statistical test, lacking scientific measurement of the effectiveness of ideological and political education. Core competencies such as students' scientific ethics in statistical modeling and their sense of responsibility in using statistical methods to serve society are not included in the evaluation dimensions. There is also a lack of an observation scale for critical thinking ability in the process evaluation, resulting in the illusion of value guidance goals. The deviation of the evaluation orientation has reduced ideological and political education to a formalized teaching link, failing to achieve the organic unity of knowledge imparting and value shaping.

## 4 PRACTICE OF IDEOLOGICAL AND POLITICAL EDUCATION IN PROBABILITY THEORY AND MATHEMATICAL STATISTICS: A CASE STUDY OF SHENZHEN POLYTECHNIC UNIVERSITY

### 4.1 Objectives of Probability Theory and Mathematical Statistics Course

#### *4.1.1 Knowledge objectives*

Probability Fundamentals: Master random event operations, conditional probability, total probability and Bayes' formula, and understand classical/geometric probabilities and event independence.

Core of Statistical Inference: Proficient application of random variable distribution, numerical characteristics, and sampling distribution theorems; Master parameter estimation and hypothesis testing methods.

Application Tools: Understand the practical significance of the law of large numbers, the central limit theorem and Chebyshev's inequality, and master the construction of confidence intervals and the distribution properties of statistics.

#### *4.1.2 Competency objectives*

Modeling application: Enhance the ability to transform and solve problems through practical cases, such as stochastic phenomenon modeling, and cultivate statistical thinking and innovative practical ability.

Technical tools: Utilize statistical software such as MWORKS, R, and SPSS to achieve data processing and analysis, and enhance the ability to apply technology and interpret results.

Scientific thinking: Develop quantitative and qualitative dialectics through cases such as the Bernoulli experiment, and enhance logical reasoning, scientific insight and knowledge transfer skills.

#### *4.1.3 Quality objectives*

Value guidance: Through Bayes' formula, such as the fable "The Wolf Is coming", strengthen the concept of integrity, interpret the meaning of persistence with the law of large numbers, and guide students to establish the core socialist values and correct outlook on life.
Scientific spirit and social responsibility: By integrating the history of mathematics, such as cases of scholars like Wang Zishen and Xu Baolu, it stimulates the spirit of exploration and cultivates an academic attitude of rigor and truth-seeking; emphasizing the authenticity of data, algorithm ethics, and the social value of statistical decision-making, and strengthening critical thinking and the responsibility of solving social problems.
Disciplinary identity and practice-oriented: Through professional integration cases such as financial risk prediction and epidemic data analysis, deepen the instrumental cognition of mathematics, enhance disciplinary interest and a sense of responsibility to serve society.

### 4.2 Reform of Teaching Content and Construction of Curriculum Resources for Probability Theory and Mathematical Statistics

#### *4.2.1 Establish a modular content system and reconstruct the logic of knowledge*

Based on the requirements of science and engineering, economics and management, and life sciences, the curriculum is divided into three core modules: "Probability Fundamentals", "Statistical Inference", and "Applied Modeling", and each module is designed with a four-level progressive structure of "basic concepts → formula derivation → practical application → frontier extension". For example, science and engineering subjects emphasize stochastic processes and distributional transformations, economics and management subjects focus on statistical decision-making and risk analysis, and life subjects focus on hypothesis testing design; At the same time, interdisciplinary cases such as financial risk prediction and genetic sequence analysis are integrated to achieve a precise fit between professional requirements and knowledge systems[8].

#### *4.2.2 Incorporate ideological and political elements to achieve value guidance*

Build a three-level ideological and political education route of "I - family - country" : At the individual level, analyze the cost of integrity in the fable "The Wolf Is Coming" through the Bayesian formula; At the social level, use Chebyshev's inequality to interpret scientific decision-making in epidemic prevention and control; At the national level, the law of large numbers is used to explain the long-term persistence in poverty alleviation. At the same time, we will explore ideological and political resources in the history of mathematics, such as the scientific spirit of scholars like Xu Bao ð« youdaoplaceholder6 § and Wang zikun, and combine the law of "quantitative change and qualitative change" in Bernoulli's experiment to cultivate a rigorous and truth-seeking academic attitude and patriotism[9].

#### *4.2.3 Complement digital platform resources to expand learning time and space*

Build knowledge graphs based on platforms such as Learning Pass and SPOC, associate 90 knowledge points, 756 exercises and micro-lesson videos, and support on-demand redirected learning, such as clicking on the "Central Limit Theorem" to link simulation animations and postgraduate entrance examination questions. Qr code teaching materials are developed, which can be scanned to access R/SPSS software operation guide, ideological and political case library and cutting-edge literature, forming a closed loop of "classroom - extracurricular - lifelong learning". Use AI teaching assistants to achieve learning progress tracking, intelligent path planning and real-time Q&A, breaking through the time and space limitations of traditional teaching.

#### *4.2.4 Stratified teaching to meet individual needs*

Implement a dynamic stratification strategy: The base level lowers the comprehension threshold through gamified cases such as card probability experiments; Advanced level design professional integration tasks such as financial risk modeling; The advanced level provides postgraduate entrance examination questions and mathematical modeling competition questions. With a multi-evaluation system, integrating process data and terminal assessment, covering dimensions such as technical application and depth of thinking, to achieve differentiated training goals.

#### *4.2.5 Project-driven to develop comprehensive abilities*

Design a full-process interdisciplinary project covering "data collection → model construction → software implementation → decision support" : Economics and management majors analyze consumer behavior data, while life science majors handle statistical inference issues of gene sequences. Introducing a competition feedback mechanism to transform the National College Students' Mathematical Modeling Contest questions into classroom cases, such as Monte Carlo simulation for traffic optimization, simultaneously enhancing innovation practice, teamwork, and complex problem-solving abilities.

### 4.3 Presentation of Teaching Process Design for De Mover-Laplace's Central Limit Theorem

#### *4.3.1 Scenario setting: Introducing the Galton pegboard experiment (10 minutes)*

Experiment demonstration: Show a real Galton nail board or a dynamic simulation animation, release a small ball and observe its distribution as it falls into the bottom grid (Figure 1).

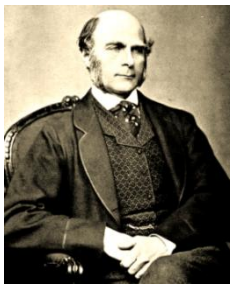
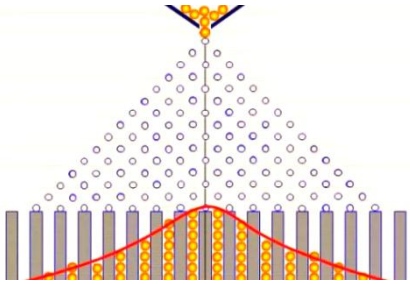

**Figure 1** Galton and His Pegboard Experiment

Key question: "What determines the final position of the ball?" (Random collision stacking of a large number of nails); "Why is the distribution always approximating a bell curve? No matter how the number of nail layers varies?"
Data recording: Students were grouped to record the distribution of small balls under 10 and 20 layers of nails, draw frequency histograms, and observe the transition from binomial distribution to normal distribution.

***4.3.2 Establish mathematical models: from binomial distribution to limit form (15 minutes)***

Abstract Experiment Essence:Let the number of nail layers be $n$, and the probability of the ball moving left/right in each collision be $p$ = 0.5. The final position is $S_n = \sum_{i=1}^{n} X_i$ ( $X_i$ is the offset of the i-th collision), and $\rightarrow S_n \sim B(n, p)$ leads to the probability formula $P(S_n = k) = C_n^k p^k (1-p)^{n-k}$ of the binomial distribution.

Dilemma Reveals:"When $n$ = 1000, calculating $P(S_n = 500)$ requires calculating $C_{1000}^{500} 0.5^{1000}$. How to deal with the numerical disaster?" → The student realized that they needed to look for approximate calculation tools.

***4.3.3 Discovery and derivation of the De Mover-laplace theorem (30 minutes)***

Historical Background: Briefly describe De Mover's proof of $p$=0.5 and Laplace's generalization to general $p$.
Theorem statement: When $n \rightarrow \infty$, approaches infinity, for any $a < b$,

$$P(a \le \frac{S_n - np}{\sqrt{np(1-p)}} \le b) \rightarrow \int_a^b \frac{1}{\sqrt{2\pi}} e^{-t^2/2} dt .$$

Intuitive derivation: By combining Stirling's formula and Taylor expansion, prove that the distribution density of the standardized variable $Z_n = \frac{S_n - np}{\sqrt{np(1-p)}}$ converges to $\Phi(z) = \frac{1}{\sqrt{2\pi}} e^{-z^2/2}$.

Dynamic demonstration: Animation of fitting the binomial distribution to the normal density curve at different $n$ values using Python.

***4.3.4 A Deeper understanding and application of the theorem (25 minutes)***

Reinterpreting the Galton nail board: "In the experiment, the standardization of $Z_n$, which represents the position of the small ball, has a limit distribution that is standard normal - this is the mathematical origin of the bell-shaped curve!"
Case 1: A factory's product qualification rate $p$=0.6, quality inspection random $n$= 10,000 pieces. "How to estimate the probability of the number of qualified products being between 5,950 and 6,050?" → Guide students to calculate using theorems, emphasizing the supporting role of statistical inference in industrial quality control in the era of big data.
Application Case 2: Simulating "fair lottery" using the Central Limit Theorem, such as scholarship selection: When $n$ is small, the results may deviate significantly from the normal distribution, leading to unfairness → Extending "small sample risk", emphasizing the importance of procedural fairness and transparency.

***4.3.5 Summary and elevation (10 minutes)***

Philosophical connotation: From quantitative change to qualitative change, the independent perturbation of random variables (like the collision of nails) accumulates over a large number of instances and eventually emerges with a deterministic pattern (normal distribution); Universality and particularity, regardless of the specific form of $X_i$ (for example, when the nail is asymmetrical, $p \neq 0.5$), the limiting distribution of the sum is unique.
Mission of a Tech Power: Point out that this theorem is the cornerstone of statistics (hypothesis testing), financial engineering (risk assessment), artificial intelligence (stochastic algorithms), and inspire students to lay a solid foundation and serve national strategic needs.

## 5 DISCUSSION AND CONCLUSION

### 5.1 Systematically Build a Case Library for Ideological and Political Education in Courses to Strengthen Content Support

Establishing a scientific and hierarchical ideological and political case library is the key to the implementation of ideological and political education in courses. The construction of the case library should be based on the characteristics of the discipline and deeply explore the ideological and political elements in probability theory and mathematical statistics:

***5.1.1 Theory combined with practice***

For example, by using the "Bayes' formula" to analyze dynamic risk assessment in epidemic prevention and control to demonstrate the importance of scientific decision-making; Use the Law of large numbers to interpret the rigor of data research in poverty alleviation and cultivate students' scientific spirit of seeking truth from facts.

***5.1.2 Integrate the history of the discipline with values***

Introduce the exploration stories of mathematicians such as Gauss and Poisson, emphasizing the spirit of innovation and patriotism, such as the story of Hua Luogeng's return to China and his contributions; By reflecting on data ethics through "hypothesis testing" cases, students are guided to adhere to academic integrity.

***5.1.3 Layered design of cases***

Basic concepts are associated with life integrity education, and the statistical inference section focuses on social responsibility, such as the impartiality of public opinion polls; The integrated application module incorporates national strategies such as big data for rural revitalization. The case library should be accompanied by a user guide, with clear ideological and political goals and teaching entry points to ensure that teachers "use it well and integrate it skillfully".

### 5.2 Enhance the Ideological and Political Teaching Capabilities of the Teaching Team in Multiple Dimensions and Consolidate the Foundation of the Teaching Staff

Teachers are the main implementers of ideological and political education in the curriculum and need to enhance team capabilities through the "training-collaboration-reflection" trinity mechanism:

***5.2.1 Professional training***

Organize ideological and political teaching seminars and invite experts from the School of Marxism to jointly analyze philosophical ideas in statistics to help teachers master values guidance skills; Carry out "course-based ideological and political demonstration classes" observation activities, focusing on how to naturally incorporate ideological and political elements rather than mechanically graft them.

***5.2.2 Interdisciplinary collaboration***

Establish collective lesson preparation groups of math teachers + ideological and political teachers + industry experts to jointly develop cases, such as the cultivation of legal awareness in financial risk models; Encourage teachers to participate in social science projects to enhance their sensitivity to real-world problems.

***5.2.3 Dynamic reflection***

Implement teaching logs to record the effectiveness of ideological and political education, and continuously optimize cases through student feedback and peer review; Establish an "Innovation Award for Ideological and Political Teaching" to stimulate teachers' intrinsic motivation and achieve a shift from "passive transmission" to "active design"[10].

### 5.3 Innovate Teaching Models and Methods to Achieve Organic Integration of Ideological and Political Elements

Break away from the traditional "single knowledge transmission" model and build a three-dimensional teaching objective of "knowledge - ability - value".

***5.3.1 Contextualized teaching***

Design project-based learning tasks, such as analyzing the statistical significance of environmental pollution data in a certain area, to guide students to understand the development concept that "green mountains and clear waters are as valuable as mountains of gold and silver"; Use Monte Carlo simulations to predict the effects of policies and cultivate a sense of patriotism and responsibility.

***5.3.2 Technology-enabled interaction***

Carry out data mining practices with tools such as R language and Python, and strengthen the scientific attitude of "speaking with data" in analyzing social hotspots; Deepen the values of technology for good by setting up ethical debates on online platforms, such as "The Causes and Countermeasures of Algorithmic Discrimination".

***5.3.3 Multiple evaluation mechanisms***

Incorporate ideological and political literacy into the assessment, such as marking data sources for report writing to reflect academic norms, and group defense to evaluate their analytical stance on public issues; Use "learning portfolios" to record the growth trajectory of students' values and achieve long-term ideological and political education.

## COMPETING INTERESTS

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