

RESEARCH AND PRACTICE OF THE "FOUR-TWO-ONE" VIRTUE-INTEGRATED TEACHING MODEL IN THE COURSE "FUNDAMENTALS OF PROBABILITY THEORY"

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Abstract: In response to issues in the teaching of the "Fundamentals of Probability Theory" course, such as the rigid integration of ideological and political education, abstract theoretical concepts, and a singular evaluation system, the teaching team has developed a teaching model centered on the "Four Transformations" (precise teaching objectives, distinctive teaching methods, modular practical teaching, and integrated assessment evaluation), "Two Integrations" (combining practical problems with probability knowledge, and integrating knowledge impartation with ability cultivation), and "One Unity" (unifying ideological education with course teaching). Through teaching practice, this model has effectively enhanced students' autonomous learning ability, stochastic thinking skills, and comprehensive quality. At the same time, it has achieved significant results in areas such as academic competitions and course pass rates, providing valuable experience for teaching reforms in similar courses.

Keywords: Fundamentals of probability theory; Four-two-one model; Virtue-integrated education; Teaching reform; Ideological and political education in courses

1 INTRODUCTION

As a core foundational course for statistics majors, Fundamentals of Probability Theory plays an irreplaceable role in cultivating students' stochastic thinking and data analysis capabilities. However, traditional teaching models exhibit numerous limitations and struggle to meet the talent development demands of the new era. Probability theory curriculum reform has become a key focus in the development of statistics programs across many universities [1]. According to relevant studies, in the context of the "Four New Constructions," probability theory courses face issues such as a disconnection between teaching objectives and the cultivation of higher-order competencies, course content lagging behind interdisciplinary needs, monotonous teaching methods, and a one-sided evaluation system [2]. At the same time, against the backdrop of the comprehensive advancement of "Curriculum Ideology and Politics," how to naturally integrate ideological and political elements into the teaching of probability theory, achieving an organic unity of value guidance and knowledge impartation, has become a significant direction in current teaching reforms [3]. Based on years of teaching practice by the instructional team and aligned with the student-centered educational philosophy, this paper constructs a "Four-Two-One" virtue-integration teaching model for Fundamentals of Probability Theory. It further explores its implementation pathways, specific application effects, and promotional value, aiming to provide references for the ideological and political teaching reform of STEM professional courses in higher education institutions.

2 TEACHING PAIN POINTS

Through an in-depth analysis of the current teaching situation of the Fundamentals of Probability Theory course, we have identified the following five teaching pain points:

Unnatural Integration of "Curriculum Ideology and Politics": In traditional teaching, the introduction of ideological and political elements is often abrupt and forced, failing to organically integrate with the specialized knowledge of probability theory. This leads to student resistance and hinders the achievement of value-oriented education goals [3]. This finding is consistent with the analysis of issues in "Curriculum Ideology and Politics" teaching in related research.

Significant Disparities in Mathematical Foundation: Students exhibit noticeable differences in mathematical background and comprehension skills. Those with weaker foundations often struggle with the abstract concepts and complex calculations in probability theory, easily developing apprehension and a sense of frustration.

Difficulty in Understanding Probabilistic Concepts: Probability theory deals with random phenomena, requiring a way of thinking significantly different from the deterministic mathematics students are accustomed to. The abstract concepts and complex theorems in the course make the theoretical components generally hard for students to grasp, let alone apply flexibly [4].

Incomprehensive Course Evaluation System: Traditional evaluation over-relies on final exam scores, lacking formative assessment and a diversified evaluation mechanism. This fails to fully reflect the student's learning process

and ability development, and does little to motivate independent learning and innovative thinking. Research indicates that diversified and dynamic assessment methods are a key direction for reform [2].

Insufficient Cultivation of Integration and Innovation Skills: Teaching disproportionately emphasizes theoretical knowledge transmission, lacking systematic training in students' ability to integrate knowledge, think innovatively, and apply knowledge practically. Consequently, students find it difficult to use probability theory to solve real-world problems.

3 INNOVATIVE CONCEPTS AND MODEL CONSTRUCTION

In response to the above-mentioned teaching pain points, the course team, after years of exploration, has established the "4-2-1" moral integration teaching model for "Fundamentals of Probability Theory", comprehensively promoting the reform of course teaching.

3.1 The "Four Transformations" Teaching Model

3.1.1 Precise teaching objectives

The course team refined the teaching objectives into three dimensions: knowledge, ability, and literacy, achieving tiered and categorized precise cultivation. The knowledge objective focuses on mastering the basic concepts, theories, and methods of probability theory; the ability objective emphasizes cultivating stochastic thinking, data analysis, and problem-solving skills; the literacy objective stresses shaping the scientific spirit, dialectical thinking, and values. Through this precise objective design, teachers can implement differentiated instruction for students with varying foundations, ensuring every student improves based on their starting point.

3.1.2 Distinctive Teaching Methods

The team developed a distinctive learning method centered on "One Look, Two Memorizations, Three Unifications." "One Look" involves browsing the textbook table of contents to build a knowledge framework and grasp the course structure; "Two Memorizations" means memorizing the table of contents, definitions, and theorems to deepen understanding of the content; "Three Unifications" refers to summarizing and integrating content from different chapters to form a systematic probabilistic thinking mode [5].

Concurrently, teachers employ diverse teaching methods, such as "scenario-based" teaching, which introduces probability concepts through real-life examples; "problem-driven" teaching, which guides students to analyze and solve probability problems; and "discussion and inquiry-based" teaching, which encourages students to collaboratively explore complex probability cases. These methods significantly enhance student classroom participation and learning initiative.

3.1.3 Modular practical teaching

Addressing the highly applicable nature of probability theory, the course team divided the teaching content into seven core modules: stimulating interest and inspiring thinking; exploring new knowledge and mastering content; classroom discussions to enhance ability; summarizing the lesson to highlight key points; in-class exercises to test effectiveness; recapitulation to consolidate new knowledge; and post-class extension to overcome difficulties. This modular design makes the teaching content more systematic, facilitating students' construction of a knowledge system.

In practical components, the team designed three levels of practice modules: basic theory, application cases, and hands-on operation. This design aligns with the "integration of theory and practice" teaching principle and resonates with the problem-driven and case-integration concepts emphasized in research [6]. For example, within the application case module, real-world scenarios like financial risk assessment, medical statistics, and engineering reliability analysis are introduced, allowing students to experience the practical value of probability theory. This approach is consistent with the "integration of theory and practice" principle and coincides with cutting-edge research emphasizing problem-driven and case-based methodologies. Furthermore, in teaching mathematical expectation, the "pooled testing" model from nucleic acid testing is introduced, guiding students to establish a mathematical model and discuss its efficiency, thereby cultivating their scientific research and innovation capabilities [7].

3.1.4 Integrated assessment and evaluation

The course team established an integrated evaluation system combining self-assessment, peer assessment, and teacher assessment. Regular performance accounts for 40%, including assignments, pre-class quizzes, collaborative tasks, and unit tests; the midterm exam accounts for 20%, conducted in the form of a short course paper; the final exam accounts for 40%, retaining the traditional examination format. This multi-faceted evaluation mechanism focuses on the entire learning process, particularly the peer assessment within collaborative tasks, effectively fostering students' teamwork spirit and critical thinking skills. This system is highly consistent with the "diversified and dynamic assessment" concept advocated by scholars [2], representing an effective innovation over the traditional single evaluation model. It focuses specifically on the student's entire learning process and effectively cultivates teamwork spirit and critical thinking skills.

3.2 The "Two Integrations" Educational Philosophy

3.2.1 Integration of practical problems and probability knowledge

The course team closely links probabilistic theoretical knowledge with practical problems from real life, using case-based teaching to help students understand the application value of probability theory. For instance, when

teaching the total probability formula and Bayes' theorem, the Aesop's fable "The Boy Who Cried Wolf" is used to guide students in applying Bayes' theorem to calculate changes in credibility, thereby mastering the knowledge while deeply understanding the importance of honesty.

In teaching mathematical expectation, incorporating the "pooled testing" model from nucleic acid testing leads students to discuss and analyze efficiency issues in medical testing, establishing a general model for medical diagnostics and cultivating their scientific research innovation and application abilities. Introducing such practical problems makes abstract mathematical theories vivid and concrete, significantly boosting student interest.

3.2.2 Integration of knowledge impartation and ability cultivation

During teaching, the team emphasizes the organic combination of knowledge impartation and ability cultivation. By designing diverse teaching activities such as group discussions, project practice, and mathematical modeling competitions, they foster students' self-directed learning ability, innovation capability, critical thinking, and teamwork skills.

The course particularly emphasizes the use of inquiry-based learning models, integrating statistical modeling concepts into classroom teaching. By connecting probability theory with specialized knowledge, it guides students to learn evaluation and analysis during the inquiry-based learning process, enhancing their imagination, critical and logical thinking, and innovation abilities. This teaching model aligns highly with the "student-centered" philosophy advocated in forefront research [8].

3.3 The "One Unification" Teaching Model

The "One Unification" model entails the unification of ideological and political education with course teaching, organically integrating ideological and political education throughout the entire probability theory course. The team adheres to three major principles: a subtle, pervasive approach like spring rain; alignment with course characteristics; and practical innovation, deeply exploring the ideological and political elements within the probability theory curriculum.

For example, when explaining Bayes' theorem, through the analysis of an "assembly line problem," students are guided to use mind maps to analyze causal relationships and explore the specific form of Bayes' theorem. Simultaneously, they comprehend the dialectical thinking in mathematics through the relationship between prior and posterior probabilities. In teaching the Law of Large Numbers, students are guided to understand that although the outcome of a single experiment is random, a large number of repeated experiments will inevitably reveal patterns,借此 encouraging the spirit of perseverance in scientific research work [9].

Furthermore, the team also utilizes information-based teaching methods to establish online teaching platforms that complement online and offline, in-class and extra-class activities, achieving the organic integration of moral education with knowledge impartation. This method of naturally integrating ideological and political elements highly aligns with the current requirements for "Curriculum Ideology and Politics" construction.

4 PRACTICAL APPLICATION AND EFFECT

Since 2017, the "4-2-1" moral integration teaching model has been implemented in the "Fundamentals of Probability Theory" course. After years of practice, remarkable achievements have been made.

4.1 Significant Enhancement of Student Abilities

Through the implementation of the "Four-Two-One" teaching model, students' self-directed learning, inquiry-based learning, and innovation abilities have been significantly enhanced. Students actively participate in classroom discussions and practical projects, demonstrating outstanding performance in activities such as statistical modeling competitions, market research and analysis competitions, and scientific research projects. Over the past five years, students have won more than 10 national awards and over 100 provincial-level awards in various academic competitions, showing a marked improvement in their comprehensive ability to apply stochastic, probabilistic, and innovative thinking.

Particularly during the implementation of the flipped classroom, students transformed from initially lacking learning initiative and requiring constant teacher guidance to being capable of independent inquiry and collaborative problem-solving. Their structured and logical thinking, as well as their ability to grasp key and difficult points, showed significant progress.

4.2 Marked Improvement in Teaching Effectiveness

Student classroom participation and learning enthusiasm have significantly increased, with a substantial rise in class engagement and interaction rates. The course pass rate has improved noticeably, and students' performance in probability theory sections of postgraduate entrance exams has also seen considerable enhancement. Course satisfaction surveys indicate that student evaluations of the course are generally higher than those for traditionally taught classes (Table 1).

Table 1 Comparison of Effects Before and after Teaching Reform

Comparison dimension	Before the reform	After the reform	Extent of increase
Classroom participation	Less than 40%	More than 80%	Significant improvement
Course pass rate	About 75%	More than 90%	Significantly improved
Awards in subject competitions	2 to 3 items per year	More than ten items per year	A significant increase
Course satisfaction	3.5/5	4.5/5	Significantly improved
self-directed learning ability	Generally weak	Significantly enhanced	A qualitative leap

4.3 Faculty and Curriculum Development

During the teaching innovation process, the teaching team members have greatly advanced their educational philosophies and teaching skills, achieving remarkable results in teaching reform. The team has received one Second Prize of the Hunan Provincial Basic Education Teaching Achievement Award, one First Prize at the university level, two Second Prizes, and one Third Prize at the university level for teaching achievements. They have also won multiple awards in provincial and university-level teaching competitions.

The course has been recognized as a first-class course at the college level. The teaching reform results have been published in academic journals, and the outcomes of the moral-integration education reform have gained peer recognition. The course team has also been invited to share experiences at multiple institutions, expanding the course's influence.

4.4 Notable Effectiveness of "Curriculum Ideology and Politics"

Through the implementation of moral-integration teaching, students have not only mastered the professional knowledge of probability theory but have also established correct core values, gaining a deeper understanding of the social value of probability theory and the scientific spirit. The integration of "Curriculum Ideology and Politics" with knowledge impartation has become more natural, achieving an organic unity of knowledge education and value guidance.

In their learning reflections, students indicate that through the course, they have not only learned probabilistic knowledge but have also deeply appreciated the importance of values such as integrity, perseverance, and dialectical thinking, achieving an educational effect that "moistens things silently."

5 CONCLUSION

The "Four-Two-One" Virtue-Integration Teaching Model for Fundamentals of Probability Theory has implemented systematic and innovative reforms addressing the pain points in traditional teaching, establishing a scientific and rational teaching system. This model restructures the teaching process through the "Four Transformations" approach, connects theory and practice via the "Two Integrations" educational philosophy, and achieves the organic integration of ideological and political education with professional education through the "One Unification," effectively enhancing both the teaching quality and the educational effectiveness of the course. This teaching model is applicable not only to the Fundamentals of Probability Theory course but also provides valuable experience for the teaching reform of other professional courses. Currently, the model has been applied and promoted in multiple science courses with positive results.

In the future, the course team will further optimize the teaching model, strengthen the development of digital teaching resources, deepen the integration of industry and education, and continuously improve teaching quality to contribute to the cultivation of inter-disciplinary and innovative talents required in the new era. Practice has shown that the "Four-Two-One" Virtue-Integration Teaching Model aligns with the requirements for higher education development in the new era, serves as an effective path to address the teaching challenges of probability theory courses, and possesses broad promotion value and application prospects.

COMPETING INTERESTS

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