

Research on the Construction of a Teaching Application Case Library for Probability and Mathematical Statistics

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Abstract: Probability and Mathematical Statistics is a fundamental core course for science, engineering, economics, management and other majors in colleges and universities. It integrates theoretical nature and practical application, and plays a vital role in cultivating students' capabilities of data analysis, logical reasoning and practical innovation. At present, the teaching of this course in most universities is confronted with prominent problems including separation between theory and practice, single teaching materials and lack of classroom attractiveness, which fail to satisfy the training requirements of application-oriented talents in the new era. As the primary carrier of curriculum teaching resources, teaching case libraries can effectively connect theoretical knowledge with practical application and optimize classroom teaching modes. Taking the teaching reform of Probability and Mathematical Statistics as the entry point, this paper elaborates the teaching value and practical significance of case library construction, clarifies the basic construction principles, and explores feasible implementation paths that match the characteristics and actual teaching of the course. It provides references for improving the curriculum resource system, elevating teaching quality and strengthening students' mathematical application abilities.

Keywords: Probability and mathematical statistics; Construction of case library; Teaching reform; Teaching application

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1. Introduction

Case teaching is a teaching method suitable for mathematics and statistics courses. It takes authentic and typical teaching cases closely linked with professional scenarios as carriers to turn abstract mathematical and statistical theories into concrete, daily, and professional content ^[1]. A systematic teaching case library serves as the prerequisite and foundation for carrying out case teaching. High-quality case resources can enrich teaching contents and transform teaching modes, enabling students to establish connections between theories and practices and deepen their understanding and application of knowledge points ^[2]. Therefore, promoting the construction of a teaching application case library for Probability and Mathematical Statistics is an important measure to implement curriculum teaching reform, improve classroom teaching quality, and cultivate students'

core literacy, which bears great practical significance for perfecting the teaching system of mathematical and statistics courses in universities.

2. Core significance of constructing the case library for probability and mathematical statistics

2.1. Enrich curriculum teaching resources and improve the teaching system

Textbooks are basic teaching materials for Probability and Mathematical Statistics. A standardized and systematic case library can supplement and expand textbook resources. The case library can collect high-quality teaching materials covering various fields and scenarios, involving basic knowledge points, key and difficult points as well as extended application contents, breaking the limitations of textbook contents. Diversified case resources can optimize the structure of curriculum resources and form a three-dimensional teaching resource system of “textbook theories + case practice”, enrich curriculum contents and provide abundant resource support for teachers to carry out diversified teaching, so as to boost the optimization and upgrading of teaching systems of mathematical and statistical courses in colleges and universities ^[3].

2.2. Optimize classroom teaching modes and improve teaching effectiveness

The construction of case libraries provides core support for case teaching, interactive teaching and inquiry-based teaching. Teachers can insert cases related to daily life and industrial practices into teaching progress by utilizing library materials, and integrate abstract theories such as random variables, probability distributions and statistical analysis into specific scenarios. Visualized cases can lower the threshold of knowledge comprehension, arouse students’ initiative and encourage them to think, analyze and solve problems, realizing the shift from passive listening to active learning. Innovative teaching modes can break the inherent barriers of traditional teaching, enhance classroom interaction and interest, and thus effectively lift the overall teaching quality and classroom effects ^[4].

2.3. Connect theories with practice and cultivate students’ application ability

The primary goal of higher education is to cultivate interdisciplinary talents with professional quality and practical capabilities. The core of statistics teaching does not lie in simply instilling theoretical knowledge, but in training students to solve practical problems with mathematical and statistical thinking. All teaching cases in the library derive from real scenarios and fit the job demands of various industries. Teaching based on case libraries enables students to fully recognize the practical value of probability and statistics knowledge, guides them to analyze real problems with statistical thinking, and master basic methods of data processing and statistical analysis. Long-term immersion in case teaching can free students from pure theoretical learning, help them develop rigorous mathematical and logical thinking, strengthen their capabilities of data analysis and problem-solving, meet the basic statistical application requirements of various posts, and facilitate students’ all-round development ^[5].

3. Basic principles for constructing the probability and mathematical statistics case library

3.1. Scientific principle

Scientific nature is the primary principle of case library construction and the key factor determining the

teaching and application value of case resources. Probability and statistics are a rigorous mathematical discipline. The selection and compilation of all teaching cases must strictly follow the discipline's theoretical system and closely align with core knowledge points^[6]. The logical framework, question setting and analytical thinking of cases shall be scientific and rigorous, consistent with fundamental theorems, formulas and statistical laws, without logical loopholes, knowledge deviations or common-sense errors. Case contents shall accurately correspond to key and difficult teaching points and conform to the main requirements of teaching syllabi and talent training programs, ensuring high compatibility between case teaching and theoretical teaching.

3.2. Practical principle

The fundamental purpose of constructing a case library is to serve classroom teaching and improve students' practical abilities, and practicability constitutes the core attribute of case resources^[7]. Case selection shall be based on real teaching needs, eliminating obscure abstract cases divorced from daily life and industrial practices, and adopting authentic scenarios related to daily life, industrial development and professional practice. The difficulty of cases shall match college students' knowledge foundation and cognitive level, featuring both theoretical basis and practical value, which can consolidate basic knowledge and guide students to professional in-depth application. Meanwhile, case resources shall be operable and suitable for conventional classroom teaching without complicated auxiliary conditions for explanation and student research.

3.3. Systematic principle

The knowledge system of Probability and Mathematical Statistics features coherent logic and clear modules. The construction of case libraries shall follow the systematic principle to build a complete, well-organized and fully covered resource system. Case resources shall comprehensively cover all core modules, including probability foundation, random variables, multi-dimensional random variables, numerical characteristics, law of large numbers, parameter estimation, hypothesis testing, and regression analysis, realizing accurate matching between knowledge points and cases and eliminating blind spots in knowledge teaching. The case library shall adopt a clear hierarchical structure divided into basic, advanced and extended types to meet teaching demands at different stages and for students of varying academic levels. Cases of each module are interrelated and progressive; they can be used independently for single knowledge teaching or combined into comprehensive cases for systematic integrated teaching, guaranteeing the integrity and logical order of the whole library system.

4. Implementation paths for constructing the probability and mathematical statistics case library

4.1. Sort out the teaching system and overall plan the library framework

In the early stage of construction, the overall planning of the curriculum shall be taken as the basis to sort out the teaching system and design the library framework for orderly construction^[8]. The university mathematics and statistics teaching team shall fully sort out the curriculum knowledge structure in accordance with the latest talent training programs and teaching syllabi, identify key and difficult points of each chapter, and define practical application fields corresponding to each knowledge point. Based on the complete knowledge system, a hierarchical and classified overall framework shall be established, with curriculum chapters as basic

units to divide core modules such as basic probability, random variables, statistical inference and regression analysis. Cases of each module are categorized into three types: basic application, professional adaptation and comprehensive expansion, with clarified teaching functions, applicable groups and training standards for each category. Systematic framework planning makes the library clear-structured and layered, adapting to various teaching scenarios including daily classroom teaching, after-class expansion and practical training.

4.2. Collect resources through multiple channels to enrich case sources

High-quality case resources form the core of library construction, so diversified channels shall be expanded to supply abundant premium resources. Teaching teams can optimize and upgrade classic cases from textbooks, simplify cumbersome procedures to fit modern teaching and retain their educational value. Cases can also be extracted from common daily scenarios such as weather forecasting, lottery probability and risk assessment to reduce students' comprehension barriers. In addition, connect full-time professional teachers and industrial practitioners to explore professional application cases based on actual posts and industrial classic projects, covering industrial quality inspection, financial risk control, market research, medical statistics, data prediction and other fields. Meanwhile, absorb high-quality domestic and foreign teaching cases relying on university teaching platforms and outstanding open courses, and carry out localized optimization in line with the school's actual teaching conditions. Multi-channel resource collection diversifies case types and improves the richness and adaptability of the library.

4.3. Standardize case compilation criteria to guarantee case quality

Unified standardized compilation rules are vital to guarantee the overall quality of the library. A standardized case compiling system shall be formulated to define the content structure, writing specifications and review standards of each complete teaching case ^[9]. A standard case shall consist of core sections including case background, corresponding knowledge points, guiding questions, analytical ideas, teaching instructions and extended thinking, featuring complete structure, clear logic and highlighted key points. The case background briefly describes specific scenarios with accurately matched knowledge points and clear teaching positions; questions are designed progressively, balancing basic mastery and thinking development; analytical ideas comply with rigorous statistical logic; teaching instructions specify applicable links, duration, and teaching objectives. All finished cases shall undergo collective review by the teaching team to eliminate knowledge loopholes, logical defects and mismatched contents, screening high-quality materials into the library while weeding out outdated and low-quality ones, so as to guarantee the overall quality from the source.

4.4. Optimize case classification system to adapt to layered teaching

The case classification system shall be optimized based on curriculum characteristics and diverse academic levels to realize refined management and targeted use of resources. From the difficulty dimension, cases are divided into three categories: basic, advanced and comprehensive ^[10]. Basic cases consolidate fundamental knowledge for students with weak foundations; advanced cases focus on flexible knowledge application for regular classroom teaching; comprehensive cases integrate multiple knowledge points for professional practical training and high-achieving students. From the major dimension, they are divided into general cases and major-specific cases. General cases apply to foundational teaching of all majors, while exclusive cases are customized for science, engineering, economics, management, art and other majors. The refined classification system enables teachers to quickly locate target cases, effectively implement layered and differentiated

teaching and maximize the educational value of case resources.

4.5. Establish a dynamic update mechanism for long-term library optimization

With the continuous advancement of teaching reform and constant renewal of industry scenarios, the case library requires dynamic updates to avoid rigid and outdated resources. Universities shall establish a regular mechanism for updating, optimizing and iterating the case library, and set up dedicated teaching teams to take charge of its daily maintenance and resource renewal. In light of annual teaching reform requirements, feedback from course instruction and emerging industry scenarios, new cases shall be added on a regular basis while irrelevant materials are phased out. Feedback on cases from teachers and students shall be collected through classroom teaching practices, and adjustments shall be made based on the cases' difficulty, practicality, appeal and compatibility to rectify problems arising during teaching application. The case library resources shall also be enriched by extracting practical cases from disciplinary competitions, course training sessions, students' innovation and entrepreneurship projects, and other relevant activities. A dynamic update mechanism ensures the case library keeps pace with teaching reform trends and industrial development, enabling its sustainable growth and continuous improvement.

5. Conclusion

The construction of a teaching application case library for Probability and Mathematical Statistics is a crucial reform measure for university mathematics and statistics courses, as well as an effective solution to the separation of theory and practice, rigid teaching modes, and insufficient talent training effectiveness. Systematic, high-quality case resources can enrich the curriculum system, optimize classroom teaching modes and strengthen students' mathematical application capabilities, matching the cultivation demands of application-oriented talents in the new era. During library construction, the four principles of scientificity, practicability, systematicness and timeliness shall be consistently followed. Through overall framework planning, multi-channel resource collection, standardized compilation rules, optimized classification systems and continuous dynamic iteration, a high-quality, reusable and highly adaptable teaching case library can be built, providing strong support for the teaching innovation and talent cultivation of university foundational mathematics courses.

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