

# *Research and Practice on Practical Teaching of Probability Theory and Mathematical Statistics*

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**Abstract:** This paper expounds the practical teaching of probability theory and mathematical statistics. Through the combination of in class experimental teaching, elective statistical tool software and extracurricular practical activities, the practical teaching system of probability theory and mathematical statistics is constructed, which stimulates students' enthusiasm and initiative in learning this course, improves students' ability to integrate theory with practice and analyze and solve problems, and cultivates students' innovative spirit and practical ability, Improved the quality of the course.

## 1. Introduction

In 2010, in order to implement the strategic deployment of taking the road of new industrialization with Chinese characteristics, building an innovative country, building a powerful country in human resources and the outline of the national medium and long term education reform and development plan (2010-2020), the Ministry of education, together with relevant departments and industry associations, jointly organized and implemented the "excellent engineer education and training plan" in relevant colleges and universities, Our school has been selected into the first batch of colleges and universities in the "excellent engineer education and training plan". Since then, our three basic mathematics courses have been comprehensively reformed, and MATLAB software has been integrated into the course teaching and written into the syllabus. With the continuous promotion of the "excellent engineer education and training plan", the course of probability theory and mathematical statistics has grown continuously in the past ten years of reform, accumulated rich teaching experience in practical teaching, and achieved remarkable teaching results.

## 2. Introducing MATLAB Software to Carry out Mathematical Experiment Teaching and Cultivate Students' Application Ability

Probability theory and mathematical statistics are a discipline that studies the statistical laws of random phenomena. In order to obtain the statistical laws of random phenomena, a large number of repeated experiments must be carried out, which is difficult to achieve in limited classroom time. The depth and breadth of traditional teaching content cannot meet the needs of practical application. Therefore, in the practical teaching of probability and mathematical statistics, through computer

graphic display, animation simulation, numerical calculation and text explanation, a new vivid and intuitive teaching environment with pictures and texts, sound and image, and number and shape has been formed. The main experiments are listed as follows:

### 2.1. Demonstration and confirmatory experiment with MATLAB software

For three common discrete random variables: (0-1) distribution, binomial distribution  $b(n, p)$ , Poisson distribution  $\pi(\lambda)$  And three common continuous random variables: uniform distribution, exponential distribution and normal distribution, By changing the parameters in the distribution, we can not only observe the changes of the probability distribution graph, but also verify the Poisson theorem, that is, the relationship between binomial distribution and Poisson distribution, and the central limit theorem, that is, the binomial distribution takes the normal distribution as the limit[1]; For multi-dimensional random variables, draw a two-dimensional normal distribution probability density diagram, etc; In the interval estimation of the statistical part, it is easy to verify the relationship between the confidence (reliability) and the length (accuracy) of the confidence interval. When one increases, the other will decrease (other conditions remain unchanged). At the same time, it can verify the impact of increasing the sample size on both[2]. Through MATLAB experiments, the abstract theory is displayed in intuitive graphics to deepen students' understanding of theoretical concepts. At the same time, students can also experience the charm of information technology in the process of receiving theoretical knowledge, and achieve the teaching effect that traditional teaching cannot achieve.

### 2.2. Applied experiments with Matlab

Probability cannot be separated from calculation, but some written calculations of probability will be very complex and cumbersome, which can be completed with the help of MATLAB at this time. Such as the probability calculation of binomial distribution, Poisson distribution, geometric distribution, hypergeometric distribution, normal distribution[1], etc; The calculation of quantiles of common statistical distributions such as normal distribution, chi square distribution, t distribution and F distribution [1]; Commonly used statistics, such as the calculation of sample mean, sample variance, sample standard deviation, quantiles, modes and sample k-order moments, and the graphical representation of sample data distribution, such as box tail diagram, stem leaf diagram, histogram [2], etc. Calculate the point estimates and confidence intervals of parameters according to the estimators, such as the parameter estimates of population mean, variance, standard deviation, ratio [1], etc.

### 2.3. Innovative experiments with Matlab

Innovative experiments have certain difficulties. They mainly focus on mathematical statistics. Under the guidance of teachers, they use the knowledge and computer technology, combined with tool software, to analyze and solve some practical problems, and write analysis reports. For example, study the distribution of the final examination results of higher mathematics, draw the frequency histogram, and analyze and compare the results of various majors and colleges through the calculation of statistics and graphics, and give a certain conclusion; Estimate the upper and lower confidence limits of your monthly living expenses; A 95% confidence interval estimate is made for the monthly living expenses of college students.

The above experimental contents are fully reflected in the published "probability theory and mathematical statistics" cloud textbook and "College Mathematics Experiment" cloud textbook. Practical teaching improves students' learning efficiency and effectively stimulates students' image

thinking.

### **3. Open Elective Courses, Enrich Practical Teaching Methods, and Improve Students' Ability to Solve Practical Problems**

In order to further cultivate students' mathematical practice ability, the college has opened a series of elective courses, including Mathematica and its application, MATLAB and its application, SAS software and its application, probability theory and mathematical statistics, and mathematical modeling practice, which are related to the probability and statistics curriculum system. After the experience of a series of mathematical practice courses, students are more flexible in dealing with practical problems. It is the so-called " It's Better to Teach fishing than to Offer Fish ".

#### **3.1. SAS software and its application**

SAS software and its applications explains in detail the theories of hypothesis testing, variance analysis and regression analysis in mathematical statistics and the methods of solving complex problems with the help of statistical software SAS, which makes up for the lack of theoretical knowledge in the basic courses of probability theory and mathematical statistics, so that students can truly understand the strength of probability and statistics knowledge and the wide range of applications, as well as the strength of using probability and statistics knowledge to solve practical problems in the era of big data. Of course, the indispensable role of powerful tool software in solving complex problems cannot be ignored.

#### **3.2. MATLAB and its application**

MATLAB and its application expands the applied experiments and innovative experiments in MATLAB, and enriches the content of innovative experiments. For example, check whether there is a significant difference between the academic performance of higher mathematics and probability statistics in a class; Investigate and analyze whether there are significant differences in the number of students from different majors participating in the National Undergraduate Mathematical Modeling Competition; Investigate whether the salary level of students in different majors is related to their majors five years after graduation; Investigate and analyze whether there is a significant difference between CET-4 and the English score of the college entrance examination, whether there is a difference in the learning atmosphere between different dormitories in the same class (academic performance), and investigate and analyze the employment rate of different majors, and give an evaluation according to the investigation and analysis results; Through the investigation and analysis of the relationship between CET-4 scores and the English scores of the college entrance examination, a mathematical model is established, and the scores of students who will take part in CET-4 are predicted; Make statistics on the correlation between board expenses and other consumption, and predict the living expenses in the next few months. Study the random model of population growth under the three child policy, the grouping model of accounting and detection under the epidemic situation, the insurance investment and income model, etc. When solving the above practical problems, students can use MATLAB software or statistical software SAS, etc., and choose flexibly according to their proficiency.

#### **3.3. Mathematical modeling practice**

Mathematical modeling practice integrates all basic mathematical courses and elective courses. It is an elective course that involves the widest range of knowledge, the most practical, and plays an

all-round exercise for students. Every problem it wants to solve must go through the process of mathematical modeling, that is, for a practical problem in reality, it needs to analyze, simplify, solve, summarize, and abstract mathematical models, which generally go through model preparation, assumptions. The steps of establishment, solution, analysis and inspection are finally presented in the form of a paper. The modeling process not only reflects the comprehensive application ability of mathematical knowledge, but also reflects the ability to solve complex problems and solve models with the help of tool software Mathematica, Matlab and SAS.

Through the study and practice of a series of elective courses, students have learned to study and apply, have the ability to apply mathematical knowledge to integrate theory with practice, and master the method of applying the learned knowledge to practice to solve problems, especially the mathematical modeling ability has been significantly improved.

#### **4. Combine in Class and out of Class to Build a Practical Teaching System of Probability and Statistics and Improve Students' Innovative Spirit and Practical Ability**

In class practical teaching activities are basic training and comprehensive practical training (such as MATLAB and its application), forming a practical teaching system that not only runs through the whole process of students' learning, but also is independent of the theoretical teaching system, has clear teaching requirements and assessment methods, and is connected with the teaching content, step by step, and well-organized [3].

Extracurricular practical teaching activities include application training and innovation training in the form of university students' scientific research training plan (URT), the combination of university students' Internet + competition, University Students' mathematical modeling activities, other university students' scientific and technological activities, etc.

Through the close combination of extracurricular practical teaching activities and in class practical teaching activities, gradually cultivate students' enthusiasm and initiative in researching problems, and stimulate students' innovative spirit and practical ability.

##### **4.1. The experiments of basic training**

The experiments of basic training are mainly demonstration experiments and confirmatory experiments, which play an auxiliary role in the teaching of basic theory. Through graphics and images, students can deepen their understanding of the content of theoretical courses. Through the calculation of examples and the analysis of results, students can further understand the theory of probability and the idea and application of statistics, so that abstract theories can be intuitively displayed, and improve students' interest in theoretical learning. Corresponding to this, practical education is the second classroom, where interest groups are formed to extend the learning and application of mathematical software outside the classroom [3].

##### **4.2. Application training**

Application training is mainly "using knowledge", which is composed of in class comprehensive practical training (Mathematics Software elective course) and college students' extracurricular scientific research training (URT plan), to cultivate students' ability to flexibly use knowledge and accept scientific research training. URT program is an extracurricular scientific research and training platform open to students by the school. It has a history of more than 20 years. The school regularly publishes more than 100 URT program programs to students on the campus Internet every year. Students can choose projects to participate in training based on their own interests and abilities. For example, while learning SAS software and its application, some students participated in the

URT project and applied the statistical software they learned to scientific research training in time, realizing the cultivation of students' scientific research.

### 4.3. Innovation training

Innovation training is to "create new knowledge" and cultivate students' innovation ability. It consists of in class research training (mathematical software elective course, mathematical modeling elective course) and extracurricular scientific and technological activities of college students (mathematical modeling competition, etc.). The school holds mathematical modeling competitions for college students every year. At the same time, it organizes students to participate in the national mathematical modeling competition for college students, the international mathematical modeling competition for college students and the mathematical modeling League of college students in Beijing. The modeling practice activities are completed by students in groups of three, which exercises the students' scientific research ability and innovation ability.

## 5. Conclusion

The practical teaching system of probability and statistics not only improves the quality of the course, but also achieves fruitful results.

After the training of probability and statistics practice teaching system, students' ability to analyze and solve problems by using computers and various tools and software has been improved, especially their programming ability has been strengthened, which has increased students' interest in learning probability and statistics courses, broadened their horizons, played a positive leading role in participating in various science and technology competitions and achieved excellent results. In recent years, in the National College Students' mathematical modeling competition, the award-winning level and the number of students in our school have significantly improved. For example, in 2021, two teams won the national first prize, two teams won the national second prize, and the fifteenth team won the Beijing first and second prizes. This achievement can fully reflect the good effect of practical teaching; URT projects have increased year by year, and many of them have been rated as excellent URT projects; Students publish many articles as the first author.

After more than ten years of practical teaching, the teachers of the course group have not only accumulated rich teaching practice cases, but also improved the teaching level and teaching effect. He has compiled and published the cloud textbook of probability theory and mathematical statistics, the cloud textbook of college mathematics experiment, mathematical modeling cases, the case collection of SAS software and its application, the case collection of MATLAB and its application, and the guide book of probability theory and mathematical statistics. Among them, the cloud textbook probability theory and mathematical statistics was rated as the "high-quality undergraduate textbook courseware" in Beijing, and the probability theory and mathematical statistics course was rated as the school level "high-quality undergraduate course". The course team published more than 10 academic papers every year.

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