Research on Probability Theory and Mathematical Statistics Teaching Empowered by Information Technology

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Abstract. With the development of science and technology, internet technology has been widely applied in various fields. Through information technology, the teaching level of probability theory and mathematical statistics can be improved. he learning interest of students can be enhanced. Based on the characteristics of probability theory and mathematical statistics courses, a student-centered interactive teaching model is constructed with the support of information technology throughout the entire teaching process before, during, and after class; Introducing computer software technologies such as MATLAB and SPSS into probability theory and mathematical statistics classroom teaching to enhance students' self-learning and practical abilities.

Keywords: Information technology; Computer software; Interactive teaching; Rain classroom

1. Introduction

Today the world is undergoing a great data revolution and ushering in a rapidly developing and changing information age. Various countries are increasingly valuing the application of information technology. With the rapid development of the internet and information technology, in order to meet the needs of social development, the country proposes to use information technology to promote the modernization of education. This can solve various problems encountered in the development of education in our country. The previous teaching models cannot meet the teaching needs of the information age. It is necessary to effectively integrate information technology with the teaching process[1,2,3]. University teachers should fully utilize information technology such as software, hardware, and resources to explore teaching resources and implement teaching. This can effectively improve classroom teaching efficiency and stimulate students' interest in learning [4,5].

Probability theory and mathematical statistics are a discipline that studies the statistical laws of random phenomena. Its application scope covers various fields of social economy. And it is a mathematics based public basic course designed for students in science, engineering, economics, and other fields. It is one of the most important compulsory courses in various majors of science and engineering colleges. It is almost the foundation of all subsequent professional courses. The widespread use of computers not only widens the application scope of probability and statistics

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methods, but also provides new growth points for the development of probability theory and mathematical statistics themselves. The course is facing the impact, challenges, and good opportunities for development in the era of big data. Relying on calculators to solve computational problems in statistics is no longer a convenient means to process massive amounts of data. In the teaching process of probability theory and mathematical statistics, it is necessary to reform the course of probability theory and mathematical statistics in order to cultivate applied talents who can adapt to the development of the times [6,7]. This article analyzes the problems in the teaching of mathematical statistics courses, proposes methods and measures to cultivate applied talents in mathematical statistics that adapt to the development of the times. This article is based on an internet teaching platform and constructs a student-centered interactive teaching model. And it introduces computer software technologies such as MATLAB and SPSS into probability theory and mathematical statistics classroom teaching, enhancing students' self-learning and practical abilities.

2. Current Situation Of Course Teaching

The update and replacement speed of information technology is very fast, which requires teachers to constantly learn and apply the latest information technology. Currently, there are mainly some problems in probability theory and mathematical statistics teaching. It leads to a backward level of informatization in teaching. This not only fails to increase the richness and vividness of the classroom, but also greatly limits students' motivation for independent learning outside of class. The main problems are as follows.

2.1 The course content is abstract and difficult to understand. It is difficult for students to learn and understand the curriculum.

Probability theory and mathematical statistics have abstract and difficult to understand content. It has many concepts, properties, formulas, strong technical skills. And it is abstract and difficult to understand. Classroom time is limited, so students are prone to falling into a state of obscurity and difficulty in understanding.

The conclusion can be proven.

2.2 The teaching mode is rigid and outdated. Students have low learning enthusiasm.

In the teaching of traditional probability theory and mathematical statistics courses, the teacher is the center, with rigid knowledge and outdated teaching methods. Teachers are accustomed to using the traditional "blackboard+ chalk" teaching model, which mainly focuses on classroom teaching and ignores the student's subjectivity. They only emphasize that students need to understand and master, lack professional targeting, and application. It leads to low classroom enthusiasm among students, insufficient learning interest, low classroom participation, and a dull atmosphere. This cannot be student-centered and cannot meet personalized needs. Students are accustomed to rote learning, making it difficult to form effective teacher-student interaction [8].

2.3 Theoretical teaching is disconnected from practice and lacks connection with practical innovation.

The content of probability theory and mathematical statistics is highly theoretical, and classroom teaching activities only focus on problem-solving and exams. Practical cases have not been effectively introduced into teaching, which cannot stimulate students' interest in learning. This objectively creates a certain level of difficulty for students to learn the course. Some students have a learning goal of passing exams. They lack motivation for deep learning and unable to support their future development needs.

Students are the new generation who grow up with the internet and are willing to accept new things. They are proficient in the application of information technology. Therefore, based on the above issues, it is particularly important to fully utilize information technology to deepen teaching reform and promote teaching innovation.

3. Hybrid Interactive Teaching Methods Under The Background Of Educational Informatization

Based on the OBE concept and supported by information technology, a blended interactive teaching approach with deep integration of online and offline is carried out. This course establishes online resources such as MOOC and SPOC, and uses teaching platforms such as Rain Classroom and Learning Pass to construct support resources for student time fragmented learning. The entire teaching process is divided into three stages: preview before class, in class learning, and post class consolidation. The specific implementation process is shown in Figure 1.

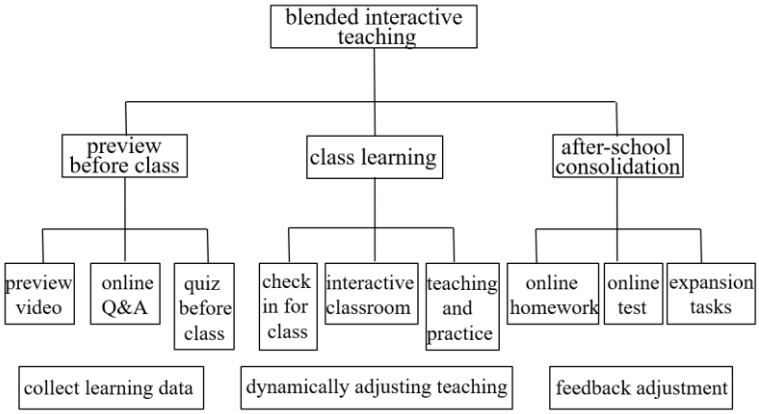


Figure 1. Implementation process of blended interactive teaching based on information technology

3.1 Preview before class

In order to apply information technology to the teaching process of probability theory and mathematical statistics and improve teaching effectiveness, teachers must carefully prepare lessons before class. Teachers carefully create teaching content before class, introducing videos,

teaching content courseware, and expanding knowledge courseware. Before class, teachers post preview tasks on teaching platforms such as Rain Classroom or Learning Pass, including lesson guides, videos, preview assignments, reading resources, etc. Students log in to the smart teaching platform, search for corresponding resources based on the tasks posted by the teacher. They can watch preview videos, complete preview assignments, and think about the questions raised by the teacher. During this period, students can interact, share, and discuss based on difficult issues. The interactive methods during the preview stage can be through answering questions and discussing on the teaching platform, as well as using tools such as QQ and WeChat outside the platform for communication. Students can also provide feedback on their doubts to teachers through online discussions and comments in advance. Teachers can use fragmented time to answer questions online, participate in post discussions, and collect feedback on student learning outcomes. Before class, teachers can collect feedback data from class students through smart teaching platforms such as Rain Classroom. Teachers can grasp the degree of students' mastery of this part of the content by previewing data statistics and testing the answers to questions. The teacher can adjust the teaching methods and strategies in a timely manner, and improve teaching efficiency.

3.2 Class learning

In the teaching of probability theory and mathematical statistics, modern information technology tools such as Learning Pass, Rain Classroom, and Smart Classroom are utilized. And the BOPPPS hybrid teaching mode is adopted. Ten minutes before class, the teachers announced attendance in Rain Classroom. In class, targeted new lesson teaching will be conducted based on the feedback from students during preview. The teachers focus on teaching students the knowledge points that are difficult to understand or master in their preview feedback. The teachers make full use of the Rain Classroom in class and timely sends multiple-choice questions, subjective questions, fill in the blank questions, and other in class exercises for answering. We can conduct lectures and tests at the same time. Based on the statistical results of the Rain Classroom test, the teachers can grasp the students' grasp and understanding of the knowledge points in real time. Teachers can adjust their teaching strategies in a timely manner to improve the effectiveness of classroom teaching. The management of Rain Classroom teaching involves a variety of classroom activities, with students at the center, to enhance their participation in the course. During the teaching process, the Rain Classroom teaching platform is used to design teaching activities (group tasks, discussions, voting, group competitions, etc.). We can integrate various activities such as peer teaching, random roll call, barrage sending, brainstorming, etc. It can enhance interaction with students and liven up the classroom atmosphere. These measures can help students understand and master basic knowledge points, and break through difficult and challenging learning.

3.3 After-school consolidation

Online homework and online quizzes are important means to check the learning effectiveness of students. After class, students log in to the Rain Classroom teaching platform to complete online assignments and test questions. Based on the quality and data of student assignments feedback from the teaching platform, the teachers can understand the student s' mastery of course content and conduct more targeted teaching in the later stage. At the same time, upload some extension assignments and learning resources on the Rain Classroom teaching platform,

such as conducting mathematical experiments, using probability and statistical methods for mathematical modeling, etc. These can expand the learning space of students. SPOC serves as a supplementary and reinforcing part of after-school consolidation, and online learning and offline classroom teaching run through the entire teaching process of teachers. Based on the differentiation of big data information feedback from student learning and homework completion, SPOC provides different teaching modes to ensure learning quality and the effectiveness of talent cultivation plans.

4. The Application Of Software In Teaching

4.1 Promoting Deep Learning through Mathematical Experiments Combined with Software

The teaching mode of combining probability theory and mathematical statistics with computer software for mathematical experiments can cultivate students' self-learning ability and promote deep learning. Teachers should make full use of the massive shared resources in online teaching platforms to complete teaching designs. They should collect high-quality teaching software from domestic and foreign teaching resources, form a teaching resource library, and enable students to learn independently online. They can use software such as MATLAB and SPSS to program mathematical experiments. Implementing mathematical experiments through programming can deepen the understanding of concepts and theorems, and improve the learning ability of research and exploration [9,10]. For example, in the learning of knowledge points such as Bayesian formulas, expectations, confidence intervals, and hypothesis testing, students are guided to design mathematical experiments and simulate them using random simulation methods. By solving complex problems through programming, their understanding of concepts and theorems is deepened. In programming, allowing students to start from problems and experience the process of solving problems has stimulated their learning enthusiasm. And their learning ability and logical thinking ability can be further improved.

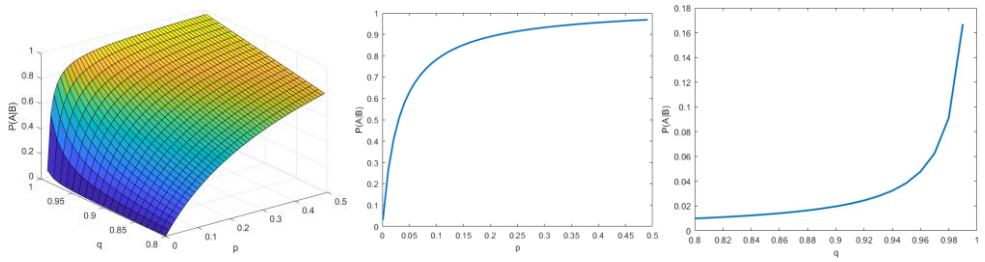
Case 1: According to the surveys, the prevalence rate of a certain disease is 0.2%, which can be screened through blood sampling tests. According to previous data, the accuracy of the diagnosis of this disease is 97%, which means that the probability of a positive test result for people with this disease is 97%. And the probability of a positive test result for people without illness is 3%. If a person's test results are positive, what is their true probability of getting sick?

Analysis: This type of problem involves calculating the probability of the causal event based on known results, which can be calculated using Bayesian formulas.

Supposing that event B represents “positive test results”, event A represents “the person being tested is sick”, and $\overline{A}$ represents “the person being tested is not sick”, then A and $\overline{A}$ form a partition of the sample space. Assuming the prevalence rate a of the disease is $P(A) = p$. The accuracy of disease diagnosis is $P(B \mid A) = q$. According to Bayes formula, a posterior probability can be concluded.

$$P(A|B) = \frac{P(A)P(B|A)}{P(A)P(B|A) + P(\overline{A})P(B|\overline{A})} = \frac{pq}{pq + (1-p)(1-q)}$$

The teacher encourages students to use MATLAB to draw a surface graph of the relationship between posterior probability, morbidity, and diagnostic accuracy, as shown in Figure 2. They can also obtain cross-sectional graphs of different values for morbidity and diagnostic accuracy. Students have enhanced their hands-on practical skills during the programming process, and through simulation diagrams, they can intuitively see the patterns of probability changes and gain a deeper understanding of the ideas behind Bayesian formulas.



(a) surface plot (b) screenshot at $p = 0.002$ (c) screenshot at $q = 0.97$

Figure 2. Relationship between posterior probability, prevalence rate, and diagnostic accuracy

4.2 Using information technology to break through teaching difficulties

With the assistance of computer software, teaching scenarios can be created through information technology, which combines sound, animation, and film and television to form a comprehensive multimedia scenario design teaching form. The teachers design typical problems in probability theory and statistics into mathematical experiments, and the abstract mathematical formulas and theorems in the course are verified through the implementation of mathematical software; For frequency issues where a large number of experiments cannot be conducted, we use MATLAB to conduct random simulation experiments and verify the correctness of theoretical calculations through simulation results; The drawing function of MATLAB can help students present theoretical knowledge that cannot be represented vividly through intuitive visual graphics. By dynamically demonstrating or displaying through images, the variation law of probability can be intuitively displayed. The use of computer software simulation can solve problems that teachers find difficult to explain and students find difficult to understand. It can reduce teaching difficulty, improve teaching efficiency, and enable students to gain a profound understanding of probability and statistics knowledge. Especially for cultivating students' observation, imagination, abstract thinking ability, and exploratory spirit, it has a very positive effect.

Case 2: There are 30 students in a certain class. Assuming that each person's birthday is equally possible on any of the 365 days of the year, what is the probability that at least two of these 30 people have the same birthday?

Analysis: Using classical probability models, the probability of at least two people having the same birthday can be calculated as:

$$P = 1 - \frac{A_{365}^{30}}{365^{30}} \approx 0.706$$

Therefore, the probability of at least two out of 30 people having the same birthday is 0.706.

The probability of having the same birthday differs from the intuitive perception. And simulation experiments can be conducted using MATLAB to obtain the results. We use the unidrnd() function to generate n random numbers ranging from 1 to 365 and simulate each person's birthday. We use a double loop to find if there are any similarities between the n numbers, that is, at least two people have the same birthday. We calculate the frequency through multiple experiments. The simulation results are shown in the following figure 3. The error between theoretical and actual values is very small. And we solve difficult to understand problems in teaching through intuitive random simulation.

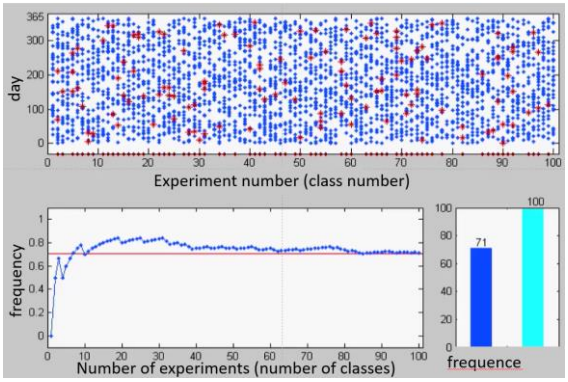


Figure 3. Random simulation of birthday problem

5. Conclusion

In the reform and construction of the course of Probability Theory and Mathematical Statistics, according to the characteristics and teaching requirements of the course, information technology is appropriately introduced to assist teaching. This effectively changes the teaching mode of teachers and the learning mode of students. And this enhances students' self-learning ability and the ability to apply probability and statistical knowledge to solve practical problems. Moreover, by using information technology, abstract probability and statistical knowledge is made more intuitive, reducing the difficulty of the course. It stimulates students' interest in learning from visual and auditory aspects. This not only allows students to gain knowledge, but also enhances their confidence in learning probability statistics.

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