

Integration of Mathematical Modeling Thought in Probability Statistics Teaching

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Abstract

The thought and method of mathematical modeling provides a brand-new idea for the reform of college mathematics teaching. By virtue of mathematical modeling, students not only can learn some important mathematical concepts, methods and conclusions, but also can understand the idea and thought of mathematics. Furthermore, they can truly master the ability of mathematical application. Based on the author's teaching experience, this paper attempted to integrate mathematical modeling thought into the probability statistics teaching. In terms of the conformation to teaching reform or students' actual development, the research and practice of integrating mathematical modeling thought in the probability theory and mathematical statistics teaching will help students learn theoretical knowledge. Besides, this will help to cultivate inter-disciplinary talents who are suitable for modern social development. Therefore, this article has important theoretical and practical significance.

Keywords: Probability statistics; Teaching; Modeling thought; Integration

1 Introduction

The traditional mathematical teaching always gives people the impression that the content of mathematical research is seemingly the logical inference deduced from axioms, formulas and definitions. In fact, like other science and technology in practice, useful mathematical technology starts from observation and it needs image thinking as a guide. Mathematical modeling restores the true nature of mathematical research of collecting data, modeling, finding answers and

interpreting argument. The integration of mathematical modeling thought is the education issue of college students and it meets the needs of the current quality education and teaching reform. Probability statistics is a discipline with a strong sense of theory and applicability. It plays an important role in each branch of engineering and science[1]. With the accelerating of science, technology and knowledge updating speed, the traditional teaching ideas must make a reform to adapt to the new situation. Nowadays, in the wake of the development of high technology, how to strengthen students' understanding of probability statistical thinking and how to enhance their ability to use probability statistical thinking to solve practical problems are questions worth thinking about seriously in the integration of mathematical modeling in probability statistics teaching. Besides, it is a very meaningful attempt about how to solve the relationship between learning and practice.

2 To establish the idea of integrating mathematical modeling thought in probability statistics teaching

The traditional probability statistics teaching methods focus more on the teaching of theoretical knowledge, the systematic and rigorous nature of knowledge structure, mathematical formula derivation and calculation training. However, it neglects the cultivation of students' application ability and also ignores the function of basic theory in solving practical problems. This results in that many students cannot develop practical application capacity and many students have a deep theoretical knowledge basis with the lack of practical application ability. Therefore, students are often confused about what they can do with the learned knowledge and how to use the learned knowledge. This puts forward new demands on our teaching philosophy. We need to transform our teaching method from imparting theoretical knowledge to combining theory and practice, and unify theory and practice in teaching[2]. In addition, an important goal of college mathematics education is to cultivate students' ability to use mathematics and apply mathematics knowledge to solve practical problems. In fact, The idea of using knowledge to solve problems is the core of mathematical modeling. Therefore, we should establish a positive attitude to the close combination of probability statistics teaching and mathematical modeling.

3 To absorb materials which embody the idea of mathematical modeling better in the teaching content

Probability statistics course is a discipline with a strong sense of theory and applicability. It plays an important role in each branch of engineering and science. First of all, it is necessary to clearly define the purpose of offering probability statistics course. The teacher's main task is to guide students to change their thinking model from the traditional deterministic thinking to the stochastic

thinking, so that students can master mathematical methods to handle stochastic problems in engineering, economic management, humanities and social sciences and scientific research. According to the characteristics of the course, we think it is necessary to reexamine, select and organize the teaching content of the probability statistics course with a modern scientific view. Besides, we need to introduce advanced science and technology, methods and application problems related to the knowledge of probability statistics to combine the traditional and modern content organically. We may insert some practical problems that the whole society concern with, such as the estimation of winning percentage of lottery tickets in the sociology, selling rate of a new product in the future market, engineering product quality evaluation, reliability optimization design of large systems, the comparison of medical treatment between new and old drugs and disease diagnosis. This will help students gain perceptual knowledge of using the probability statistics knowledge to establish mathematical models and solve practical problems, which will sparkle their interest in probability statistics knowledge. Consequently, students will change study state from passive learning to active learning. This is very helpful of their engagement in scientific research in the future[3].

On the premise of maintaining original system knowledge, probability statistics textbooks need to increase 2-3 applications cases derived from scientific research. This can reflect the whole process of mathematical modeling with probability statistical knowledge. The process is "problem \rightarrow mathematics model \rightarrow software solution \rightarrow result analysis \rightarrow model modification \rightarrow application". For example, the introduction of a comprehensive case about fair distribution of resources. This is an optimization decision problem, which uses a variety of probability knowledge and methods, such as the method of proportion, maximum entropy method, method of maximum probability and minimum deviation method. Another example is a comprehensive case about the commodity demand analysis, which uses a variety of statistical inference principles. Besides, the case about rainfall analysis of a meteorological observation station utilizes the principles of correlation analysis and regression analysis. By learning these cases, students can experience the whole process of mathematical modeling with using probability statistics knowledge. This will deepen their understanding of probability statistics knowledge and further enhance their application awareness and interest; in turn, this promotes students to learn theoretical knowledge of probability statistical, so that this teaching method can truly achieve the goal of putting knowledge into practical use. As the probability statistics is a course with short teaching hours, inserting some cases in teaching content is bound to affect the teaching content required by normal syllabus. The use of multimedia teaching methods can save some time. We can also compile some cases in teaching materials for students to study independently. We believe that the case teaching method is suitable for the probability statistical courses and case teaching can enhance students' capabilities of mathematical modeling and innovation.

4 To improve classroom teaching methods

What can we do to get better result of the classroom learning? We believe that teachers should abandon the cramming education and adopt heuristic analogy teaching model. Furthermore, they should explain problems from the easy to the difficult and from the intuitive to the abstract, so that students can really master math concepts and methods, and enjoy the learning. For example, when we explain the binomial distribution, we should pay attention to the introduction of the nail plate model designed by British bio-statistician Galton and simulate the model with the computer. By induction and analogy, we find that the frequency diagram of pitching the ball for 5000 times is extremely similar to the theoretical graphic of binomial distribution. In this way, students can not only understand the source of the binomial distribution, but also realize how to use the actual model to test the theoretical model[4]. At the same time, students can deepen their understanding of the principle that frequency is approximate to probability; they also can understand the computer simulation method. Another example is about how to explain the central limit theorem. First of all, teachers should raise questions: Why does a project often assume that a research object is subject to normal distribution? What is this assumption based on? Then, teachers introduce the theorem. The key point is to introduce the important role that the central limit theorem plays in practical applications. In addition, teachers need to use modern multimedia teaching methods to conduct experimental teaching and simulate a normal distribution in a certain condition by computer simulation. This will help students deepen their understanding of the central limit theorem. That will lay a solid foundation for studying mathematical statistics knowledge.

The teaching of mathematical knowledge should not be limited to the dissemination of knowledge. We also should pay attention to the expansion and extension of knowledge and attach importance to cultivating students' broad, rigorous and innovative thinking. For example, exclusiveness and independence between two events are two different concepts and teachers should make it clear. They need to illustrate cases to prove it in order to ensure the precision of knowledge points. In addition, teachers should pay attention to the extension of knowledge. Students can associate some knowledge of multidimensional random variables by learning one-dimensional or two-dimensional random variable knowledge. For example, when we discuss the distribution of extreme value of binary function, we need to extend it to the distribution of multiple extremes function. The linear additive property of the distribution of binary linear function " $X + Y$ " can also be extended to the case of multiple linear functions. In short, in the classroom, teachers use heuristic teaching method. They need to inspire students to cultivate positive thinking and master knowledge. On the other hand, they should fully mobilize students' initiative to develop their interest and curiosity in learning, so as to improve students' ability to analyze and solve problems[5].

For example, before teaching conditional probability, teachers can propose a question for students to prepare in advance: students need to count how many classmates are shortsighted and how many female students are shortsighted. N is

for the number of the whole class; N_{short} is for the number of shortsighted students; N_{girl} is for the number of girls; $N_{\text{short girl}}$ is for the number of shortsighted girls. Event A: the randomly selected one is a shortsighted student; Event B: the randomly selected one is a girl. We calculate $P(A)$, $P(B)$ and $P(AB)$.

That is: $P(A) = \frac{N_A}{N}$, $P(B) = \frac{N_B}{N}$, $P(AB) = \frac{N_{AB}}{N}$. If the sub-population of all the female students replaces the overall population, students need to calculate the probability that the randomly selected one is shortsighted: $\frac{N_{AB}}{N_B}$. At the

beginning of the conditional probability teaching, we draw students attention to note that $P(A)$ is different from $\frac{N_{AB}}{N_B}$ on this issue. Then it is very natural to introduce a new concept that if the event B occurs, the probability of the occurrence of event A is recorded as $P(A/B) = \frac{N_{AB}}{N_B} = \frac{P(AB)}{P(B)}$, which is easy for students to accept.

5 To lay emphasis on students' practical teaching

In order to achieve the goal of consolidating students' knowledge and cultivating their ability to solve problems flexibly, we need to design a variety of training topics in materials in practical teaching. Generally, editors of the textbooks tend to focus more on the teaching content and neglect the selection, order and collocation of exercises. In most cases, the designed exercise is too difficult for student to learn, which affects students' learning enthusiasm. In fact, exercise is a very important part in a mathematics textbook. We believe that the exercise of new textbooks should go from the easy to the complicated with reasonable classification to meet the needs of students in all levels. In addition to the general exercise of probability statistics, the textbook should add some interesting probability statistics topics which are closely related with daily life and reflect the comprehensiveness and mathematical modeling ideas. At the same time, we need to design probability statistics cases, such as exercises with the use of computer simulation technology, statistical inference and data fitting. Students' learning of mathematical modeling and mathematical software programming calculation not only enriches their extracurricular practice activities, but also enhances their practical ability[6].

Probability statistics is a practical subject, especially in mathematical statistics topics. If we use the scoring text to examine students, it will lead to that students memorize knowledge mechanically and do a lot of exercises to cope with the examination. This will result in students' passive learning; they will lose interest in learning and to inspire students' sense of innovation cannot be achieved totally. Therefore, we must reform the current assessment method and promote the

assessment method to combine closed-book and open-book exam. The examination of basic concepts, theories and calculations of probabilistic statistics is closed-book, while the examination of comprehensive and applied case should be open-book[7]. We can use probability statistical knowledge combined with computer software to assess students. As probability statistics is a short-term course, students practice should be few but good. Besides, we should encourage students to actively participate in the math experiment course and mathematical modeling contest activities to broaden students' horizons and develop their application and innovation ability.

6 Conclusion

Mathematics teaching reform is a long-term and complex system engineering. To integrate ideas of mathematical modeling into mathematics main course teaching in universities is a new method and idea advocated by the Ministry of Education. As a mathematics educator, to consciously explore and practice in the teaching process is our bounden duty. The feedback information from students indicates that the learning atmosphere has changed greatly and a large part of the students become interested in mathematics. In particular, trying to solve some practical problems by mathematical methods has gradually become students' discussion topic after class. Students' overall quality has been enhanced compared with previous students. At present, our work is only in the initial stage and the conditions are still relatively simple, especially application software teaching environment which needs to be further improved. However, we firmly believe that the direction of the reform is correct and we will fully learn from successful experience of other institutions. Moreover, we will continue to improve our program in the course of practice to make a contribution to the mathematics education reform.

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