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Practical Experience in Teaching Reform of Probability Theory and Mathematical Statistics Course under the CDIO Educational Concept

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Abstract **– This paper introduces CDIO engineering education model, discusses the teaching reform of probability theory and mathematical statistics under this model and tests it with practical methods. Based on the new educational model, we summarize the practical experience of the teaching reform of probability theory and mathematical statistics course, and promote the new brilliance of the teaching reform of probability theory and mathematical statistics course.**

Keywords **– Probability Theory and Mathematical Statistics Course, Teaching Reform, CDIO Engineering Education Model, Practical Experience.**

I. Introduction

A. *CDIO Introduction*

CDIO represents conception, design, implementation, and operation, it is based on the life cycle of product development to the operation of the product, allowing students to learn engineering in an active, practical, organic way between courses. Since 2000, multinational research consisting of four universities, including MIT and the Royal Swedish Institute of Technology, has received nearly $ 20 million from the Knut and Alice Wallenberg Foundation. After four years of exploration and research, CDIO Engineering Education has been established. The concept and the establishment of an international cooperation organization named after CDIO.

CDIO training outline divides the ability of engineering graduates into four levels: engineering basic knowledge, personal ability, interpersonal team ability, and engineering system ability [1]. The outline requires that students achieve their intended goals at these four levels in a comprehensive way. The concept of CDIO not only inherits and develops the concept of engineering education reform in Europe for more than 20 years, but also systematically puts forward 12 standards that can be operated, fully implemented, and tested and evaluated. The Swedish National Institute for Higher Education used these 12 standards to evaluate the country's 100 engineering degree programs in 2005. The results showed that the new standard is wider than the original standard and is more conducive to improving quality. It is particularly important that the new standards provide the basis for the systematic development of engineering education.

B. *Engineering Education reform is of Great Significance*

Cultivating innovative talents is the trend of educational reform in today's world, and must rely on innovative education model. Engineering education is an important channel for transporting engineering talents to the country. However, there is a serious shortage of engineering talents. In order to train more engineering talents, each institution has successively carried out engineering education reforms. CDIO engineering education model and other new education models are produced in this context. At the same time, probability theory is breaking through the traditional application scope to various fields, and the interaction with other disciplines is increasingly active. Jevons, a British logician and economist, praised probability theory: "Probability theory is the real leader of life. If we do not have some estimate of probability, then we cannot move and do nothing. Therefore, the teaching reform of probability theory and mathematical statistics courses is very necessary, and the cultivation of students 'probability statistics is particularly important.

C. *The Necessity of Teaching Reform in Probability Theory and Mathematical Statistics*

Probability theory and mathematical statistics is an important public basic course in colleges and universities, but it is different from other public basic courses in mathematics such as higher mathematics and linear algebra. It is a very practical mathematics discipline that studies the statistical regularity of random phenomena. Random phenomena exist in various fields and aspects of real life. Therefore, this discipline has a wide range of applications in many fields. At the same time, it is different from those professional courses that are directly related to engineering projects. The courses of probability theory and mathematical statistics belong to basic mathematics courses, passing on mathematics ideas and using mathematics as a tool to solve practical problems. Specifically, the course of probability theory and mathematical statistics teaches students the basic ideas and basic methods for dealing with random phenomena, and trains students to use the theory and methods of probability statistics to analyze and solve practical problems.

Under the trend of educational reform, the problems in the courses of probability theory and mathematical statistics appear. In the past, the teaching of mathematics courses only emphasized the interpretation of sample questions and formulas, ignoring the interpretation of basic concepts, theoretical ideas, and the training of practical application links, so that students could learn for the examination and become useless after learning. As a result, students are often helpless when they encounter probability statistics in practice, and they cannot use probability statistics to analyze problems. If we cultivate innovative talents and adapt to new educational ideas, we can no longer follow the previous teaching methods and teaching patterns. We must reform the courses of probability theory and mathematical statistics.

II. Practical Experience in Teaching Reform of Probability theory and Mathematical Statistics

A. *Teaching Reform Focusing on Mathematics Thought and Method*

The teaching of a mathematics course is to explain the idea and essence of this mathematics course. Mathematical thoughts are the basis of theory, the essence of mathematical theory, and the essence of things. It is the concept of mathematics that best embodies the idea of mathematics. The description of the concept is often difficult. How to explain its essence and how to show its essence to students in an easy-to-understand, lively and attractive way. It should be the goal of every teacher's efforts. To this end, teachers need to constantly explore, continuously collect various materials, and learn from various experiences. For a concept, first throw a question, heuristically lead to the definition of the concept, or give the concept directly, use an example to explain its essence, and may also need specific analysis of the specific problems of the teacher. For example, to explain the concept of "correlation coefficient", only to give a formula, students cannot really understand. To speak of this concept, we must start from the reason why it is introduced. Although covariance can also reflect the relationship between two random variables, it is affected by the measurement units used by the variables. For example, consider random variables (X, Y), X represents the weight of the population, Y represents the height of the population, and according to the covariance formula $\mathrm{Cov}(aX,bY)=abCov(X,Y)$, if the unit of measure changes, The corresponding covariance will double. The correlation coefficient is not affected by the unit of measurement and is a dimensionless quantity [2].

Mathematical thought is also embodied in the explanation of the formula. Teachers must explain how the formula is produced and what problems are solved. Only by letting students understand these can they know how to use this formula. The full probability formula is a basic formula in probability theory. It is used to calculate the probability problem of complex events and convert the probability of complex events into the summation problem of simple events that occur under different circumstances or different reasons or different approaches. The formula states that: When the direct calculation of P(B) is not possible under complex circumstances. A division $\{A_i(i=1,2,\cdots$ can be constructed according to the specific situation, the probability of occurrence of event B is the sum of the probability of occurrence of event B under the condition of event $A_i(i=1,2,\cdots$ If the student truly understands the essential purpose of full-probability formula, then a division of the sample space can be found through a comprehensive analysis of different causes, different situations, or different ways of occurrence. Thus, the probability of this complex event is obtained by using the full probability formula [3].

Mathematical thoughts and mathematical methods are often realized by means of heuristic teaching and case-based teaching. For example, when explaining the maximum likelihood estimation method, we can first introduce an example: a classmate goes hunting with a hunter. Assuming that the probability of a classmate hitting is 0.1, the probability of a hunter hitting is 0.9, and if a hare jumps from the front, at the sound of a shot, the hare fell, causing the students to guess who had hit it. This attracted the students 'attention. Since only one shot was shot, and the probability of the hunter's hit was greater than the probability of the classmate's hit, it was generally speculated that the shot was shot by the hunter. In fact, this is a parameter estimation problem. There are two possible values for parameter P. For event A = "hit only one shot" has already occurred. We believe that the possibility of an event should be very large. Therefore, we look for the value of the parameter P to maximize the probability of occurrence of event A. This is the idea of maximum likelihood estimation, that is, in the case where experimental results have been obtained, Look for the value that makes this result most likely to appear as an estimate of the parameter. In this way, students have a preliminary understanding of the maximum likelihood estimation method, and when they are explained in depth, they are more easily understood.

B. *Focus on Student-Oriented Teaching Reform*

Under the classical education mode, teachers are often the main body, and teachers occupy the main position in the teaching process. In order to enhance students 'initiative and enthusiasm, CDIO engineering education model requires teachers as the guide and students as the main body. In classroom teaching, teachers should always keep in mind the student-oriented, should change the teaching methods, redesign the teaching links, not only to achieve knowledge and interest, but also to have ideological and applied. Teachers choose representative application cases of courses, preferably related to students 'majors, to guide students to think, discuss, and answer, so that students fully realize the practicality of the course of probability theory and mathematical statistics, and cultivate students' modeling ability. The exercise course is divided into two parts. One part is the explanation and training of the key questions and key methods in this chapter. It is mainly based on the model of student practice and teacher teaching. The other part is the discussion part, mainly using probability as a tool to solve some examples that are close to real life [4]. The discussion topics should be arranged in advance and the students should be divided into several groups. In class, the main discussion is students. The teacher makes appropriate guidance and final comments. In short, the exercise course is based on the model of teachers 'intensive lectures and students' practice. Students are encouraged to speak more, practice more, and use more brains. Students are effectively involved in the classroom and better integrated into classroom teaching, thus stimulating students 'enthusiasm for learning. Enhance the team spirit and collective sense of honor of the students; cultivate the students 'sense of competition and comprehensive quality.

The student-oriented teaching reform should also pay attention to the reform of the assessment system. In the past, the assessment was a test at the end of the period. After passing the final exam, he passed the exam and failed the exam. His usual performance did not play any role. As a result, students only attached importance to the final exam and ignored the performance of the usual learning process [5]. What is more, I feel that there is time to wait until the examination is near and then try hard. Finally, I find that there is too much content and it is difficult to make up for the homework. Based on this situation, teachers conduct several periodic examinations, pay attention to the situation of students 'knowledge points at any time, and actively adjust the progress of teaching in the classroom according to the problems reflected in the periodic examinations, and at the same time increase the proportion of ordinary students in the assessment system. Let the examination system better reflect the students 'learning situation.

C. *Emphasis on Teaching Reform Linked to Practical Issues*

The new education model focuses on the cultivation of students 'abilities. In choosing examples and discussing topics, it is important to pay attention to leaving some practical examples or examples close to life for students to understand how to use the knowledge of probability statistics to explain practical problems. When students first encounter these problems, they often have no idea, no clue, and no way to start. This practice will help to improve students 'mathematical literacy and ability to use mathematics to solve problems.

In ordinary life, people often use "water dripping stone" and "as long as the Kung Fu is deep, the iron pestle is ground into a needle" to describe what is going to happen, but some people think that these are impossible. If you look at it in terms of probability, it makes a lot of sense. Why is that?

This is an example of a problem that is explained by probability. The conversion to probability language is: In an experiment, the probability of occurrence of event A is ε (>0), independently repeat the test N times, solving the probability that event A will occur at least once.

The probability of the event not appearing in the first test is $1-\varepsilon$, the probability that none of the previous trials will occur is $(1-\varepsilon)^n$, so the probability of at least one occurrence in the previous test is $1-(1-\varepsilon)^n$. When $n\to\infty$, the probability approaches 1, this means that sooner or later there will be a probability of 1. After the appearance, take the next test as the first time, repeat the above reasoning, it is inevitable that A will appear again [6].

At the same time, we can also give the following examples of close to life:

The display of fireworks and firecrackers during the Spring Festival is a national tradition that has continued for more than two thousand years. It has long been part of China's long history and culture. However, fireworks and firecrackers often cause accidents and cause tragedies. Assume that the probability of starting a fire with each firework is one in 100,000. If there are 1 million fireworks in Beijing during the Spring Festival, the probability of no fire is calculated.

The above two examples are simple and do not use much knowledge, but they reflect the probability that knowledge can solve practical problems. Two examples show that although a small probability event is almost impossible to occur in one experiment, it is almost inevitable that it will occur in a large number of repeated independent tests over a long period of time. Examples can enable students to better understand the principle of small probability. Of course, as the course progresses, comprehensive topics can be practiced later in the course. This practical problem is even more so when it comes to the statistical section.

III. Requirements of the New Educational Model for Young Teachers

First, young teachers must pay attention to the study of mathematics history. Only by understanding the history of mathematics development can they clarify the origin of mathematics development and better grasp the essence of mathematics curriculum. In addition, the history of mathematics has some short stories about mathematicians. It can be reasonably applied to the classroom and can stimulate students 'learning enthusiasm and learning initiative. Young teachers introduce the history of probability theory in the classroom, promote students 'understanding of the content of the course, enrich the content of the course, so that classroom teaching is not boring [7].

Secondly, young teachers should pay attention to the convergence between probability theory and mathematical statistics courses and professional courses. If the teacher is only familiar with the course he teaches, he is unfamiliar with the connection between the course and other related courses. In this way, the teachers of each course teach their own, and the students attending the course receive fragmented content. It is difficult for students to link the various courses together, and they can not apply the knowledge they have learned in an integrated manner.

Finally, young teachers should pay attention to the cultivation of personality charm. Teachers should not only impart knowledge, but also, and more importantly, the spirit of rigorous study [8]. The spiritual outlook of teachers is very important to students. Teachers should inherit a spirit of sunshine, vitality, youth, and unfailing words. This spiritual guidance is more important than the teaching of knowledge.

IV. Conclusion

The teaching goal of probability theory and mathematical statistics courses is not only to teach students professional knowledge, but also to cultivate students 'mathematical logical thinking ability and improve students' mathematical literacy. In order to achieve this goal, under the concept of CDIO engineering education model, we try to reform the teaching of probability theory and mathematical statistics courses. We hope that with the continuous advancement of reforms, the teaching of probability theory and mathematical statistics courses will be closer to life and more full and vivid. [9] At the same time, the reform will inevitably have new requirements for teachers, especially young teachers, and will continue to update knowledge and ideas to have a better future.

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