# Exploration and Practice of Online and Offline Hybrid Teaching Mode

## —Taking the Stochastic Process Course as an Example

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**Abstract:** The current online and offline teaching status of the "stochastic process" course has been analysed, and the problems of students in the process of learning the course have been analysed. To solve the existing problems, the online and offline hybrid teaching reform of the course was carried out. And from solving the problems of insufficient teaching hours, students' poor foundation, improving the "two natures and one degree (high-order, innovative, challenging) "of the course, and improving the quality of ideological and political education of the course, the online and offline hybrid teaching reform of the course "Stochastic Process" has been explored and practiced. The course adopts the assessment method combining process assessment and summative assessment, and it is found that the online-offline hybrid teaching can increase students' interest in learning and improve their motivation to learn, which achieves a better teaching effect.

## 1. Introduction

Compared with offline teaching, online teaching has the unique features of rich learning resources, anytime and anywhere, personalized learning, independent learning, differentiated learning, data diagnosis and analysis, personalized resource push, and especially significant effect on the learning of knowledge and skills. Online teaching can also not be limited to fixed classes and class sizes; it cannot be restricted by the time and space limitations of about 45 minutes per lesson; it can adopt different learning progresses, allowing students with different learning abilities to independently choose the appropriate learning content and resources; it can be repeated through on-demand, playback of related video resources and other ways of learning and consolidation, which meets the learning needs of different students for the same learning content that requires different learning time. This can meet the different learning needs of different students who need different learning time for the same learning content.

However, there are some problems: (1) Since the online course is open to students and social personnel at different levels across the country, the teaching content of some of the "Stochastic Processes" online open courses is simple, lacking the introduction of some important definitions and theorems, with fewer or simpler application examples, and the solution ideas follow the textbooks, which fails to realize the "two natures and one degree" of the courses better. " The course content is simple and lacks the introduction process of some important definitions and theorems. (2) Many students who choose "Stochastic Processes" MOOC have low motivation to study, fewer students take the exam, and the results are not satisfactory, and students show indifference to the course. (3) "Stochastic process" online open course, the content of curriculum ideology and politics is less, and some even have no curriculum ideology and politics.

The offline course "Stochastic Process" also has some problems: (1) The course has fewer hours and more content, so teachers can only speed up teaching in order to cover every part of the content as much as possible, which leads to the lack of detailed explanations of some of the knowledge points in the course of teaching. (2) The teaching of the course exists "heavy on theory, light on examples", and students have the problem of "learning knowledge will not be used".

In view of the above problems, it is especially important to carry out the reform exploration and practice of online and offline hybrid teaching mode of "Stochastic Process" course, which is

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cantered on comprehensively improving students' ability.

## 2. Teaching objectives of the course

Combined with the characteristics of students majoring in Financial Mathematics and Mathematics and Applied Mathematics in Nanjing University of Finance and Economics, the course focuses on the fundamental task of establishing morality and educating people, and takes students as the centre, takes problems as the forerunner, and combines the heuristic, problematic, and exploratory teaching methodologies to guide and promote students' learning by means of autonomy, cooperation, and investigation. It aims to cultivate students' solid professional theoretical foundation and knowledge and skills, as well as their ability of active thinking, analysing problems, connecting theory with practice and innovation. On this basis, we focus on the following three teaching objectives.

### 2.1. Knowledge Objective

The course enables students to understand and master the basic ideas and methods of stochastic processes, the basic concepts and basic theories of stochastic processes, including Poisson processes, discrete-time Markov chains, continuous-time Markov chains, matingale, Brownian motion, stochastic integrals, stochastic differential equations and so on.

### 2.2. Competency Objective

The competency objective is to cultivate students' ability to analyse and solve practical problems by applying the theories and methods of stochastic processes, and to improve students' ability to raise questions, analyse and solve problems, as well as their sense of innovation.

### 2.3. Quality Objective

The quality objectives are to shape students' spirit of pursuing excellence and their positive and resilient personalities, to stimulate students' patriotic fervour, as well as to cultivate students' sense of independent innovation, socialist core values and craftsmanship, and to cultivate a sense of family and country.

## 3. Online-Offline Hybrid Instructional Design, Reform and Practice

### 3.1. Hybrid Instructional Design

In the teaching process of this course, we organize the teaching with the problem as the guide, and combine the heuristic, problematic, and inquiry teaching methods to guide and promote students to adopt independent, cooperative, and inquiry ways of learning, and to promote students to realize the independent construction of knowledge and the enhancement of ability. Our on-campus course team has created a MOOC online course on stochastic processes. Knowledge that needs to be memorized, understood, and conceptualized is put online before class, and the online learning content is released through the MOOC teaching platform, allowing students to complete the online learning content by self-study. In the offline teaching process, teacher-student interaction and student-student interaction are the main forms of teaching organization and implementation, and students' online learning is first checked in the classroom through the "classroom questioning" session. In the classroom using multimedia tools, the abstract concepts and theories of stochastic processes are vividly presented to students, the abstract concepts and theorems are visualized in images, the important concepts and theorems in the course are designed to be appropriate examples, the important formulas and theorems in the course are extended in the method of proof, and some practical problems are modelled and trained. Carry out modelling training for some practical problems to extend the knowledge of the course. After the class, online practice problems and chapter tests are released to consolidate the knowledge learned and complete the stage learning evaluation for students.

In addition, some extracurricular reading materials are also sent to the students, the history of

stochastic process mathematics, the literature of the course, and the original English classic textbooks of foreign countries. The extracurricular reading materials and the mathematical history of the course expand students' knowledge, and the literature of the course and the original English classic textbooks broaden students' horizons, expanding the breadth and depth of the course and realizing the "challenging degree" of the course. Outside the classroom, we make use of the discussion forum of the Rain Classroom Teaching Platform, the class QQ group to establish communication and discussion channels with students and carry out personalized tutoring and Q&A in a targeted manner. For example, after learning the theorem on the conversion of non-homogeneous Poisson processes to Poisson processes, students can be instructed to read the relevant literature [1].

### 3.2. Addressing offline course instructional hours

At present, there is a common problem in the course of "stochastic process" in domestic colleges and universities, which is that there are fewer hours and more contents in the course. Nanjing University of Finance and Economics School of Applied Mathematics "stochastic process" course has 51 hours, these hours to the stochastic process content has been stretched to the limit, because in addition to teaching the stochastic process in the Poisson process, discrete time Markov chain, continuous time Markov chain, but also to teach martingale, stochastic analysis, stochastic differential equations and other content, also facing a serious shortage of teaching hours. To solve the problem of serious shortage of teaching hours and to achieve a better teaching effect, a hybrid online and offline teaching reform has been carried out in the course of "Stochastic Processes".

Before class, the online learning content of pre-study and self-study is released through the Rain Classroom teaching platform, including lecture notes, courseware and videos, and relevant tests are completed, so that students can master the basic concepts of the course and the knowledge that needs to be understood and memorized through online learning.

In the classroom, the rain classroom wisdom teaching tools are used to carry out teaching activities such as taking attendance, classroom interaction and accompanying tests, explaining the problems of students in the process of self-study, analysing and explaining in detail the key points and difficult problems of the course, expanding the methods of proving the important formulas and theorems of the course, and carrying out the modelling training of some practical problems, so as to comprehensively improve the overall quality of the students.

After the class, according to the learning data of each student obtained from the rain classroom teaching platform, combined with the classroom performance, the learning evaluation of students in a single class is completed.

The teaching practice of the course shows that through the online and offline hybrid teaching reform, it not only solves the problem of "stochastic process" course content, but also expands the knowledge of the course, broadens the horizons of the students, and realizes the " two natures and one degree " of the course. "

### 3.3. Addressing students' poor foundations

The course "Stochastic Processes" is usually offered in the third year of undergraduate study, when students have already studied probability theory. Due to the students' forgetfulness or poor grasp of probability theory, they will encounter many problems when learning stochastic processes. For example, the Poisson process and Brownian motion in the probability calculation and proof of properties and other important content, students need to master the Poisson distribution and the properties of the normal distribution and independence and other concepts. However, through the usual practice found that students in the study of Poisson process and Brownian motion there are greater difficulties, some students cannot correctly understand the concepts, solving the process of unclear thinking and other problems. The main reason for the existence of such problems is that students do not have a firm grasp of the Poisson distribution, normal distribution, independence, and other knowledge points. To solve this problem, before teaching the corresponding part of the course, through the rain classroom teaching platform to organize the relevant Poisson distribution, normal distribution, independence and other knowledge of the document and video sent to the

students in advance, so that the students through the Internet to complete this part of the content of the review consolidation in advance. At the same time, in the offline teaching process, students are guided to use the "probability theory" to look at this kind of problem and analyse it to recognize the essence of the problem, so as to achieve twice the result with half the effort through online and offline mixed teaching.

### 3.4. Enhancement of two natures and one degree of the course

In the offline teaching process, the teaching content is optimized by adding examples of important concepts and definitions in the course, so that students can understand the origin of the concepts and know what they are. Through online learning, students have mastered the basic knowledge of the course. Therefore, in the offline teaching process, the proof methods of important formulas and theorems in the textbook can be expanded to increase the breadth and depth of the course. The specific teaching strategy is to draw on what students have already learned in the course, to sublimate what they have learned, and to use it to complete the proofs of some of the formulas and theorems in the “Stochastic Processes” course, which are completely different from those in the textbook, and to increase the “higher order” of the course by using these new methods of proof. Before the class, we send the students to review the knowledge they have already learned through the rain classroom teaching platform and guide them to think and solve new problems with the knowledge they have already learned in the class, which cultivates their innovative thinking, broadens their horizons, and improves the "innovativeness" of the course.

For example, the application of Markov chain in economics can explain the problem of economic mobility[2], which can be demonstrated through a specific example that the economic status of an individual will change in several generations. Regardless of an individual's socioeconomic status, his offspring may enter a different economic stratum. Intergenerational mobility, or the movement of economic classes, has long been a popular topic of discussion among sociologists and economists. Through these teaching cases, students are guided to use the knowledge of "stochastic process" to solve new problems in practice, and to cultivate students' innovative consciousness, innovative thinking, and innovative ability.

In addition, the offline teaching process focuses on solving practical engineering and theoretical problems with the knowledge of stochastic process, which improves the "higher order" and "challenge" of the course. Brown's motion, as a symmetric stochastic swimming limit process, has a continuous orbit. Brown's motion is a symmetric stochastic process in the limit, and its trajectory has continuity. In practice, when studying the stock market, due to some reasons, the stock price will be suddenly shocked, which is inconsistent with the continuity of Brown's motion, and then we can add the explanation of Poisson jump diffusion process. This process was proposed by Press (1967), and can be used to describe the stock price behaviour process. In practice, in some special circumstances, the inclusion of models with jumps in the nature of the stock fluctuations and trends of the prediction of the accuracy may be improved, as a complementary note, can deepen students' understanding of Brown's motion and expand the course content.

As an example, when teaching about stochastic calculus, students can be introduced to the Black-Scholes option pricing formula, which is an explicit solution to the Black-Scholes partial differential equation. In this way, students can apply what they have learned, not only to enhance their understanding of the model, but also to further deepen the theoretical learning.

### 3.5. Improvement of the quality and effectiveness of the curriculum in educating people in the field of philosophy and culture

The course "Stochastic Process" is designed to improve students' abilities and strengthen the function of ideological and political education. That is, we set ability and strengthen the function of ideological and political education as the core, with patriotic education as the main line and knowledge of the course as the carrier, integrating the elements of ideology and politics into the course knowledge, and utilizing the course knowledge to reveal its profound inner nature, and at the same time, dig deeper into the connotation of moral education and interpret the value tendency and national sentiment behind the knowledge.

For example[3], the Poisson process was initially proposed by the famous French mathematician Poisson in 1837, who theorized the number of wrongful convictions in a certain country by focusing on a specific random variable N, which is the number of occurrences of a discrete event within a certain time interval. count. Subsequently, C. Palm applied it in 1943 to the telephone business service problem, A.Я. Sinchin in 1955 in a mass service The Poisson process was further developed by A.Я. Sinchin in 1955 in a systematic study of mass service theory. The study of the origin of the Poisson process can stimulate students to grasp the nature of knowledge and develop their dialectical thinking skills.

## 4. Reform of assessment methods

The online learning content, online practice questions, online test questions, as well as the completion of post-course homework, attendance, and final written examination results are combined to form the overall assessment grade at the end of the course, which is a comprehensive assessment of the students' comprehensive quality.

At present, the test question bank of our random process course has been completed. The examination adopts the form of combining theoretical assessment and practical ability assessment to comprehensively investigate students' theoretical mastery and practical ability to analyse and solve problems. The examination method is to decompose the final grade into two parts: the usual grade accounts for 40%, and the final closed-book examination accounts for 60%, and the usual grade includes the online learning content, online practice questions, online test questions, as well as the completion of post-course homework and attendance.

This has largely changed the learning status of students, who neglected the usual learning and sudden review at the end of the term, so that the content of classroom teaching is gradually grasped by the students, and after-class review and self-study of students is promoted.

## 5. Conclusion

This paper analyses the current online and offline teaching status of the stochastic process course and points out its problems; it also analyses the problems of students in the process of learning stochastic process. Taking the students of the School of Applied Mathematics of Nanjing University of Finance and Economics as the target, we set new teaching objectives, redesigned the course teaching, and carried out the online and offline hybrid teaching reform of the course in terms of solving the problem of insufficient teaching hours, poor foundation of the students, the enhancement of the " two natures and one degree ", and the enhancement of the quality of the course's ideological and political cultivation.

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