

Analysis of the Influence Degree of Higher Mathematics Teaching on Probability Statistics Teaching

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Abstract: Higher mathematics and probability statistics are compulsory courses in higher education. For students with different learning levels and different understanding levels, probability statistics is more difficult to learn than higher mathematics, and the flexibility of learning methods of higher mathematics is insufficient, which has a negative impact on learning efficiency and teaching efficiency. In order to further reduce students' difficulty in learning probability statistics and improve students' flexibility in learning higher mathematics knowledge, this study analyzes the impact of higher mathematics teaching on probability statistics teaching, and proposes targeted strategies on this basis to make full use of the impact of higher mathematics teaching on probability statistics teaching to improve teaching efficiency.

1. Introduction

Probability statistics is a subject which is based on quantitative analysis to make statistics on the law of occurrence of accidental phenomena. Probability statistics is an important branch of mathematics. On the basis of retaining most mathematical thoughts, it has a unique probability statistics thought, which is called "probability thought" in the academic circle. The first chapter of the higher mathematics textbook is "probability". By learning the first chapter of higher mathematics, students can preliminarily understand the knowledge and function of probability. Therefore, on the basis of fully analyzing the influence of higher mathematics teaching on probability and statistics teaching, we should further optimize the teaching, improve the teaching efficiency and reduce the learning difficulty of higher mathematics and probability and statistics.

2. Research design

2.1 Research object

In this study, 100 freshmen, sophomores and juniors studying advanced mathematics and probability statistics and 10 teachers of probability statistics in freshmen, sophomores and juniors were selected as research objects.

2.2 Questionnaire Design

This questionnaire is designed to investigate the relationship and influence degree between higher mathematics and statistical probability from three dimensions. Through this survey, teachers mainly consider the degree of correlation between higher mathematics teaching and probability statistics teaching; The third part is about the influence of student factors on the teaching of higher mathematics and statistical probability. 30 questions of higher mathematics and statistical probability are designed in the questionnaire. The topic is percentage system, and the ability and quality of students are investigated. Among them, questions 1-7 examine the students' basic knowledge of series, limit, calculus, spatial analytic geometry, linear algebra, series, ordinary differential equations, etc. Questions 8-20 examine the students' ability to master the main contents of random variables, probability distribution, population and sample, central limit theorem, etc. Questions 21-30 investigate students' ability to master difficult contents such as integral of one variable function, integral of multiple functions and differential of multiple functions, and investigate students' subjective cognition, that is, the influence of higher mathematics teaching on probability and statistics teaching ^[1].

2.3 Questionnaire analysis method

The questionnaire analysis methods used in this study include multivariate analysis of variance, correlation analysis and principal component regression analysis. Among them, the correlation analysis mainly analyzes the influence of higher mathematics teaching on probability and statistics teaching. Principal component regression analysis mainly analyzes the impact of higher mathematics teaching on probability and statistics teaching by students ^[2].

2.4 Optimization of the questionnaire

2.4.1 Internal consistency analysis

The internal consistency of the designed questionnaire was assessed using reliability, as shown in Equation (1):

$$X = T + B + E \quad (1)$$

Where: X- Measurement result

T- The true value

B- Systematic error

After calculation, it is learned that the internal consistency credibility of the designed questionnaire is 0.862, which proves that the questionnaire has relatively good credibility.

2.4.2 Factor analysis

Table 1: Variables test table

KMO	.844
Bartlett	5852.477
df	991
Sig	.000

* Df-degrees of freedom; Sig-logical sty function

In order to further verify the validity of the structure in the questionnaire, SPSS28.0 was used in this study to test questions 1-30, test statistic (KMO) was used as the measurement standard of the

range of statistics, and Bartlett spherical test was used to test the correlation degree of each variable. Table 1 shows the variable test table.

The KMO for this analysis was performed as follows. 844, between 0.8-0.9, indicating good fitness, corresponding The Bartlett of 5852.477, proved that the structural validity of the questionnaire was sufficient to support the common factor analysis. Variable test plots are shown in Figure 1.

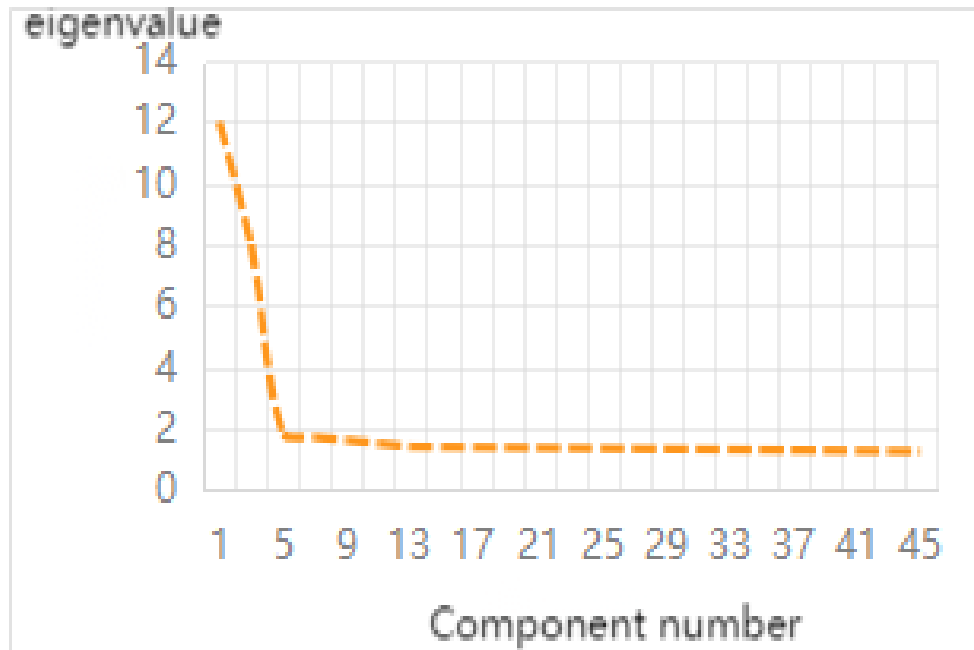


Figure 1: Variable test

3. The relationship between higher mathematics teaching and probability statistics teaching

3.1 Discipline Analysis

From the perspective of subject nature, this study summarizes the influencing factors of higher mathematics teaching on probability and statistics teaching. By analyzing the commonly used formulas and main research fields of higher mathematics and probability and statistics, this study analyzes the influence of higher mathematics education and probability and statistics teaching ^[3].

Through the analysis of Table 2, it can be found that higher mathematics and probability statistics have a common research field from the perspective of the nature of the discipline. More specifically, probability is a further in-depth study of the probability part of higher mathematics, and the content of probability statistics can be appropriately introduced into the teaching of the probability part of higher mathematics in practical teaching ^[4]. This study believes that higher mathematics and probability statistics have close subject correlation, and there is a strong connection in practical teaching.

Table 2: Shows the common formulas and main research fields of higher mathematics and probabilistic statistics

type	probability	Random variable
	Classical generalization	Expect formula
$P(A) = A = m/n$	$E[X] = \sum xP(x)$	
Geometry	Variance formula	
$P(A) = A$	$D[X] = \sum x - E[X]^2 * P(x)$	
Higher mathematics	Conditional probability	Conditional probability
$P(A B) = Nab / Nb =$	$P(A B) = Nab / Nb =$	
$P(AB) / P(B) = AB$	$P(AB) / P(B) = AB$	
The Benuri phenotype	Continuous variable with the model	
$Pn(K) = Cn * p \wedge k$	(1)Uniform distribution: $f(x) = \begin{cases} \frac{1}{b-a} & a < x < b \\ 0 & \end{cases}$	
	(2)Exponential distribution: $E(\lambda)$	
$f(x) = \begin{cases} \lambda e^{-\lambda x} \\ 0 \end{cases}$		Discrete uniform distribution
		$F(x) = \begin{cases} 0 \\ 1 - e^{-2x} \end{cases}$
	$f(x) = \frac{1}{n}$	Continuous uniform distribution
probability statistics		
Normal distribution		
$f(x) = \frac{1}{b-a}$	$f(x, \mu, \sigma) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}(\frac{x-\mu}{\sigma})^2}$	
Normal distribution		
$f(x, \mu, \sigma) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}(\frac{x-\mu}{\sigma})^2}$		
exponential distribution		
$f(x; \lambda) = \begin{cases} \lambda e^{-\lambda x} \\ 0 \end{cases}$		

3.2 Analysis of exercises

Exercise analysis is carried out with the example of item 19 in the questionnaire:

Let the joint distribution law of two-dimensional random variables (x, y) be $P(x=0,y=0)=1/3, P(x=1,y=1)=1/3, P(x=1,y=-1)$, solve $Cov(x,y)$.

Solution: $\because P(X=0)=1/3, P(X=1)=2/3, P(Y=-1)=1/3, P(Y=0)=1/3, P(Y=1)=1/3;$ $EX = \frac{1}{3}, EY=0,$

$EXY=0$

$\therefore Cov(x, y)=0$, X is not correlated with Y; $P(X=0, Y=0)=1/3 \neq P(X=0)P(Y=0)=1/3 \times 1/3= 2/9$, Neither X nor Y are independent.

By solving question 19, it can be found that relevant knowledge about the distribution of two-dimensional discrete random variables is used in this exercise, and two-dimensional discrete random variable distribution is the key content of higher mathematics teaching and probability and statistics teaching. In probability and statistics, further in-depth analysis of two-dimensional discrete random variable distribution knowledge is carried out. Therefore, it can be preliminarily judged that probability and statistics teaching can supplement higher mathematics teaching to a certain extent [5].

3.3 Test situation analysis

Ten students were selected from the study subjects and numbered according to ①-⑩. Among them, the students who passed the probability statistics score in the last semester were selected as the observation group with the serial number ①-⑤, and the students who failed the probability statistics score in the last semester were selected as the control group with the serial number ⑥-⑩. All the students answered the questions in the questionnaire and made statistics on their scores. The results showed that all the students in the observation group passed, while the students in the control group failed. Therefore, it was preliminarily concluded that probability and statistics teaching had a direct relationship with students' scores in higher mathematics tests, and further speculated that probability and statistics teaching was closely related to the quality of higher mathematics teaching [6]. In order to further verify the rationality of the judgment, Aspin-Welch was used for analysis in this study:

$$t = (\bar{x} - \bar{y}) / \sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}} \quad (2)$$

t degrees of freedom distribution calculation:

$$df = \left[\frac{R^2}{n_1} + \frac{(1-R^2)}{n_2} \right]^{-1} \quad (3)$$

$$R = \frac{S_1^2}{n_1} / \left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2} \right) \quad (4)$$

Calculate students' advanced mathematics study performance and probability statistical score r:

$$r = \frac{N \sum x_i y_i - \sum x_i \sum y_i}{\sqrt{N \sum x_i^2 - (\sum x_i)^2} \sqrt{N \sum y_i^2 - (\sum y_i)^2}} \quad (5)$$

Where: df- degrees of freedom

t- Critical value

N- Number of samples

x_i - Higher Mathematics results

y_i - Probability and statistics score

After calculation, the degree of freedom of T statistic in observation group and control group is $31 \leq df \leq 40$, and the critical value $t = 2.71$.

According to the calculation results, it is further concluded that:

Students who passed in probability statistics last semester can effectively deal with higher mathematics problems, while students who failed in probability statistics last semester are not able to deal with higher mathematics problems, indicating that students' knowledge level of probability statistics is positively correlated with higher mathematics, and their opinions indicate their performance in probability statistics teaching. It is proved that probability statistics teaching is directly related to students' higher mathematics achievement^[7].

3.4 Teachers' Views

According to this survey, teachers generally believe that higher mathematics teaching is highly related to probability and statistics teaching, which is embodied in teaching content, teaching methods and teaching ideas. Teachers say that probability and statistics, as a branch of higher mathematics, play an important complementary role in the actual teaching of higher mathematics^[8]. Teachers of advanced mathematics and probability statistics generally believe that the differences between advanced mathematics and probability statistics are mainly reflected in the calculation methods and learning content. There are differences in calculation methods between higher mathematics and probability statistics. Probability statistics uses relatively single calculation methods, taking data collection and data analysis as the main problem-solving methods. Only on the basis of data analysis can calculation formulas be used to solve problems and verify judgments^[9]. The calculation methods of higher mathematics show diversity, and common methods of higher mathematics calculation include extreme limit evaluation, auxiliary line, undetermined coefficient, etc.^[10]. There are some similarities between higher mathematics and probability statistics in theoretical content and problem-solving thinking, but there are still big differences in key research contents^[11]. Probability statistics can be further divided into mathematical statistics and economic statistics according to categories. The key research objects of economic statistics focus on actual social production, such as event statistics and probability analysis, while the content of higher mathematics is more theoretical, mainly calculating abstract indicators such as integral, function, vector and linearity^[12]. Although the content of advanced mathematics is more theoretical than that of probability and statistics, most teachers have always believed that advanced mathematics is the basis for learning other sciences, and the application of advanced mathematical thinking to solve practical problems will form more diversified ways and richer ideas, so the teaching of advanced mathematics is of great significance for the development of probability and statistics teaching^[13].

Taking "Teaching One-dimensional Continuous Random Variables and Probability Density" in Chapter 1 of "Course of Probability Theory and Mathematical Statistics" as an example, students are required to master the relevant basic knowledge of "Probability" in the first chapter of "Higher Mathematics". In the teaching of probability density function of random variable X, students are required to master the knowledge of continuous uniform distribution and discrete uniform distribution in the first "probability" of higher mathematics:

$$f(x) = \begin{cases} Ax \\ 0 \end{cases},$$

[Example 2] The probability density of continuous random variable X is known among $0 < x < 1$, (1) find the constant A; (2) find the X distribution function F(x). Formulae to be used in teaching topics:

$$\int_{-\infty}^{+\infty} f(x)dx = 1 \tag{6}$$

$$F(x) = P[X \leq x] = \int_{-\infty}^x f(x)dx \tag{7}$$

The problem can be solved by using the fixed integral in advanced mathematics, using the Newton Leibniz formula:

$$\int_a^b f(x)dx = [F(x)]_a^b = F(b) - F(a) \quad (8)$$

$F(x)$ is the original function of $f(x)$, and the integral interval is an uncertain interval $[a, b]$. Therefore, it is complicated to use Newton Leibniz formula to solve such problems, so the method of partial solution is chosen:

(1) Find the constant A.

The unknown constant in the density function is solved according to formula (6), and in actual teaching, students can understand that the integral of the density function is constant to 1 in nature. For the probability density function of piecewise function, the number line integral should be analyzed on the basis of clarifying the additivity of the integral interval, and it should be transformed into the density function integral of the non-zero interval [14].

$$\int_{-\infty}^{\infty} f(x)dx = \int_{-\infty}^0 f(x)dx + \int_0^1 f(x)dx + \int_1^{+\infty} f(x)dx \quad (9)$$

Given $f(x) \neq 0$ in this question, it is known that the number axis definite integral:

$$\int_{-\infty}^{\infty} f(x)dx = \int_{-\infty}^0 f(x)dx + \int_0^1 f(x)dx + \int_1^{+\infty} f(x)dx = \int_0^1 Axdx \quad (10)$$

Finally, we can obtain the constant $A=2$.

(2) X-distribution function $F(x)$.

Through the observation $F(x) = \int_{-\infty}^x f(x)dx$. Its lower limit is $-\infty$. The upper limit of x is the difficulty that students encounter when solving the problem. In order to reduce the difficulty of solving problems, teachers usually represent $f(x)$ through the number axis in their teaching. The interval corresponding to $f(x)$ has $(-\infty, 0]$, $(0, 1)$, $[1, +\infty)$, Corresponding to different intervals will appear different situations, so in the actual problem solving, the situation of the three intervals should be analyzed separately.

When $x \in (0, 1]$, further emphasis on the integration interval is needed $(-\infty, x]$, Known as $f(x) = 0$ in the interval $(0, 1)$, Students should be clear $(-\infty, x] = (-\infty, 0) \cup [0, x]$, Because the integral interval is additive,

$$\text{So } F(x) = \int_{-\infty}^x f(x)dx = \int_{-\infty}^0 f(x)dx + \int_0^x f(x)dx = \int_0^x 2xdx = x^2 \quad (11)$$

According to the integral interval additivity, it can be based on $x \in [1, +\infty)$, $(-\infty, x] = (-\infty, 0) \cup [0, 1] \cup (1, +\infty)$, in the case of, $F(x)$, it solves:

$$F(x) = \int_{-\infty}^x f(x)dx = \int_{-\infty}^0 f(x)dx + \int_0^1 f(x)dx + \int_1^x f(x)dx = \int_0^1 2xdx = 1$$

Therefore, students should be taught in the actual teaching, $F(x) = \int_{-\infty}^x f(x)dx$ Independent of the upper limit, x value, the integration interval is constant $(-\infty, x]$. In the actual calculation, we need to combine the expressions of $f(x)$ corresponding to different intervals, based on the range of x value $(-\infty, x]$ It is decomposed into different sub-intervals, thus reducing the difficulty of

solving the problem.

According to the teachers' views and the analysis process of [Example 2], there is a direct relationship between higher mathematics teaching and probability and statistics teaching, which is usually manifested as the application of basic higher mathematics knowledge to solve complex probability and statistics problems [15].

4. Influence of higher mathematics teaching on probability and statistics teaching

4.1 Subjective cognitive statistics

According to the results of the questionnaire survey, students' subjective awareness of the impact of higher mathematics teaching on probability and statistics teaching is shown in Figure 2.

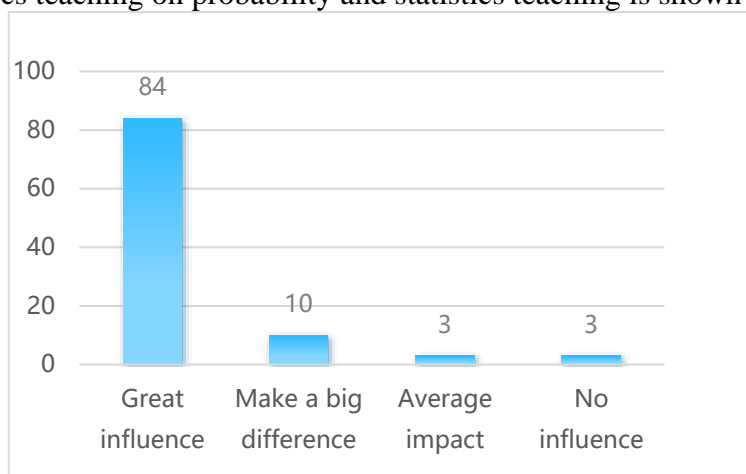


Figure 2: Students' subjective awareness of the impact of higher mathematics teaching on probability and statistics teaching

According to the data in Figure 2, 97% of the students believe that higher mathematics teaching has an impact on probability and statistics teaching, and 94% of them believe that higher mathematics teaching has a high impact on probability and statistics teaching.

4.2 Teaching optimization strategy

In the follow-up study, students can master more advanced mathematical knowledge and use advanced mathematical knowledge to solve probability problems, but they will find that the problem solving process is tedious and the ideas are complicated, that is, they cannot accurately grasp the research object of probability and statistics by using calculus and linear algebra of advanced mathematics. Common questions include "The relationship between the probability of an event and its actual occurrence" and "the fact that the probability of an event is zero does not mean that it cannot occur." Therefore, in practical teaching, we should make full use of the influence of higher mathematics teaching on probability and statistics teaching, realize the optimization of teaching, and reduce the difficulty of students learning probability and statistics.

4.2.1 Statistical software

Probability statistics is more difficult than advanced mathematics. On the one hand, it is because of the difference of thinking, on the other hand, it is because of the abstract painting of the teaching content. Therefore, statistical software can be used in actual teaching to more intuitively present the content of probability and statistics to students. For example, in the teaching of central limit

theorem, it is difficult to solve the problem solely by relying on advanced mathematical knowledge in the proof stage, so it is necessary to use probability and statistics knowledge, but the reference answer will not list the proof process in detail. Therefore, under the influence of the reference answer, students will default to prove the result, but still cannot clearly prove the process ^[16]. The application of Matlab in teaching can more clearly show the proof process of the central limit theorem to students, and can adjust the random variables according to the teaching needs, and cooperate with the graph drawing so that students can intuitively observe the inherent law of the central limit theorem. Figure 3 shows the law of the central limit theorem.

Matlab program:

```
clear; close; K = 1000; a = 2; b = 8; N = K; M
=1000; r = unifrnd(a, b, N, M); mu0 = (a + b)* 0. 5* N;
sigma0 = sqrt((b - a). ^2/12* N); s = (sum(r)- mu0)/
sigma0; mu = mean(s); sigma = std(s); [n, x]= hist(s,
mu -5* sigma: 0. 5* sigma:mu +5* sigma);bar(x, n/M/sig-
ma* 2,'r'); hold on; h = mu -5* sigma:0. 1* sigma: mu +
5* sigma; t = exp(- (h - mu). ^2/2/sigma^2)/sqrt(2* pi)/
sigma; plot(h,t,'K');title(' central limit theorem '); legend('Independent RV and ',' normally
distribution');
hold off;
```

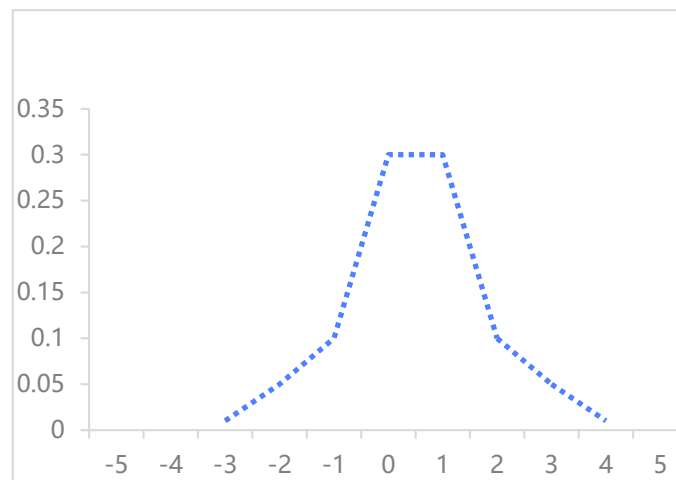


Figure 3: The central limit theorem law

4.2.2 Fusion of thinking

In practical teaching, the integration of the thinking of probability statistics and higher mathematics can effectively improve the teaching efficiency. The combination of number and form is an effective way, which can be flexibly applied to the teaching of probability statistics and higher mathematics. Teachers will intuitively present the results obtained from each deduction in front of students by drawing. It enables students to learn relevant knowledge more effectively ^[17]. For example, the contents of permutation and combination in probability and statistics teaching are similar to those of higher mathematics, but the permutation and organization of probability and statistics are more in-depth than that of higher mathematics. Teachers can apply the permutation

and combination thought in higher mathematics to probability and statistics permutation and combination in teaching, and students can find that using different thinking to solve permutation and combination problems can reduce the difficulty of permutation and improve the accuracy of permutation and combination. The teacher uses the combination of numbers and shapes to show the possible results of various combinations of columns to the students, and shows the incidence of each combination by drawing, so that the students can have a clearer logical thinking. So that students in the understanding of probability and statistics content, the mind can immediately appear analysis chart, rather than boring words and formulas. For example, the function distribution of continuous random variables in higher mathematics can be solved by means of the number combination method. On the basis of the explicit formula, the number form association method is used

On the basis of the combination of number and form, students are guided to observe the graphical representation and find the integral interval within the known value range. Students can quickly find different integral intervals by observing the graph, and the integral interval directly determines the function distribution relationship of continuous random variables, so that students can see the function distribution form of continuous random variables more intuitively. As shown in Figure 4.

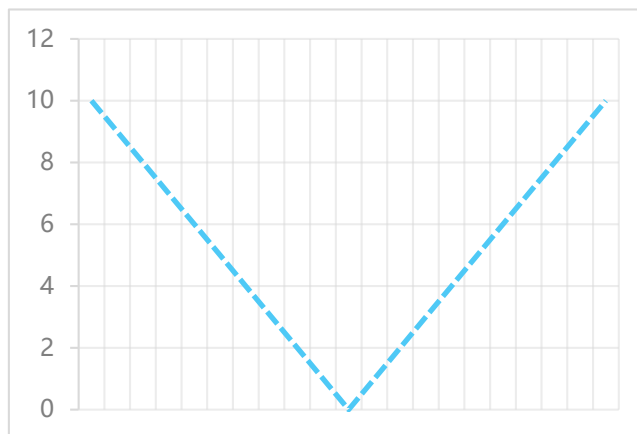


Figure 4: Line plot of the function distribution for continuous-type random variables

5. Conclusion

This study shows that higher mathematics teaching has a high impact on probability and statistics teaching. As an important branch of higher mathematics, probability statistics is a further in-depth analysis of the probability content of higher mathematics. The teaching of probability statistics requires students to have a solid foundation of higher mathematics knowledge, such as calculus, definite integral, etc. Therefore, higher mathematical thinking can be applied to probability statistics in the teaching of probability statistics to realize the flexible application of higher mathematics knowledge and probability statistics knowledge. Teachers should further emphasize the basic knowledge in the teaching of higher mathematics, so that teachers can use the basic knowledge of higher mathematics to solve complex probability and statistics problems in the future teaching of probability and statistics, and realize the improvement of teaching efficiency.

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