Theory and Practice of Research Teaching of "Partial Differential Equation"

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Abstract: Partial Differential Equation is an Important Branch of Modern Mathematics. "Partial Differential Equation" Course Aims to Let Students Learn and Master the Basic Concept, Solution Method and Basic Theory of Partial Differential Equation, Learn to Use the Knowledge Learned to Solve Some Practical Problems, and Improve Students' Scientific Literacy. the Teaching Methods and Strategies of "Partial Differential Equation" Course Mainly Include: Open Teaching and Discussion Teaching the Forms of Learning, Inquiry Teaching and Assessment Are Diversified.

1. Introduction

Partial Differential Equation is an Important Field of Modern Mathematics. They Are Many Important Applied Mathematics and Applied Mathematics Majors in Differential Geometry, Physics, Mathematics, Computer Graphics, Calculation and Financial Mathematics. They Are the Professional Route for College Students as Partial Differential Equations, and One of the Core Courses for the Training of Mathematics and Applied Mathematics Experts. the Task is to Establish Mathematical Models, Solve Them, Carry out Theoretical Analysis, and Achieve the Purpose of Explaining Physical Phenomena[1].

The Purpose of Pde is to Learn and Master the Basic Concepts, Solutions and Basic Theories of Pde. through This Course, It Provides Necessary Information for Improving the Quality of Students' Comprehensive Mathematics, and Further Studies the Basic Theory of Partial Differential Equation.

2. Curriculum Design Ideas

Participate in Learning through the Whole Process. the Purpose of This Project is to Improve Students' Ability to Master the Basic Theory and the Method of Partial Differential Equation, Analyze and Solve Problems[2]. the Order of the Course Content Follows the Order of the Basic Steps of Pdes. It is Convenient for Students to Participate in the Whole Process of Learning, and It is Also Convenient for Students to Master and Master the Knowledge of Partial Differential Equation in Stages.

Class discussion. Partial differential equation is a specialized course of mathematics and applied mathematics. In the process of learning, students are encouraged to use what they have learned to improve independent analysis. In addition, the ability to solve problems and positive evaluation, timely feedback, better stimulate students' interest in learning.

Extracurricular survey. In addition to classroom learning, I suggest students to explore after class, write a small document, and continue to prepare for learning.

3. Teaching Objectives

The purpose of this study is to solve the theoretical and practical problems of PDEs proposed by physics, mechanics and other application fields. In order to improve the scientific literacy, improve the students' interest in the study of PDEs, and provide backup force for the law.

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4. Teaching Methods and Strategies

Open trading. The main body of open teaching is teaching content, teaching level, guiding method, means, operation practice, evaluation, evaluation, etc. The content of textbooks is combined with the research of teachers and the frontier knowledge of subjects[3]. The introduction penetrates into the front of class, special explanation and discipline. The teaching level, the specialty of auxiliary teachers, the principle of teaching students in non class, teacher and cross training experiment class of mathematics and physics, fully embody the training package of various goals. The main part of the class of natural education is to teach students the class of consultation, question and answer questions, and supplement the scattered composition in the class.

Research class guidance. Research class education is mainly used in the teaching of the main classroom which combines lecture notes and discussion. It can be divided into two levels: one is to improve the impact of classroom interaction, the other is that teachers (possibly students) can discuss in advance. The content is for students to study inside and outside the class after necessary preparation [4].

Inquiry guide. Corresponding to open teaching, through the combination of teaching content, inquiry based professors are mainly used for extra-curricular investigation and research. Combined with the discussion content, guide students to read materials, write a small document, abide by a small document, select a good paper for further research and processing, and publish a report. The purpose is to stimulate students' enthusiasm for mathematics learning more effectively, improve students' enthusiasm for scientific research, and cultivate students' ability of scientific research and innovation.

Various forms of evaluation. The existing final written test, plus the open book, paper articles and defense evaluation are supplemented according to posture. The class dispute is that the more objective test of evaluation of education effect has made a link, and the professor is beneficial to improve the quality.

5. Learning Requirements and Training

5.1 Learning Requirements and Method Guidance

Through exercises training, we can deepen the understanding and mastery of the textbook knowledge, and improve the ability of flexibly using various methods to solve different problems

Under the guidance of teachers, students are required to complete two course papers, which are mainly used to train students' innovative thinking ability and comprehensive induction ability, and to cultivate students' interest in scientific research, so as to find a group of potential students to encourage them to continue to engage in the subsequent study of PDEs

Based on the platform of College Students' scientific research projects, guide some students to participate in scientific research projects and cultivate their ability to comprehensively use the knowledge they have learned to solve practical problems.

5.2 Strengthening the Training of Young Teachers and Promoting Sustainable Development

The cultivation of young teachers is an important part of the construction of teachers' team. It is directly related to the sustainable development of the construction of excellent courses[5]. In order to make young teachers grow up rapidly and healthily, we can actively create various favorable conditions for the growth of young teachers, formulate special systems, and take effective measures. Young teachers' teaching tutorship system. Before the independent opening of classes, young teachers should, The experienced professors of teaching and scientific research in the course group are responsible for “spreading, helping and guiding” young teachers [6]. Through regular guidance, discussion of teaching plan, pre class trial, class following, after class communication and other forms, young teachers can grow up as soon as possible, and be strict in Ideological and political requirements, and set an example in action, so as to cultivate their good teachers' morality and style In order to improve young teachers' academic level and ability of foreign exchange, the curriculum

group actively strives for various opportunities, encourages and supports young teachers to participate in various academic conferences and activities at home and abroad To study and study in well-known universities or research institutions at home and abroad [7]. To strengthen the self-cultivation of the University. The curriculum group to give full play to the strong strength of teachers, strengthen the self-cultivation of the University.

6. Teaching Resources and Teaching Conditions

Build the website of partial differential equation course[8]. The online classroom, teaching resources and other modules have been preliminarily completed, and some teaching videos have been online for students to learn independently. The syllabus of this course, the teaching plan of each teaching teacher in each semester, the tutoring of each main teacher, the time and place of answering questions, etc. are published on the online teaching website for students to learn.

In order to further strengthen the quality-oriented education, the Ministry of Education issued a document in 2005, some opinions on Further Strengthening the undergraduate teaching in Colleges and universities, advocating the implementation of research-based teaching in the undergraduate teaching classroom. The article clearly stated: “actively promote research-based teaching and improve the innovation ability of college students.” the so-called research-based teaching means that in the teaching activities, students are the center, In the classroom teaching, we should change from the traditional teacher centered knowledge transfer to the combination of knowledge transfer and exploration, and adopt the open, discussion, inquiry and self-study counseling Methods: teachers and students interact with each other in order to arouse students' enthusiasm for independent learning and stimulate students' desire for knowledge and creativity. In order to implement the spirit of JG No.1 document [2005], colleges and universities all over the country have chosen several courses to carry out research-oriented teaching, which has achieved good teaching results and played an important role in cultivating innovative high-quality talents. As a national, provincial and school level excellent course, equation course is selected as a research-oriented teaching demonstration course. Here is a teaching example of research-oriented teaching in partial differential equation class[9]. Let's talk about the understanding of research-oriented teaching and exchange with you. In the teaching of partial differential equation, there is a section about how to solve the initial and boundary value of one-dimensional heat conduction equation problem.

$$u_t - a^2 u_{xx} = 0$$
$$0 < x < 1, t > 0$$
$$u(x,0) = \varphi(x)$$
$$0 \le x \le l$$
$$u(0,t) = u(l,t) = 0$$
$$t \ge 0$$

Fig.1 Formula of Partial Differential Equation

6.1 Questions

It is known that the initial boundary value problem of the heat conduction equation on the half-line can be solved by the heat reflection principle just as the wave reflection principle on the half-line can be solved by the wave reflection principle[10]. So a natural question is whether the initial boundary value problem of the heat conduction equation on a finite interval can be solved by the heat reflection principle just as the initial boundary value problem of the wave equation can be solved by the wave reflection principle.

6.2 Group Discussion

Divide the whole class into 4 groups, each group recommends a leader democratically, and the leader is responsible for organizing discussion. Teachers patrol between groups and give guidance

when necessary, noting that teachers' guidance cannot replace students' independent research and discussion.

6.3 Team Concluded

After group discussion, the group leader should write the discussion conclusion. As a result, three groups got very complete and correct answers, while only one group got incomplete answers. Using the reflection principle of heat, the solution of the problem can be obtained as follows.

$$u(x,t)=\int_0^1 \varphi(y)k(x,y,t)dy$$

Fig.2 Group Discussion Formula

6.4 Problem Extension

After students' discussion and conclusion, the teacher put forward two questions: question 1: the solutionobtained by using the “reflection principle of heat” and the solution obtained by using the “separation of variables” are not the same in form. Are they the same solution? If so, how?

Question 2: the formula of initial boundary value problemis given by using “separation of variables” and “heat reflection principle”. Can the same method be used to solve the Neumann initial boundary value problem as follows.

$$\begin{gathered} u_t-a^2u_{xx}=0 \\ 0<x<1,t>0 \\ u(x,0)=\varphi(x) \\ 0\le x\le l \\ u(0,t)=u(l,t)=0 \\ t\ge 0 \end{gathered} \tag{1}$$

The solution of the initial boundary value problem obtained by the separation of variables method is the same as that obtained by the heat reflection principle , which is two different forms of Poisson's formula.

$$\begin{gathered} \int_{-\infty}^{+\infty}\phi(y)G(x-y,t)dy \\ =2\sum_{n-1}^{+\infty}\frac{2}{l}\int_0^1\varphi(x)\sin\frac{n\pi}{l}xdx\sin\frac{n\pi}{l}x\int_0^{+\infty}\cos\frac{n\pi}{l}y\frac{1}{2a\sqrt{\pi t}}e^{\frac{y^2}{4a^2dy}} \end{gathered} \tag{2}$$

Conclusion two: the solution of the problem is given by using the separation variable method.

$$u(x,t)=\frac{1}{l}\int_0^1\varphi(x)dx+\sum_{n-1}^{+\infty}\frac{2}{l}\int_0^l\varphi(\zeta)\cos\frac{n\pi}{l}\zeta d\zeta e^{-(\frac{an\pi}{l})^2t}\cos\frac{n\pi}{l}s \tag{3}$$

The solutions of the initial boundary value problem given by are the same as those given by, and they are two different forms of Poisson's formula.

$$k_1(x,y,t)=\frac{1}{2a\sqrt{\pi t}}[\exp\{-\frac{(x-y-2nl)^2}{4a^2t}\}+\exp\{-\frac{(x+y-2nl)^2}{4a^2t}\} \tag{4}$$

7. Conclusion

This research teaching example shows that, on the one hand, students' learning enthusiasm and initiative have been greatly improved, inspiring their urgent learning desire, strong learning motivation and high learning enthusiasm. Students generally think that this class of research-based learning, always proceeding from the key and difficult problem, through group discussion, students come to the conclusion that the final end to solve the problem, this lets the student experience the whole process of scientific research in the teaching of new teaching methods, make the student's own ability to analyze problems, generalized ability, scientific innovation ability and the team cooperation ability get the training and development. Understanding and mastering the new

knowledge, and having a deeper understanding of the “principle of wave reflection” previously learned, is one of the best attempts to learn happiness.

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