On The Teaching Innovation of The Differential Equation Course for Engineering Students

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Abstract

This paper focuses on the teaching innovation of differential equation course for engineering students, and explores the innovative methods and ways of teaching mode, teaching content and teaching means in this course.

Keywords: Teaching Content; Engineering Differential Equation; Teaching mode.

1.   Introduction

Differential equation is one of the important tools for people to understand and transform nature and society. It is one of the main ways of integrating mathematics with practice. According to the actual background, people can use differential equation to establish mathematical model, try to find the solution or numerical solution of the model. We do analysis of the variables in the model so as to achieve the purpose of understanding the nature and the society. Undergraduate differential equation courses include "ordinary differential equation" and "partial differential equation". These two courses are compulsory courses for undergraduate mathematics majors, and some engineering majors also list these two courses as their professional basic courses. There are many papers on teaching research and teaching reform of ordinary differential equations and partial differential equations. Refer to documents 1, 4, 5, etc. there are also many teaching materials for these two courses. As pointed out in 5, ordinary differential equations and partial differential equations are two parallel disciplines. The research of the two disciplines focus is different. For example, partial differential equations are devoted to solving the well-posedness of the equation under the condition of definite solution, while ordinary differential equations focus on the orbital structure in the whole phase space; when partial differential equations are committed to the overall existence of solutions, ordinary differential equations focus on the continuous dependence of solutions on parameters, pay attention to time variables, strongly mediate the evolution process of time, and the models considered are relatively macro, while partial differential equations pay attention to spatial variables, and the models considered are relatively micro, etc

Many universities and research units have research collectives in the application of differential equations, and have received strong support from the national industry, science and technology departments and the military. For example, the Courant Institute in the United States, IMA and INRIA (National Institute of information and Automation) in France, which have great international influence, have listed differential equations as their main research directions. World class universities such as Cambridge University in the UK and MIT in the United States have high-quality differential equation teaching teams and advanced teaching ideas, and have trained a large number of excellent talents with strong practical ability who can combine theory with practical application.

In order to explore new ideas for the teaching reform of the course, explore a new teaching mode for cultivating new military talents with equal emphasis on mathematical quality and innovation ability, and cultivate excellent talents with strong practical ability. We explore the ideas of teaching reform of this course, and put forward some feasible reform measures combined with teaching practice.

2.   Main contents

Innovation is reflected in the introduction of physical objects into new fields, the realization of re combination, bringing new benefits, which is conducive to cultivating learners' ability of independent discovery and independent exploration. Whether for teaching content, teaching mode or teaching means, "research" or "guided inquiry" is an innovative mode often used in the teaching process. The modernization of teaching content is an important way to introduce teaching content into new fields and an important link to realize teaching innovation. It is mainly reflected in two aspects: one is how to deal with traditional teaching content

with modern or prior mathematical viewpoints and methods, and the other is how to select practical examples suitable for the level of modern science and technology or this background, let students feel the authenticity of knowledge. Because by solving these practical problems, we can cultivate students' ability to integrate with practice and explain phenomena, that is, describe the practical problems as clear mathematical problems in mathematical language, and then translate the conclusions or mathematical results of the solved mathematical problems into the explanation of some phenomena in nature or life. There is no doubt that this process is very important and indispensable for cultivating students' innovative spirit and practical ability.

In terms of the innovation of teaching content, teachers in many colleges and universities carefully choose the teaching content according to the fact that some engineering majors need more and more in-depth knowledge of differential equations in the study of professional courses (such as machinery and automation, system engineering and other majors), combined with years of teaching practice and through careful demonstration. For example, in describing the basic theory of first-order differential equations, the solution of linear differential equations, qualitative theory and stability theory, meeting the professional requirements of automatic control, machinery and automation, system engineering, etc., the basic theory and solution method of first-order difference equations, the solution of second-order difference equations and the preliminary theory of stability are added, Finally, closely combined with professional characteristics, an application case with professional characteristics and simulation background is given for students' learning and reference. For the selection and processing of teaching content, on the one hand, let the students understand the overview of the basic theory of differential equations and difference equations, and consider the knowledge background of engineering students. Abandon the strict theoretical proof of many theorems and only give their intuitive description and explanation, and focus on the application of theorems through specific examples, which greatly reduces the learning difficulty of engineering students.

In the innovation of teaching mode, relying on the development of computer technology, especially the emergence of powerful mathematical software, we can use computers to carry out geometric representation and numerical calculation of the solutions of differential and difference equations. Therefore, we can integrate the means and methods of mathematical experiments in the teaching process and pay attention to the auxiliary role of mathematical software, Highlight the organic combination of mathematical theory and graphics to make the teaching content more vivid.

In addition to the improvements in teaching content and teaching mode described above, we have also done the following work according to the different engineering majors in the teaching process.   (1) According to the courses offered by famous universities at home and abroad to science and engineering students, they pay more attention to the courses of partial differential equations (Mathematical and physical equations) and special functions. This is because partial differential equations have a wide range of applications, such as mechanics, especially fluid mechanics, aerospace, atmospheric water flow and other fields are inseparable from the theory of partial differential equations. It is suggested that while strengthening the mathematical foundation of undergraduates, the school should pay attention to the teaching of mathematical physics equations and special functions, and strengthen the teaching of Laplace transform and Fourier transform according to the professional basic requirements of relevant engineering majors, so as to consolidate their mathematical foundation. For example, the textbook of ordinary differential equations offered by MIT for science and engineering students is "elementary differential equations with boundary value problems" (5thed. Upper saddle River, NJ: Prentice Hall, 2003) written by Edwards, C. and D. Penney 1. According to the curriculum standard, teachers need to teach Fourier series for 3 hours and Laplace transform for 7 hours, so as to strengthen the ability of engineering students to use mathematical knowledge such as differential equations and special functions.

(2) According to the training objectives of various majors, it is suggested to set up "Introduction to partial differential equations" in the second classroom, so that some students with solid mathematical foundation can understand and master the basic theories and methods of second-order linear partial differential equations, teach students in accordance with their aptitude to a certain extent, and improve their ability to apply mathematics. At this time, we use the English textbook "fundamental theories of ordinary differential equations" compiled by Hsieh, P. F. and Sibuya, Y. 3 as the textbook of ordinary differential equations for applied mathematics .

(3) For some applied mathematics majors, the requirements of mathematical experiment are added. Students' fresh ideas can be realized quickly with the help of mathematical software, so that they can get true knowledge in failure and success. This way changes passive indoctrination into active participation, which is conducive to cultivating students' independent working ability and innovative spirit. It is suggested to grasp several important knowledge modules of ordinary differential equation course, compare the advantages of various teaching materials, grasp the key teaching contents and carry out mathematical experiments to ensure the quality of teaching. The determination of teaching contents should follow the following points:

① contents conducive to stimulating students' interest in learning or research and cultivating innovative thinking;

②The teaching content plays a prominent role in the curriculum system;

③The teaching content is widely used in engineering problems;

④   Students have the practical conditions of teaching content.

(4) Establish three-dimensional teaching resources of differential equation course, build some mathematical experiments of differential equation, build typical examples of differential equation modeling, build a differential equation course website, enrich the teaching content of Engineering differential equation, timely reform the course assessment methods, and improve students' mathematical modeling ability and innovation ability. We rely on convenient and fast high-speed campus network and campus network to expand the scope of interactive teaching. The goal of interactive teaching is communication and development. Therefore, it should face an open teaching space, including equal learning, communication, discussion and teaching activities between teachers and students in addition to classroom teaching, and in the virtual interactive environment created by real life and modern information technology.

3.   Conclusions

According to the teaching process and teaching design of differential equation course for science and engineering students, combined with the author's working experience, we put forward some suggestions in this paper, hoping to be further divergent and perfect in the future teaching practice. Relying on modern educational technology, we should build a modern teaching content system and three-dimensional teaching materials. We integrate visual mathematical experiments, rich digital resources and various forms of teacher-student interaction into the teaching process, which makes the differential equation teaching for engineering full of vitality.

Acknowledgments

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