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Analysis and Solutions to the Dilemmas of Advanced Mathematics Teaching

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Abstract. Advanced Mathematics is an important basic course in engineering colleges, and the present situation of its teaching status has been confronted with crisis. This paper analyzes the dilemmas and the underlying reasons in the teaching of Advanced Mathematics. Three solutions were given in this article.

The Importance and the Dilemmas of Teaching Advanced Mathematics

There are three distinct characteristics about mathematics which distinguish it from other disciplines: its abstractness, its accuracy, and its extensive application. It is these three characteristics that give mathematics an especially practical function and potential of cultural and social value. When asked by the media what qualities are needed to be a scientist, Roentgen, Nobel Prize winner in physics, said "The first one is mathematics, the second one is mathematics, and the third one is still mathematics." This shows the importance of mathematics. Advanced Mathematics is a compulsory basic course for students majoring in engineering. It not only lays the necessary mathematical foundation for further study in subsequent courses, but also has a positive effect on improving students' ability in identifying, analyzing and solving problems, abstract thinking and logical reasoning. In this new era, with rapid development of high technology and the increasing wide and extensive application of mathematics, mathematical quality requirements for college students are getting higher and more comprehensive if they are to be talents of science and technology. Advanced Mathematics is the base point of future new mathematical knowledge. Only by mastering Advanced Mathematics can students maintain a long-term motivation to study mathematics in their future work, and continue to learn and use mathematics by various means and methods, so that they can better solve the problems related to their specialized areas and promote their career development.

However, at present most of the engineering colleges are facing a dilemma in teaching Advanced Mathematics: teachers are devoting more and more attention to teaching while students' learning enthusiasm is getting less and less; the degree of difficulty of test papers is gradually lessening while failure rate is increasing each year; teachers are complaining of students, while students are complaining that they are biting off more than they can chew and as a result they fear and hate to study Advanced Mathematics. Therefore, it is particularly important as to how to change these difficult situations to take the teaching of Advanced Mathematics out of this dilemma, and how to effectively raise the quality of Advanced Mathematics education.

The Causes of Advanced Mathematics Teaching Dilemmas

As is known to all, China's higher education has entered the stage of mass education and the higher education gross enrollment rate has been increasing year by year, which will inevitably lead to the decline of the overall quality of the students and the big difference in individual level of students and so on.

In addition, due to months of relaxation after the National Entrance Examination, it is not uncommon for freshmen to form some misconceptions about college study. For example, many think it is quite acceptable to just pass a subject, or they don't have to study hard anymore. Consequently, many students are weak in self-control and lack the motivation to study. These seem to have caused the current difficulties in the teaching of Advanced Mathematics[1]. But there are other deeper reasons.

Lack of Application in Teaching Leads to the Myth of "Learning Math Is Useless" and Students' Indifference to Math Study

"What is the use of mathematics in the end?" This is a frequently asked question by many students. The same question did not use to affect students' enthusiasm to study mathematics during the middle school stage, because the proportion of mathematics scores was larger in the college entrance examination, and problem solving training also brought students joy and satisfaction after the difficult problems were solved. However, once after entering colleges and universities, these students usually begin to doubt about the meaning of studying mathematics. So this question must be reiterated seriously and urgently, otherwise it will weaken students' enthusiasm in learning Advanced Mathematics.

Knowledge Chain Breaks down Because of the Great Discrepancy between Contents of Secondary and Post Secondary Level Mathematics

With the promulgation and implementation of *The New Curriculum Standards for High School Mathematics*, the teaching content of high school mathematics has changed greatly, while the teaching content of Advanced Mathematics has not been adjusted accordingly. Thus arose the problem of disconnection between contents of secondary and post secondary level mathematics[2]. For example, polar coordinates, which used to be very important before the curriculum reform in the middle school textbook, has been set as expanding series after the curriculum reform. As a result, this part of knowledge was no longer being taught in middle schools, making it more difficult for college students to learn integral calculus because polar coordinates is a very important tool for integral operation in Advanced Mathematics. Another example, most of the trigonometric & inverse trigonometric functions, as part of the basic elementary functions, which used to be required learning content of elementary mathematics, are eliminated from the new curriculum criteria except sin, cos and tan, and as to the learning of product & difference formula and differential product formula, students only have to be able to apply them in calculation. All these have become obstacles to the study of Advanced Mathematics. What's more, there are obstacles almost everywhere in teaching and learning about the trigonometric function transform and inverse trigonometric function properties.

Huge Differences in the Way of Thinking and Learning between Middle School Mathematics and Advanced Mathematics Result in Students' Difficulty in Learning

Middle school mathematics knowledge is relatively simple; the association of theory and application is not strong; the research object is constant, and students take a more static point of view in solving problems. On the contrary, the content of Advanced Mathematics is more abstract; the association between logic and theory is stronger; expression of mathematical problems is more formal; research object is variable. Therefore, college students must use dynamic and dialectical thinking to solve mathematical problems. High school mathematics teaching was still examination-oriented, over-emphasizing skills training and knowledge transfer, ignoring the cultivation of mathematical thinking and mathematical ability. Consequently, students are not open-minded, lack initiative and are poor in autonomic learning, and their ways of thinking are usually stiff and simple. Advanced Mathematics teaching is far more than teaching mathematical conclusions and computing skills. It is also about teaching mathematics thought, method and mathematics spirit. It emphasizes the ability to solve practical problems by applying mathematical ideas based on mastering basic knowledge. The Advanced Mathematics study belongs to the learning of deeper level. The great differences in the way

of thinking make college students find it so difficult to meet the needs of learning that they lose interest and confidence in learning.

Advanced Mathematics Teaching Effect Is Greatly Affected by Out-of-Date Course Content, Single Teaching Model, and Short Teaching Hours

Compared with the high school curriculum reform and social progress requirements, the reform and development of Advanced Mathematics education is lagging behind. Teaching content remained unchanged for decades. It not only caused disjointing of teaching contents, which has already been mentioned in the previous sections, but also reduced the effect of Advanced Mathematics teaching. Moreover, text-books are boring and lack absorbing materials, and many modern mathematics ideas have not been reflected in these books. In addition, the concept of mathematics is relatively rigid, not reflecting the development of mathematics itself nor reflecting the wide application of Advanced Mathematics in the modern society. These have weakened the students' enthusiasm for learning.

At present, the teaching model of Advanced Mathematics is relatively simple and still uses the "injection" teaching method, which is lecture-based and lack of information feedback and interactions between teachers and students. Too much mathematics knowledge is taught but too little source of the knowledge is given, and the practical application of knowledge is even less. Only knowing about this knowledge but not knowing the underlying reasons have caused some students' emotional weariness in learning.

Meanwhile, the teaching hours of basic courses of Advanced Mathematics have been reduced because of the on-going improvement and adjusting of teaching plans and curriculum systems, but the teaching content has not been reduced at all. Teachers, in order to come up with the teaching plan, have to teach very little or less or even skip some content. What is taught in class is either too difficult or too easy, no matter how well students can accept. Consequently what a scattering knowledge students learned in class was forgot after class because of their low interest in learning. Thus the teaching effect is very poor.

The Solutions to the Dilemmas of Advanced Mathematics Teaching

How to solve the difficulties in Advanced Mathematics teaching to improve the teaching quality and facilitate teaching development is an important issue to which higher educators are paying close attention [3,4]. According to many years of teaching practice, the author believes that the problem should be solved in the following ways.

Informing the Students of the Usefulness of Mathematics, Clarifying Learning Objectives, and Stimulating Students' Learning Interests

Teachers can introduce the latest application of mathematics in the subject in connection with different majors, so that students can learn the importance of mathematics in the fields of scientific research and are inspired by mathematics and application. By putting theory into practice, their view of "mathematics is useless" will be completely changed and they can be greatly interested in mathematics learning. For example, the application of differential equations can be explained in connection with population growth model, infectious disease model and so on when teaching other majors. In teaching computer science, the link between Boolean algebra and computer technology can be emphasized. In teaching telecommunication, students can be informed that the reduction of waiting time is directly related to the application of the queuing theory. As for chemical engineering majors, they would learn the fact that, it is the group theory of mathematics that R. Hoffmann and Kenichi Fukui, 1981 Nobel Prize winners in chemistry, had applied to create and develop the famous "orbital symmetry conservation principle" .

In addition to the obvious examples in practical application, the students should also be informed that the training and the mathematical thinking they obtained in Advanced Mathematics learning would always play a positive role in professional research and become the most important factor in

research success. Once they witness the great power of mathematics, students will naturally have a strong interest in it and initiatively put the existing knowledge into practical issues.

There are so many methods of stimulating the students' learning interest in mathematics, which the author has covered in article [5,6] and need not be repeated here.

Preparing Lessons Diligently, Designing Teaching Activities Carefully, Using Various Means Flexibly, and Holding the Main Position of Advanced Mathematics Teaching Stably

The teacher should clarify what and why the main content of the lesson is selected and in what order it is exposed at the beginning of teaching, so as to prepare the students. Later, in the course of explanation, teachers should always review the contents of each section finished and guide the students to guess the subsequent teaching contents. It is essential that teachers diligently prepare lessons so as to fully understand the teaching content. Hence, they can use clear and natural language to summarize the contents and convey them to the students. On the other hand, students should have a clear learning objective and keep sharp. They should listen to the teachers attentively so as to follow the teacher's train of thought.

When preparing lessons, teachers should stand in the shoes of the students until every detail is clarified. And the difficulties and confusions students might encounter in learning are predictable and these parts can be emphasized during teaching. Hence objectives are clarified and every corner is covered. By taking appropriate measures to eliminate difficulties and confusions, teachers can encourage the students' to think independently and freely and students' learning interest and confidence will be greatly enhanced.

During teaching, teachers should make flexible use of various teaching methods to explain profound theories in simple words and take serious matters easily. For example, the contrastive method can be used to link middle school mathematics to Advanced Mathematics. Skillfully designed questions can be asked to guide the students to think actively and promote classroom interaction. Students' ability of autonomous learning can be improved through group discussion, debate and so on. The advantages of multimedia can be made full use of to make teaching more intuitive[7]. The mathematics culture can be integrated to make classroom instructions more interesting and to foster the students' mathematics thinking and confidence. The relevant content of the mathematics experiment can be introduced to emphasize application, and improve the students' ability of mathematics application in analyzing and solving problems, and so on.

As the saying goes "There are variety of ways in teaching, but what matters most is to apply them effectively", teachers should make flexible use of various teaching methods, giving full play to their own strong points to make their teaching interesting, informative and easy to understand.

Training Students' Self-Learning Abilities by Strengthening Preview and Review Links and Paying Attention to Homework Feedbacks

Preview is an important part of learning Advanced Mathematics, but is not often taken seriously by students. The amount of information of each advanced mathematics lesson is large, and the contents are profound and abstract with a compact structure. So it is difficult to follow the teacher's thoughts without preview. In order to promote the students to preview, teachers can put forward the preview plan about the next lesson at the end of each class. The plan should be designed reasonably and the leading problems can be posed at a great percentage. Then, in the next lesson, teachers can check the preview tasks of students and solve the leading problems. These measures ensure that the students, with the preview problems and a keen interest in new knowledge, can focus on the teaching contents, listening to the ways to problem solutions, conclusions, applications, and the causes and effects.

The majority of students didn't have the habit of reviewing after classes when they were in the middle high schools. So they often feel it's hard to fully digest and completely grasp the large amount of knowledge in the advanced mathematics' classes, and thereafter lose confidence in learning. So review is more important than preview for advanced mathematics study. Teachers should guide students to make a timely review after each class, a stage review after each unit and an overall review

at the end of each semester. Teachers can check the review tasks at the beginning of each lesson by assigning exercises, raising questions or in other ways, and should make full use of exercise classes to test students' review tempos. By doing so, students can strengthen their understanding and mastery of what they have learned, form a systematically complete knowledge structure, apply the knowledge and thinking mode to the sequent courses and practical issues in future as well as improve their autonomous learning abilities.

While strengthening preview and review, teachers should also pay special attention to the arrangement and correction of homework, and take advantage of the feedback information of homework to timely correct the students' thinking errors. The assignment of homework can play a positive role only when it is scientific and reasonable, covering the important knowledge points and taking into account the students' abilities. Hierarchical arrangement of homework is a good practice, because it not only takes into consideration good students but also can protect the learning enthusiasm of poor students and enhance their confidence. In addition, teachers can engage students in checking homework, summarizing and presenting the problems. Then teachers check again, test the students' summary, and then make all corrections. This can promote students' self-learning abilities by discovering and correcting the errors in their own homework and others' homework.

The teaching practices of some classes have proved that the implementation of the above measures can help in training students to learn independently, autonomously, willingly and diligently so as to effectively get out of the teaching dilemmas of advanced mathematics as time passes.

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