The Application of Hierarchical Teaching in Advanced Mathematics Teaching in Colleges and Universities

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Abstract: In recent years, China strongly popularizes and promotes the higher education, and the era of mass higher education has come. The enrollment scale of higher institutes is continuously expanding, which also directly results in the decline of college students' comprehensive quality and obvious difference in basic quality between individuals. With insufficient teaching staff and increasing teaching difficulty, the teaching quality cannot satisfy students' basic learning demand currently, and there are serious problems in teaching management and students' management. Therefore, in order to ensure the teaching quality of colleges and universities, teachers are required to actively make innovations on teaching mode, satisfy the learning demand of different students, realize the diversification of teaching mode and ensure the teaching quality.

Advanced mathematics is the public basic course in colleges and universities, and students of most majors need to learn it. It is the basis for students to learn other professional courses and plays an important role in improving students' comprehensive ability. College students come from different regions, and there is obvious difference between individuals. If teachers adopt unified teaching method, the effectiveness of classroom teaching will be impacted, which is not conductive to the joint improvement of all students. The application of hierarchical teaching in advanced mathematics can meet the learning demands of different students, realize the joint improvement of all students, and play an important role in students' growth and development, which deserves teachers' in-depth research and application.

1. The Necessity and Significance of Applying Hierarchical Teaching in Advanced Mathematics

1.1 The Necessity of Applying Hierarchical Teaching in Advanced Mathematics

Advanced mathematics, an important pubic basic course, belongs to compulsory course for most majors. It can comprehensively improve students' overall competence and basic capacity so that they can grasp thinking mode of mathematics, improve scientific competence, and further promote the learning of professional courses to lay a good foundation for the growth and development. Because college students come from different provinces and regions, there is large difference in learning basis. In the teaching of advanced mathematics, teachers are required to perform individualized teaching, give full play to students' specialties, and realize the improvement of all students. In traditional teaching mode, teachers adopted unified teaching content, teaching programme and teaching plan, and students' growth is constrained. The learning burden of many students with lower requirement of mathematics is increased, and learning enthusiasm is declined. Whereas, the learning of some students with higher demand for mathematics cannot be fully satisfied, which influences the overall improvement of teaching quality. The adoption of hierarchical teaching can meet the learning demands of different students, suitable for basic educational concept of individualized teaching [1].

The knowledge of advanced mathematics is relatively abstract and the logic is strong, so some students will encounter many problems in learning advanced mathematics. In the advanced mathematics classroom, students need to accept the knowledge which is more difficult in depth and width than middle school mathematics in a short period, so many students cannot adapt to it. What's

worse, there is obvious difference in learning basis and learning ability, so there are different learning levels. Thus, based on teaching content and students' basic characteristics, teachers need to actively adopt hierarchical teaching to improve teaching quality. At present, social requirements for talents is diversified, so students are required to be equipped with strong ability of accepting new technology and new knowledge, and solid professional basis. Besides, there is large difference in learning advanced mathematics between students of different majors, with different learning motivation, so it is necessary to conduct comprehensive hierarchical teaching.

1.2 The Significance of Applying Hierarchical Teaching in Advanced Mathematics

In traditional teaching mode, students with poor basis cannot keep pace with teaching progress, and will gradually lose enthusiasm for learning. However, students with stronger ability will lose the initiative for learning due to simple teaching content. The adoption of hierarchical teaching can effectively solve these problems, to overall improve the learning at different levels, inspire learning enthusiasm and ensure the teaching quality. In applying hierarchical teaching, teachers shall deeply understand students' basic characteristics, design different teaching objectives and teaching links, strengthen the communication between teachers and students, according to problems existing in students at each level, actively find out solutions and ensure the clear and targeted teaching objectives [2]. Hierarchical teaching mode puts forward higher requirements for teachers, to continuously study new knowledge, break through the boundaries of disciplines, and realize the comprehensive improvement of their own abilities.

2. The Basic Principles of Hierarchical Teaching in Advanced Mathematics

The hierarchical teaching requires teachers to fully consider students' mathematics basis and perform effective hierarchical teaching according to their basis. Teachers, in essence, are required to fully consider students' different learning abilities, implement specific teaching according to the basic principle of ability, realize the accurate analysis of students, and correct them timely when there is mistakes in analyzing students' basic characteristics. At the same time, the hierarchical teaching needs to fully meet students' individualized learning demands, set different teaching contents according to different majors and realize the common improvement of all students [3].

3. Problems in Hierarchical Teaching in Advanced Mathematics

3.1 Problems in the organization of teaching process

With the increasing enrollment of colleges and universities, teaching resources in colleges and universities have been widely applied. Constrained by resources, there are problems in course arrangement for students. In hierarchical teaching, students will be distributed into different classes with different class time, and evaluation and attendance need to be re-processed, which is not conductive to the implementation of teaching and adds difficulty in managing students. In evaluation, teachers cannot use the same test paper, need to set different paper contents. In this way, the learning score of students in lower-level class will be higher than those in high-level class, which cannot ensure the fairness in scholarship assessment.

3.2 Problems in teaching objectives

At present, there are great controversies in the setting of hierarchical teaching objectives in advanced mathematics. Many students think that the same teaching objectives shall be set in the situation of same major and tuition fee. There is the problem of fairness in hierarchical teaching, so there are problems in the setting of teaching objectives [4].

4. The Practice of Hierarchical Teaching

Taking the course of single variable integral calculus as an example, according to teaching contents, teachers divide students into three levels, and complete classroom teaching by reasonably

arranging classroom teaching time.

4.1 Basic methods of dividing levels

The basic requirements of the first level are the properties of infinitives, integral formulas, basic concepts, general methods of distribution integrals, and two methods of changing variables, the basic concept of definite integrals, Newton Leibniz formula-basic formulas of calculus, and basic calculation of indefinite integral and definite integral.

The basic requirements of the second level are the basic proof of inferences, theorems and reference examples, the definite integral upper limit function-the basic formula of calculus, and the basic processing method of the upper and lower limits of definite integral in the second method of changing variables, the classic case of application of definite integral in physics and geometry, the judgment and the basic concept of the convergence of the concept of improper integral, and the calculation of the integral calculation problem with certain difficulty.

The basic requirements of the third level are the basic proof of general properties such as theorems, inferences, and reference examples, simple cases of definite integral in physics and geometry, and expression processes of improper integrals, more complicated integral calculations with higher difficulty and approximate calculation. The focus of the teaching process is the calculation of integral and related concepts, to proficiently grasp the table of integrals, and realize the improvement of comprehensive ability.

4.2 The arrangement of teaching time

According to the pre-established teaching plan, there are a total of ten lessons of single variable integral calculus, with 1200 minutes, divided into 24 class hours. In traditional teaching mode, teachers allocate the teaching time on average according to the content of the teaching materials, longer time for chapters with more contents. The chapter with most contents needs 150 minutes, and some chapters with less content need 100 minutes to complete the teaching. Students need to master all the classroom knowledge within a certain period set by teachers, which is more difficult for some students with poor basis of mathematics. With the hierarchical teaching, teachers allocate different time for different contents, and put forward different learning requirements for students, which significantly improves the quality of teaching. In the process of practical application, teachers will explain the first level of teaching content and basic calculations in detail. It takes a total of 600 minutes to strengthen the basic training for students. Students need to practice basic knowledge through long-term practice. The second level of content takes 400 minutes. This stage is suitable for middle-class students to learn. Some students with poor learning ability will have different levels of difficulty. The third level takes the least time, which is 200 minutes. This level is more difficult and suitable for some students with better mathematics for detailed understanding [5].

4.3 The process of classroom teaching

The most commonly used method in the calculation of integrals is the indefinite integral change of variable. The content involved in this part is more complicated. The first level involves the most content, which needs to be mastered by all students. In the teaching process, the first change of variable takes 130 minutes, and the second change of variable needs 70 minutes, which is instructed in two times. For the first time, teachers shall focus on the basic methods, theorems, classroom exercises and example demonstrations of the first change of variable. Students need to clarify the basic concept of the first change of variable, and understand the main basis through the differential of the composite function and basic formulas. Teachers need to explain relevant knowledge in detail and thoroughly, to ensure that all students can accurately understand, proficiently apply, and cooperate with exercises and demonstration of examples, so that students can grasp the key points of teaching content in detail.

The first level of content contains most of the simple and basic calculations, such as power function composite function integral and linear function composite function integral. More than two examples can be given for each type, explaining the methods and ideas of solving the problem in detail for students' proficient application. After the explanation of the examples, teachers can give

similar questions, train students' ability to solve problems, focus on the problems existing in students, and enable students to master the correct problem-solving methods. The second level of content includes simple trigonometric function integration by substitution and rational function integration by substitution. These two types can be explained without detailed steps, focusing on students' thinking, and teachers need to conclude students' learning. The third level of content includes trigonometric function integration by substitution and rational function integration by substitution with greater difficulty. Teachers can do not focus on this part, simply explain the examples, and do not need to conduct exercises in class and after-class. After completing these teaching steps, teachers can first explain the basic content of the homework for students, and distribute the homework to students in advance, explain the various problems in the homework in a comprehensive and detailed manner, encourage students to actively ask questions, and ask students to complete homework correction in listening.

5. Reflections on the Application of Hierarchical Teaching in Advanced Mathematics

Hierarchical teaching, as the best practice of individualized teaching, can enhance students' enthusiasm for learning, promote teachers' improvement of professional ability, improve the teaching quality and standardize teaching procedure, which deserves in-depth popularization.

5.1 The design of teaching objectives

The focus of hierarchical teaching is to help all students achieve improvement. Students who have strong mathematics learning ability should not be constrained by too many restrictions. The minimum requirements for students with poor learning basis should meet the basic learning requirements of non-mathematics major. This teaching mode can meet the learning needs of different majors and students with different basis, and achieve an overall improvement of learning ability of all students. Students can have a more comprehensive recognition and understanding of the value, basic methods and main ideas of mathematics, and many students with poor learning foundations can realize gradual improvement for higher level. In setting teaching objectives, it is required to comprehensively consider the basic principles and methods of mathematics, focus on training students' ability to solve problems, and strengthen scientific quality education. For low-level students, more encouragement is needed to improve their interest in learning and ability of independent learning, reduce skills, and enhance inspiration. For high-level students, it is necessary to focus on explaining deeply mathematical concepts and basic methods, so that they can clearly recognize the basic laws of mathematics.

5.2 The hierarchy of teaching process

Because different basis of students' learning, there is a big difference in the requirements of mathematics learning among different majors. Therefore, it is necessary to set a reasonable proportion, highlight key points, and control the overall scale in hierarchical teaching. Before the hierarchical classes, a combination of placement test and the entrance test score can be adopted. The hierarchies can be divided according to students' individual interests and majors, into fast and slow class, or fast, medium and slow class, and then sub-divided after a period of trial, according to the basic progressive principle, to guarantee the hierarchical effect. The textbooks also need to be layered to different hierarchies. Students from different majors use textbooks with different depths to appropriately increase or decrease the content of the textbooks. The basic requirements for learning are separately formulated for students at different levels, to enhance the operability of hierarchical teaching.

5.3 The hierarchy of lesson preparation and tutorship

Teachers are required to actively transform the teaching concept, reasonably set the curriculum content, change the guidance mode, improve students' ability of independent learning, actively use modern teaching methods such as multi-media, improve students' interest in learning, carefully arrange all aspects of teaching, and reduce the requirements of theoretical knowledge, and realize

the diversified teaching by preparing lessons for different levels. After completing the classroom teaching, teachers need to sum up the shortcomings of students in time, adopt the combination of collective and individual tutorship, combine pre-class and after-class tutoring, combine the special tutorship with general counseling, and combine in-class and after-class counseling, to realize the improvement of all students. In arranging the homework, it is necessary to carry out the necessary hierarchical method. They can increase the content for students with better foundations and arrange the questions with certain difficulty, should adopt a gradual and progressive mode for middle-level students to improve mathematical ability in ensuring the mastery of basic knowledge, should strengthen psychological counseling, enhance confidence, reduce the difficulty of homework, and strengthen repeated practice for students with poorer basis.

5.4 The hierarchical evaluation

To adopt hierarchical teaching, it is necessary to adjust the examinations. The examinations are divided into open-book exam and closed-book exam, to increase open-ended questions, strengthen the relationship between teaching content and real life, add basic questions to the content of closed-book exam, and appropriately design questions with greater difficulty, to achieve effective evaluation of students at different levels.

6. Conclusion

Traditional teaching mode cannot satisfy students' learning demands in the new era. Therefore, it is necessary to actively conduct the reform on advanced mathematics and adopt hierarchical teaching to realize the common improvement of students at different levels.

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