Course Construction and Practice of Computing Methods in Engineering Colleges

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Abstract. The course construction of Computing Methods meets the new curriculum requirements, implements the “problem-driven” teaching idea, and takes the teaching mode of “case teaching as the main line, experiment as guide and integration of knowledge teaching into ability development”. The course construction group put forward a new teaching concept of “modernized teaching ideas and concepts, scientific and diversified teaching methods”, conducted research and reform over the teaching system, contents, methods and measures and those of the experiment teaching, which is characterized by close association with reality and computer software, and achieved many breakthroughs in this field.

Introduction

The rapidly developing computer technologies have made the computer a powerful computing tool, which has become an indispensable part in conducting scientific research and engineering design with scientific computing. Numerical simulation has become a new method of scientific research following theoretical research and experimental research, and sometimes it may replace or even goes beyond the effects achieved in practical experiments. As a branch of mathematics, computing method focuses on the numerical method of solving mathematic problems with computers and the realization of the related theoirs and software development. Therefore, Computing Methods is a selective course for cadets of all majors in our academy. Besides, Numerical Analysis has been opened to the undergraduates in the Academy and its task group members have conducted researches and reform on the teaching system and experiment teaching system together with their contents, teaching methods and measures, which has has been characterized by close relation with reality and computer software.

Construction Ideas

After implementing the “problem-driven” teaching idea and taking the teaching mode of “case teaching as the main line, experiment as guide and integration of knowledge teaching into ability development”, the task group put forward a new teaching concept of “modernized teaching ideas and concepts, scientific and diversified teaching methods”, which conforms to the new teaching standards and requirements.

Integrating knowledge teaching into ability development. In teaching knowledge, teachers are required to integrate theory into practice, expound theories, induce interests, ignite motives, strengthen the practical teaching and enhance the cadets’ ability to utilize knowledge and innovative abilities. In teaching practice, mathematics software is properly introduced to strengthen the practical teaching of computing methods by using mathematics models and software. Course study pays equal attention to knowledge teaching and ability development, which are made to promote each other and develop coordinately.
Combining the teachers’ leading character with the cadet’s subjectivity. In teaching practice, the leading character of teachers shall be fully played to ensure the efficient operation and cadets’ initiatives shall be encouraged to enhance their study abilities.

Putting teaching into full play. Based on the teaching laws of computing methods and the new talents training plan, teachers shall select the teaching contents properly, improve their teaching methods, teaching the students according to their actual abilities and put computing method in full play to develop the cadets’ qualities, focusing on inciting their study interests and optimize the teaching information.

Achievements

During this course construction, faced with new talents training plan and total teaching hours and based on the curricular construction plan, we have obtained achievements in terms of teaching contents, teaching modes and teaching team building, which are demonstrated as follows:

In terms of teaching content. By teaching requirements, computing with mathematics software is added, examination requirements are revised, and the course assessment takes the integrated one of process assessment and term examination, the former of which consists of class performance and homework while the term examination takes the form of open-book written examination. As of the percentage of both process examination and term one, the former accounts for 30% of the final score, including class performance of 20% and homework of 10%, while the latter is 70%. The examination has expanded from a single form of written exam to a combination of homework, experiments and written examinations. As for homework, cadets can freely form their own study groups based on the instructive questions assigned by the teachers, each group choosing a question to build a mathematics model, designing computing methods, providing their solutions and finally submitting their report. As for the term examination, the teachers take the form of open-book written examination, that is, during examination, cadets are allowed to refer to examination materials. The final term examination includes various types of test items, having wide coverage of examination materials with the aim to test the cadets’ ability to solve problems independently with their own ways and methods, which helps to train the cadets to be fully developed. As for teaching contents, practical methods of scientific computing are highlighted, fundamental principles of computing methods and basic concepts of various methods as specially noted. The integrated teaching takes “numerical approximation” as its principal part and the content of “numerical solution” as auxiliary teaching material, thus forming a condensed and continuous theoretical teaching practice. It introduces more background information and classic theories of computing methods with the aim of being “concise” and “deep”, thus developing the cadets’ logic thinking and application abilities. Teaching reference books are compiled and teaching of numerical computing abilities has been developed. In the books numerical experimental questions are properly provided with certain width and depth. In addition, scientific computing abilities with mathematical application software are reinforced. Based on the concrete items in each chapter, the corresponding Matlab function documents for various algorithms are provided to complement the algorithm description and its application.

In terms of teaching modes. Based on the researches conducted in colleges and universities and military institutes and through collective course preparation and teaching discussions, the teaching method of “four steps” is developed as follows: practical problems → mathematical models → computing methods → program design and calculation with computers, which integrates the mathematical modelling into course teaching to lay solid foundation for the cadets to attend the army-level, national and international mathematical modelling competition. Meanwhile, in class teaching, various effective teaching methods, such as teaching less and practicing more, case study, heuristic method, participation in study activities and infiltration mode, are adopted to stimulate the cadets’ study interests and creativity and develop their thinking and learning abilities. Besides, mathematics software is introduced into class teaching to demonstrate analytical solution and numerical solution, thus helping to analyze and handle the practical problems they might encounter.
In terms of teaching task teams. After this round of course construction, Computing Methods has helped to train a teaching team with striking features. By careful analysis of each teacher in this team, their strong points and weak ones will be weighed to find out the proper teaching style he will take. After a series of abilities promoting activities, all members shall have their teaching abilities promoted. Through trial teaching at the beginning of each term, younger teachers with less teaching experiences have made great process in their teaching abilities. Regular collective teaching activities help to enhance the teachers knowledge and teaching skills and these questions collectively discussed are often well solved and become root materials for teaching papers. By going to the institutes, colleges and universities, both military and civilian, the member teachers have learned advanced application background of teaching experiences and computing methods, and both their civilized knowledge and military qualities are largely improved.

Construction Experiences

Construction of teaching contents. According the new talent training plan, teaching hours are reduced and levels of cadets vary. However, as a selective course, Computing Method is characterized by large amounts of contents and complex computing methods. It not only involves rigorous theory and logic but wide experimental application, which requires more of the teachers in their teaching methods and measures. In order to adapt to new teaching trend, the task team revised the curriculum standard to meet the requirements of the new talent training plan, compiled the teacher’s reference books, such as Synchronized Reference Book for Computing Methods and Application Cases for Computing Methods, which put the teaching concepts and mathematical modelling ideas into practice, thus helping the teachers to improve their teaching methods and measures and inducing the cadets to understand that the computing science comes from and applies to practice and applies, which is the essence of mathematic logic and theories.

Reform of teaching modes. In terms of teaching measures, modern media technologies are fully adopted to integrate the multimedia teaching and traditional blackboard teaching. Multimedia are well adopted to explain background information, make algorithm description of numerical methods, demonstrate example computing, compare error effects and present application examples, which help the cadets to conduct sensitive cognition. On the other hand, the traditional blackboard teaching is taken to do algorithm derivation and theoretical analysis, which guides the cadets to experience the process of solving problems, to enjoy the strict mathematical logic and to appreciate the wisdom in the creative process, thus understanding deeply the knowledge points and developing logic and thinking abilities. In terms of teaching methods, introduction of background information is reinforced, and class teaching is integrated with class questions and discussions. The basic theories of Computing Methods come from the practical problems in scientific computing, and the method of “model teaching” is an effective way to put theory into practice. In teaching process, teachers select some simplified practical problems or some of mathematical modelling to reinforce the teaching effort, thus promoting the accepting level of the cadets and enhance their ability to solve practical problems, which finally brings better teaching effects. Besides, Q&A method in class teaching is also very effective by teaching a numerical method systematically, bringing questions for the cadets to ponder over, discussing these questions in class and asking them to draw conclusions based on their own analysis. The construction process of these concrete algorithms well represents the thinking process from the mathematical models based on the practical problems to their solutions through the methods and steps of abbreviation instead of complexity, straightforwardness other than curvedness, dispersion instead of continuity, progressive precision and infinite approximation. It is a perfect example of enlightening thinking and developing mathematical thoughts. Therefore, its basic concepts, methods and principles shall be taught in class.

Construction of teaching staff. In course construction, because of teaching reform research, deep investigation of teaching methods, exploration of practical teaching, screening of teaching contents and collecting teaching resources, course quality has been greatly improved by studying and
exchanging teaching methods, teaching reflections and experiences. The overall teaching level has been greatly promoted with the methods of collective class preparation, speaking lessons and trial teaching before the course begins, experiences summary after class and discussing the achievements they have in the class. Meanwhile, the team members are organized to attend investigations and exchanges outside the Academy to get advanced and better experiences from other institutes to widen their knowledge and horizon, laying foundation for further course construction.

Summary

Through the course construction, especially by making comparisons before and after construction and with other like institutes, the construction quality and teaching effects of this course construction are mainly presented as follows:

Based on reduced teaching hours, new curriculum standards are scientifically made out and suitable course books are selected. According to the new talents training plan, both curriculum standard and course books are largely adjusted to adapt to the new curriculum requirements for the new curricular system is more scientific, modern and feasible, it highlights basic concepts, basic computing and mathematic knowledge the cadets will use in their follow-up lessons and it optimizes the systematic structure and reduces those too complicated derivations.

The reform of teaching modes begins to come into effect. By establishing the teaching method of “four steps”: practical problems → mathematical models → computing methods → program design and calculation with computers, thoughts of mathematical modelling is integrated into class teaching to help the cadets to combine the numerical computing with computers, thus strengthening the relation between them and improving their comprehensive qualities and computer operation abilities, which has been well demonstrated in the previous mathematical modelling competitions at various levels. In class teaching, teachers encourage the cadets to attend these contests by providing and expounding the test materials and awarding papers to them, which not only deepens their understanding of the knowledge involved but also opens their horizon to promote their ability to solve practical problems.

Case teaching is successfully conducted. By compiling the application cases in computing methods, case teaching is carried out, which effectively ignites the study interests of cadets, enhances the study effect and takes the individual requirements of the specialties, thus removing the obstacles to study the follow up courses.

A teaching team with higher levels is established. The teachers who teach the course of Computing Methods are universally scored high in their class teaching, and most cadets attend these lectures think highly of their teachers, acknowledging these lectures are more instructive, put modern mathematical thoughts into teaching, and open a window to mathematic thoughts. They also praise that these lectures are thought-provoking and highlight developing their abilities to analyze and solve problems.

References