Exploration on the Construction Mode of Course Group in Medical and Engineering Integration

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Abstract: The education mode of multi-disciplinary integration has become one of the mainstream of the current education reform. The specialty of medical and engineering integration is currently set up in many domestic engineering and medical colleges. This paper focuses on the teaching reform for biomedical engineering major in local medical colleges. By comparing the advantages and disadvantages of medical colleges and engineering colleges, as well as the current employment situation and future development needs of medical and engineering integration major, this paper introduces the reform mode of course group construction with software application and design as the core. A two-year coherent practical reform method is introduced into students' teaching, scientific research application, graduation design and graduation practice. It has solved the confusion of medical and engineering integration students in medical colleges about their employment prospects, also improves students' practical ability, enhances students' comprehensive quality, and improves the overall employment rate. This reform method provides a new idea for medical and engineering integration in local medical colleges.

1. Introduction

The connotation of the integration of medical and engineering is to combine the principles and methods of engineering with those of life science.It is an interdisciplinary application of life science and engineering[1].Due to the characteristics of the interdisciplinary knowledge structure, large span, strong comprehensiveness, interdisciplinary integration of various high and new technologies, and fast development speed, the cultivation of application-oriented talents in the interdisciplinary subject not only needs to be completed through practical work after graduation, but also needs to be cultivated during the University[2].The integration of medical and engineering talents should be able to develop new concepts, establish new knowledge, create new technology, develop new materials and instruments, and serve the human health. This requires that the integration of medical and engineering students should have compound professional knowledge structure and higher comprehensive ability and quality[3].

As one of the representatives of the integration of medical and engineering, biomedical engineering first established its teaching programs in graduate school in the United States in the 1950s.These programs usually recruit students from engineering or biomedical fields[4]. Until the success of graduate education, biomedical engineering was implemented as an elective specialty in the undergraduate teaching plan in the traditional engineering department. Since then, biomedical courses have been included in the traditional undergraduate engineering courses.

The undergraduate education of medical and engineering specialty in China started in the late 1970s, which includes both engineering colleges and medical colleges[5]. Due to the differences in teaching conditions, teaching objectives, teaching resources and employment situation, there are great differences in training mode and training objectives for the same major of integration of medical and engineering. After more than 30 years of development, they have formed their own characteristics[6-7].

Compared with science and engineering colleges, medical colleges have their own advantages in

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the cultivation of medical and engineering students.First of all, medical courses are equipped with strong teachers, and students have a solid grasp of medical knowledge. Secondly, the affiliated hospitals of medical colleges are rich in resources. students' internship, graduation design and other teaching activities can be better combined with clinical practice. In spite of this, there are still many deficiencies in the training of medical and engineering students in medical colleges compared with those in science and engineering colleges,such as:

(1)The basic knowledge of engineering technology is relatively weak, the practical resources are lack, the development of the industry is backward, and the opportunities for students to practice in factories are less, which limits the students' practical ability to analyze and solve problems.

(2)Medical colleges pay more attention to the teaching of medical related knowledge and adopt the mode of medical student training, while engineering courses are often less or less refined, especially software courses.

The results of the questionnaire survey for the students majoring in the integration of medical and engineering show that as many as 84% of the students are confused about their employment and future development, and they are not clear about the practical significance and development prospects of the integration of medical and engineering.Therefore, the author and his team organized a reform of course group construction with software application and design as the core. This reform is carried out in an all-round way for biomedical engineering students who are the representative of the integration of medical and engineering.

2. Methodology

2.1 Reform Objects

In this paper, the reform method of course group construction selected class 1 of biomedical engineering specialty in a medical college in Heilongjiang Province as the object, a total of 26 students in this class, 13 of whom are randomly selected as the object of course reform. The other 13 students are trained as regular classes according to the established training program.

2.2 Reform Plan

2.2.1 Adjustment of Theoretical Teaching Content

The 13 students in the reform class accepted the two-year adjustment of the teaching content of theoretical courses, including 11 professional courses and basic courses. The students in the ordinary class learned the relevant courses according to the original training plan. The teaching contents of students' changes in reform classes are as follows:

(1)Study the necessary software courses for engineers (the first semester of sophomore year), including: MATLAB, AutoCAD, Mimics and finite element analysis software (3D reconstruction simulation), in which MATLAB and AutoCAD are compulsory courses, and the other two courses are optional courses for students.

(2)The teaching adjustment of basic courses (the second semester of sophomore year)include medical imaging physics, signal and system, and analog electronic technology.

(3)Teaching adjustment of professional courses(the first semester of junior year)include medical image processing, digital electronic technology, medical laboratory equipment.

(4)Teaching adjustment of professional courses(the second semester of junior year) include medical imaging equipment and medical clinical equipment and instruments.

2.2.2 Adjustment of Practice Teaching Content

In this reform, the practical teaching content of 6 courses has been adjusted accordingly, which not only improves the practical ability through software operation, but also exercises the students' design thinking. Compared with the original training scheme, the increased practical content is shown in Table 1.

Table 1 List of New Contents of Practice Course in Reform Class

Course	Content of practice teaching
Signal and system	(1)Using MATLAB to complete 12 kinds of waveform signal drawing (2)Using MATLAB Simulink to complete the signal generation and display simulation
Analog Electronic Technology	(1)Using MATLAB Simulink to simulate integrated operational amplifier (2)Using MATLAB Simulink to simulate rectifier and filter circuit
Medical imaging physics	(1)Using MATLAB to draw periodic Fourier transform image
Medical image processing	(1)Using MATLAB to complete image fusion processing (CT, MR image fusion) (2)Using Mimics and finite element analysis software to complete the image segmentation and 3D reconstruction
Digital electronic technology	(1)Using MATLAB Simulink to complete the adder (2)Using MATLAB Simulink to complete the design of combinational logic circuit
Medical sensors	(1)Drawing circuit diagram of AD590 sensor with AutoCAD (2)Use MATLAB Simulink to complete the simulation of photodiode and phototriode

2.2.3 Adjustment for Job Seeking

In order to adapt to the future employment and work of medical and engineering integration specialty, five employment oriented tasks are designed for the students in the reform class:

(1)Translation and explanation of English instructions for medical devices: in view of the fact that the main place of graduation internship and work is a medical device company, and a variety of large-scale medical devices are mainly produced abroad, each student is required to complete the translation and explanation of the main operating instructions for a large-scale medical device (CT/MRI, etc.) within one semester, and in the form of PowerPoint report to the students in the class.

(2)Software design and development: after studying four kinds of software in the first semester of sophomore year, students are required to complete a software development and design during the opening hours of the laboratory on weekends. Students in a group of 3-4 are required to experience the complete software development process:research → requirement analysis → outline design → detailed design → code writing → testing.

(3)Writing students' scientific research project application: in the second semester of sophomore year and the first semester of junior year, each student is required to write an application for university students' scientific research project, and explain the application project to the class students in the form of PowerPoint report, and try to apply for it.

(4)Writing Scientific research thesis: in the second semester of junior year, according to the above three contents, students completed the thesis writing work (medical device cognition, software development and application, scientific research project summary, etc.), and independently drafted the graduation thesis.

(5)Making a resume: for the students in reform class, the training of making resume production and interview skills are carried out, and the actual simulated interview are completed before the junior internship unit recruited interns.

3. Results and Discussion

The reform has gone through four complete semesters and achieved remarkable results. This paper makes a fair and accurate evaluation from the students' professional course scores, the number of innovation projects, foreign language scores, the opening of graduation thesis and the admission of graduation practice units. The reform results are displayed in detail.

3.1 Analysis of the Professional Courses Results

Due to the different teaching order (different semester of examination) between the reform class and the ordinary class, it is guaranteed that the teacher is the same and the difficulty of the examination is close. Now the average score and excellent rate of the main courses are compared, as shown in Figure 1.

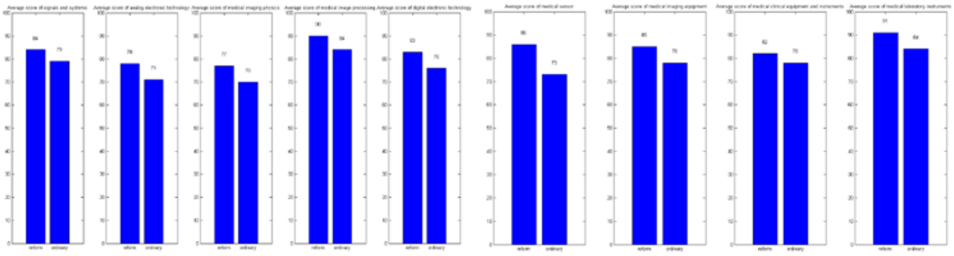

Fig.1 Comparison of Average Scores of Basic Courses and Professional Courses between Reform and Ordinary Class

3.2 Application for Scientific Research Projects

In April 2019 and April 2020, the university applied for two college students' scientific research projects respectively. In the two applications, 13 students in the reform class declared three projects as leader, and 10 students participated in the project. 13 students in the ordinary class declared one project as the leader, and three students participated the project.

3.3 Passing of Cet-4 and Cet-6

By June 2020, all 13 students in the reform class have passed CET-4, and 7 of them have passed CET-6. The passing rate of CET-4 is 30% higher than that of the ordinary class, and the passing rate of CET-6 is 39% higher.

3.4 Opening of Graduation Thesis

In May 2020, before the students enter the internship, the school has arranged the graduation project opening work. By the end of December 2020, 13 students in reform class have successfully completed the project opening work, and 9 of them are related to the software used in the course reform, accounting for nearly 70%.

3.5 Internship

At present, all 26 students of biomedical engineering major in 2017 have entered the internship stage. In the process of recruiting interns, 13 students of reform class are selected by different internship units in the first round of interview (a total of three rounds of internship interviews were conducted).

4. Conclusion

This course group construction reform with software application and design as the core aims at cultivating students' comprehensive ability, and takes students' internship and employment as the guidance. The main effects are as follows:

(1)In the future career of students majoring in the integration of medical and engineering, the application of software occupies a large proportion.This kind of teaching method can enhance students' practical ability and ensure their employment in the future.

(2)The course group with software application and design as the core can involve multiple disciplines. The reform method can be used in the main professional courses and basic courses of the integration of medical and engineering. The reform has a strong integrity, which not only facilitates teachers of different disciplines to master the learning status of students, but also reduces the workload of laboratory teachers to manage students.

(3)After the introduction of application and design methods in practice class and students' scientific research, the traditional hand-painted method has been used for graphic analysis, comparative analysis and error analysis of a large number of previous data, which has been qualitatively improved and optimized.This helps the students to complete the content of the practice course and enhance their interest in scientific research.

After the development of biomedical engineering, it is expected that other software will continue to be introduced to further reform content. At the same time, other medical and engineering integration majors will be further explored to lay the foundation for medical colleges to cultivate suitable students.

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