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Exploration and Practice for Applied Course Teaching of Biomedical Signal Processing Combined with Medical-engineering

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Abstract:

Biomedical signal processing is a core course of biomedical engineering. To make the teaching more practical, it optimizes the original curriculum system, improves the teaching content, adopts the PBL model for classroom learning, and utilizes the resources of schools, hospitals and enterprise-related to carry out the practical teaching mode of "Combination of Medical-engineering," strengthen the practice experiment teaching in the course.

Keywords:

Combination of Medical-engineering
Biomedical Signal Processing
Applied course
PBL teaching

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1. Introduction

Currently, to actively promote the transformation and development of the higher education system and build a talent pool that adapts to and meets the demands of today's economic and social development, undergraduate education in China has focused on the word "application." This requires universities to emphasize students' practical abilities in talent cultivation, stressing their hands-on and innovative skills, and cultivating undergraduate talents with strong technical application abilities [1].

The discipline of biomedical engineering is a highly interdisciplinary and comprehensive frontier subject, covering various fields such as biology, materials science, bioinformatics, and medicine. It researches and solves related problems encountered in biology and medicine. "Biomedical Signal Processing," as a core basic professional course in biomedical engineering, also has the characteristics of high interdisciplinarity and comprehensiveness. Based on the features of various collected biomedical signals, it performs analysis and processing, which can be applied to various scenarios such as physiological information collection, medical monitoring, clinical diagnosis, and biological information detection. It plays a huge role, especially in medical testing such as electrocardiograms, color Doppler ultrasound, and nuclear magnetic resonance. As a core basic course for biomedical engineering majors, "Biomedical Signal Processing" is particularly important

in students' practical engineering applications. Through systematic learning and training in this course, students should master the collection and extraction of biomedical signals, corresponding software programming, and data analysis and processing capabilities. They should be able to operate, maintain, test, repair, design, and research general medical equipment. The exploration and practice of applied course teaching for biomedical signal processing based on the integration of medicine and engineering aim to enable students to better apply their knowledge to practical engineering [2,3].

2. Optimizing the curriculum system and developing diverse online teaching

The teaching content of this course is divided into two aspects: theoretical knowledge teaching and practical experiment teaching. The theoretical knowledge teaching of "Biomedical Signal Processing" is not a simple course that starts from scratch. Advanced mathematics, digital signal processing, signals and systems, Matlab, and other prerequisite courses provide a certain theoretical knowledge foundation and software application abilities for learning this course. Therefore, given the comprehensiveness of the "Biomedical Signal Processing" course, it is scheduled for the second semester of the third year.

Students' mastery of the course depends on the teaching effectiveness, which in turn depends on the two main bodies: teachers and students. On the one hand, teachers should enrich and improve the teaching content of this course, strengthen course construction, clarify teaching objectives, and improve their teaching abilities. Teachers should also compile corresponding course materials and experimental guidance books, as well as develop corresponding online courses and course test banks. On the other hand, teachers should actively interact with students, guide them in practical activities related to this course, and provide support for student activities [4]. Optimize the original course teaching system and develop a theory and practice course construction The optimized course teaching system mainly focuses on optimizing teaching content and improving teaching methods that are "guided by teachers and student-centered" (**Figure 1**).

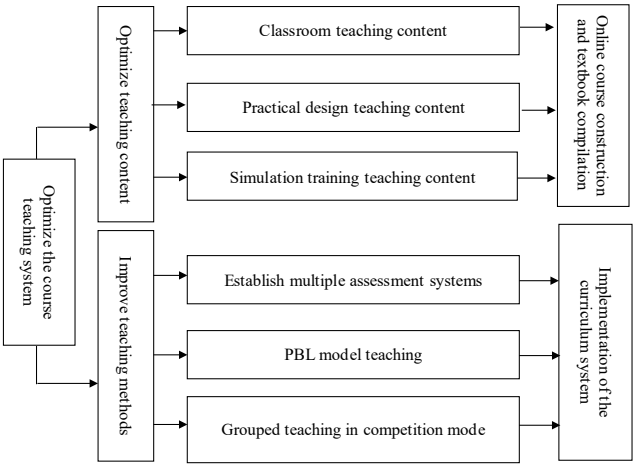

Figure 1. Optimize the curriculum system.

Classroom theoretical learning adopts the PBL teaching model, which guides students with problems and requires them to solve practical problems through theoretical learning. Students are required not only to master the subject knowledge but also to broaden their knowledge base by searching, learning, and practicing more. Practical experiments use a competition-style group teaching method to stimulate students' initiative and enthusiasm. In addition, this course includes a practical training component where students can freely choose a research direction that interests them or select a research topic provided by the teacher. During the training process, students are required to independently search for information, design the training framework, independently perform software programming, and summarize their findings at the end of the training period through a PPT presentation. Scores are determined based on competition standards, using competition to stimulate students' independence and innovativeness. To meet students' needs for experimental platforms, the professional laboratory is open to all students upon application, and course instructors can provide professional guidance during regular working hours [4,5].

In the current era of advanced networking, online teaching has become an indispensable part of the educational process. Therefore, this course also includes an online classroom featuring various components such as a virtual lecture hall, an online question bank, video tutorials, online assignments, and interactive platforms, enabling students to communicate and interact with teachers beyond the physical classroom. In addition,

the student evaluation system is not solely based on regular assignments and course assessments. Online exams, interactive participation, and practical experiment competitions are also integrated into the evaluation system to enhance students' learning enthusiasm.

3. Highlighting key points and implementing a "medical-engineering integration" teaching model to strengthen experimental and practical teaching

The multidisciplinary knowledge integrated into "Biomedical Signal Processing" is not just a simple addition or repetition of "1+1=2." Through theoretical learning and practical experiments in this course, students are able to fully grasp and apply multidisciplinary knowledge with ease. However, due to limited class time, teachers cannot cover all aspects of the course. Therefore, during course development, teachers emphasize key learning points while covering a broad range of topics. The theoretical and practical experiment class hour ratio in this course is close to 1:1 (36 hours of theoretical teaching, 12 hours of practical experiments, and 1 week of course training ≈ 1:1). This arrangement provides students with sufficient classroom time to integrate theory into practical experiments, strengthening experimental and practical teaching, and allowing students to engage in "real-world" scenarios to enhance their comprehensive qualities [6,7].

To facilitate better learning, the school not only keeps professional laboratories open 24/7 for students to prepare for experiments, practice, and competition preparation, but also collaborates with affiliated hospitals and relevant enterprises to implement a "medical-engineering integration" teaching model. Course instructors are trained in hospitals and enterprises, and experts from these institutions are invited to provide guidance to students, comprehensively enhancing the teaching capabilities of this course. In addition, during the course, students are taken to hospitals and enterprises for field visits to observe the collection and processing of biomedical signals, as well as the software operation procedures used by doctors and enterprise staff, deepening their understanding of the course and clarifying its practical engineering applications [8,9].

4. Focusing on regular learning and cultivating students' practical innovation abilities

Knowledge accumulation is a crucial aspect of learning, which is often a challenging and long-term process. Therefore, course instructors regularly monitor students' learning progress and have established a related assessment system for regular learning, gradually shifting from teacher-guided learning to independent learning. Furthermore, instructors provide research topics ranging from basic to advanced levels, gradually cultivating students' logical thinking and programming abilities. The online question bank also offers practical engineering projects in biomedical signal processing for students to choose and solve independently.

Simultaneously, instructors actively guide students to develop practical innovation abilities during regular learning, providing a professional practice platform through the school's laboratories. Comprehensive guidance, training, and continuous support are provided during the innovation process, enabling students to improve their integrated knowledge application, exploration, logical thinking, and other skills. Additionally, students' innovative ideas and outstanding works can be utilized in scientific research activities and competitions, stimulating their innovative consciousness [8–10].

5. Student-led, teacher-assisted, and active "second classroom"

To enhance students' comprehensive qualities, teachers actively advocate and the college provides support to create a favorable environment and conditions for actively developing the "second classroom" of this course. Following the principle of "student-led, teacher-assisted," various activities such as student-hosted biomedical signal processing knowledge quizzes, lectures, and programming design competitions have received enthusiastic responses and participation from students [11,12].

6. Conclusion

Exploring and practicing the application-oriented teaching of biomedical signal processing based on medical-engineering integration is part of the school's biomedical engineering program development. Apart from optimizing the curriculum system, improving teaching content, strengthening experimental and practical teaching, utilizing the school's advantageous resources, and collaborating with hospitals and relevant enterprises to implement a "medical-engineering integration" teaching model, the focus is on guiding independent learning, cultivating practical innovation abilities, enhancing professional practical skills, and fostering proactive exploration among students to improve their comprehensive qualities.

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Disclosure statement

The authors declare no conflict of interest.

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