Undergraduate Experimental Teaching Platform for Intelligent Limb Rehabilitation Training Based on "Medical-Engineering Interdisciplinary Crossing"

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Abstract In view of the key role of undergraduate experimental teaching reform in cultivating high-quality talents with both innovative spirit and practical ability, this paper deeply discusses multi-dimensional reform strategies. Specifically, the teaching mode of "double teachers for every student" is innovatively introduced, and scientific research projects are deeply integrated into undergraduate experimental teaching, aiming at realizing the modern development of teaching content and the diversified expansion of teaching methods. By designing and applying the undergraduate experimental teaching platform for intelligent limb rehabilitation training based on the concept of "medical-engineering interdisciplinary crossing", it not only builds a bridge for students to contact cutting-edge scientific research and strengthen practical skills, but also provides valuable ideas and practical models for the innovation of undergraduate experimental teaching. In the future, with the continuous optimization and upgrading of platform functions, it is expected to provide students with a richer and richer learning experience and comprehensively promote students' overall quality.

Key words Undergraduate experimental teaching, Reform, Undergraduate experimental teaching platform for intelligent limb rehabilitation training, Medical-engineering interdisciplinary crossing

1 Introduction

With the continuous deepening and expansion of the field of "medical-engineering interdisciplinary crossing", the reform and development of undergraduate experimental teaching, as the frontier of educational innovation, has become an important driving force to improve the quality of higher education and cultivate compound talents. Undergraduate experimental teaching, as a bridge between theoretical knowledge and practical application, not only bears the important task of consolidating and deepening theoretical study, but also is the key stage to cultivate students' innovative consciousness, practical ability and scientific spirit. As an indispensable part of the higher education system, undergraduate experimental teaching effectively promotes students' in-depth understanding and comprehensive grasp of professional knowledge by promoting the deep integration of students' theoretical knowledge and practical operation. In addition, undergraduate experimental teaching also plays an important role in stimulating students to explore the unknown, cultivating scientific research interest and teamwork spirit. Under this background, it is necessary to deeply think and explore the reform and development of undergraduate experimental teaching. This paper is to analyze the current situation and challenges of undergraduate experimental teaching, and explore the new ideas and strategies of undergraduate experimental teaching reform under the background of medical-engineering interdisciplinary crossing, so as to provide strong support for cultivating more medical-engineering compound talents with innovative spirit and practical ability.

Received: September 19, 2024 Accepted: November 23, 2024

Supported by Undergraduate Teaching Research and Reform Project of University of Shanghai for Science and Technology in 2024 (JGXM24281); University-Level First-Class Undergraduate Course Construction Project of University of Shanghai for Science and Technology in 2024 (YLKC202424394).

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2 Thoughts on the reform of frontier undergraduate experimental teaching

2.1 The need for reform At present, there are still some problems to be solved urgently in undergraduate experimental teaching, such as the disconnection between experimental content and scientific research frontier, single teaching method, and insufficient participation of students. These problems limit the cultivation and individualized development of students' innovative ability, and greatly reduce the effect of undergraduate experimental teaching[1]. The goal of undergraduate experimental teaching reform is to build an experimental teaching system that is closely combined with scientific research, modernized teaching contents, diversified teaching methods and highly participated in by students. Through the reform of undergraduate experimental teaching, we hope to cultivate students' innovative thinking, practical skills and lifelong learning ability.

2.2 Reform strategy In order to achieve the goal of undergraduate experimental teaching reform, we hereby put forward the

following series of strategic suggestions, aiming at comprehensively promoting the innovation and development of experimental teaching.

2.2.1 Deep integration of scientific research resources and teaching. It is necessary to advocate the effective integration of scientific research resources into undergraduate experimental teaching, so that students can experience and master the latest scientific knowledge and technology in the process of participating in actual scientific research projects. This deep integration not only helps to enhance students' academic vision, but also stimulates their scientific research interest and innovation ability[2].

2.2.2 Diversification and innovation of teaching methods. It is necessary to encourage the adoption of diversified teaching methods, including case teaching, flipped classroom, project-driven learning, etc., combined with online and offline teaching modes, and the organic combination of factory practice and school education. These methods aim to cultivate students' awareness of active learning, improve their problem-solving ability and teamwork ability, and enable them to achieve all-round development in diverse learning environments.

2.2.3 Strengthening practical teaching links. In order to enhance students' practical ability, we plan to increase the proportion of experimental courses and enrich the experimental contents to make them closer to practical application. By strengthening practical teaching, it is expected that students can better apply theoretical knowledge to practice, so as to deepen their understanding and mastery of knowledge in practice.

2.2.4 Improving the overall quality of teachers. Excellent teachers are the key to experimental teaching reform. Therefore, teachers' scientific research ability and teaching training should be strengthened to improve their teaching experience and skills. By regularly organizing academic exchanges, teaching seminars and other activities, it can promote experience sharing and cooperation among teachers, and jointly promote the reform and development of experimental teaching.

2.2.5 Building an ability training-oriented evaluation system. In order to comprehensively evaluate students' experimental operation ability, innovative thinking and practical achievements, a set of evaluation system oriented by ability training should be established. The system will focus on the investigation of students' comprehensive quality, including experimental design ability, data analysis ability, teamwork ability and innovative thinking. At the same time, students should be encouraged to participate in various scientific research competitions and practical activities, and their learning effectiveness should be tested through the display and evaluation of practical results.

2.3 Implementation of reform The implementation of undergraduate experimental teaching reform needs the joint efforts of universities, teachers, students and all walks of life. Universities should provide necessary policy support and resource guarantee; teachers should actively update their teaching ideas and methods; students should actively participate in experimental teaching activities; all sectors of society should provide students with practical platforms and entrepreneurial opportunities[3]. In addition, laboratory safety management in colleges and universities is also a key factor for the success of experimental teaching. The research results of Yang Yongming *et al.* [4] provide valuable laboratory safety management experience for the implementation of undergraduate experimental teaching reform.

On the basis of the above discussion, this paper further explores the integration of the concept of "medical-engineering interdisciplinary crossing" into undergraduate experimental teaching[5], and then builds an undergraduate experimental teaching platform for intelligent limb rehabilitation training based on "medical-engineering interdisciplinary crossing". This platform will help deepen the industry-university-research cooperation, promote the deep integration of scientific research projects and undergraduate experimental teaching, and provide students with more cutting-edge scientific research experience and richer practical opportunities.

3 Industry-university-research-based and scientific research project-based undergraduate experimental teaching

3.1 Laboratory function innovation under the integration of industry-university-research Driven by the national strategy of "first-rate universities and disciplines", university laboratories, as the intersection of scientific research, education and social services, play an important role in cultivating innovative talents. Through the design and development of the undergraduate experimental teaching platform for intelligent limb rehabilitation training based on "medical-engineering interdisciplinary crossing", the educational strategy of deep integration of industry-university-research can be demonstrated. The platform integrates the three major areas of scientific research, education and social services, creating an interactive environment that promotes the common growth of all parties[6].

3.1.1 Scientific research practice. With the help of cutting-edge scientific and technological projects, the platform provides valuable opportunities for students to participate in scientific research. In close collaboration with scientific researchers, students can experience scientific research projects in depth, and cultivate innovative thinking and the ability to solve practical problems.

3.1.2 Teaching integration. The platform incorporates the latest scientific research achievements and cutting-edge technologies into undergraduate experiments, which enables students to keep pace with the cutting-edge of disciplines in their study, deepens their mastery of basic theories, and ignites students' enthusiasm for scientific exploration.

3.1.3 Social service practice. The close cooperation with the laboratory industry makes it the connection point between academic research and social needs. By participating in social service pro-

jects, students can gain insight into industry trends, improve their vocational skills and lay a certain foundation for career planning.

3.2 Curriculum-based scientific research projects in undergraduate experimental teaching By closely combining the resources and technology of scientific research projects with undergraduate experimental teaching, a brand-new undergraduate experimental curriculum model has been formed. The undergraduate experimental course mode has the following characteristics:

(i) Keeping pace with the frontier of the discipline. The content of undergraduate experimental courses is updated synchronously with the latest progress of the discipline, incorporating innovative theories, methods, technologies and directions, which enables students to broaden their academic horizons while laying a solid foundation. (ii) Deepening the professional depth. The undergraduate experimental course design focuses on the key issues of professional theory or engineering application, strengthens experimental research and in-depth analysis, and cultivates students' scientific research interest. (iii) Stimulating learning motivation. The teaching strategies of undergraduate experimental courses extract fascinating learning questions from scientific research projects, create an attractive learning environment, and enhance students' interest in learning. (iv) Enhancing teaching flexibility. The teaching arrangement, time, place and evaluation system of undergraduate experimental courses are flexibly adjusted according to the characteristics of scientific research projects to meet different needs, and at the same time, the students are encouraged to produce scientific research results. For example, students are encouraged to write and publish academic papers as the first author, write and apply for national invention patents as the first inventor, participate in college student innovation plan projects as the first person in charge, and participate in subject competitions as the first person in charge.

This brand-new undergraduate experimental curriculum model can effectively combine students' theoretical knowledge with practical skills, significantly improve their scientific research literacy and innovative ability, and lay a foundation for cultivating outstanding engineering talents with exploratory spirit, innovative consciousness and scientific thinking.

4 Design and development of undergraduate experimental teaching platform for intelligent limb rehabilitation training based on "medical-engineering interdisciplinary crossing"

4.1 System architecture and function of teaching platform

The undergraduate experimental teaching platform for intelligent limb rehabilitation training based on "medical-engineering interdisciplinary crossing" built by us is a comprehensive education and research tool, which aims to realize the optimal allocation of teaching resources and effective management of teaching process by applying advanced big data technology and visual information technology. In addition, the core goal of the platform is to significantly improve the convenience and flexibility of teachers' teaching, while sparing no effort to optimize students' learning experience and ensure that the teaching process is both efficient and highly personalized. As shown in Fig. 1 – 5, the undergraduate experimental teaching platform for intelligent limb rehabilitation training based on "medical-engineering interdisciplinary crossing" is mainly composed of three core components: Android teacher client, Android student client and Web server.

4.1.1 Android teacher client. Teacher client is the main tool for teachers to manage teaching. Its main functions include the following.

Course management: Teachers can create and edit course content, publish teaching materials and reading materials. Student interaction: Through online discussion and real-time feedback, teachers can keep abreast of students' learning situation and promote classroom interaction. Grade evaluation: Teachers can correct homework and tests online, and the system automatically records grades and provides analysis reports. Teaching resource sharing: Teachers can upload teaching videos, presentations and other resources for students to learn and refer to.

4.1.2 Android student client. The student client provides a convenient mobile learning environment for students. Its main functions include the following.

Course learning: We have access to course content, including multimedia courseware and online lectures. Assignment submission and feedback: Students can submit assignments online and receive feedback and grading from teachers. Grade checking: Students can check their learning progress and grades in real time, and keep abreast of their learning status. Interactive communication: Students can participate in classroom discussions and communicate with teachers and classmates through the client.

4.1.3 Web Server. As the data management and service support center of the whole platform, the Web server undertakes the following responsibilities.

Data storage and processing: Centrally storing teaching data for efficient data processing and analysis.

Communication and coordination: Ensuring the data synchronization between teacher client and student client, and ensuring the stability of system operation.

Security and privacy protection: Using encryption and security protocols to protect user data from unauthorized access.

4.2 Innovation and practice of experimental teaching model

4.2.1 Teaching mode of "double teachers for every student". We adopt the teaching mode of "double teachers for every student", which combines the strength of the project team's teacher team and the graduate team to provide personalized and in-depth study guidance for undergraduates[7]. In this mode, each student can get the attention and guidance of two teachers, one is the teacher responsible for teaching content, and the other is the graduate student responsible for experimental guidance.

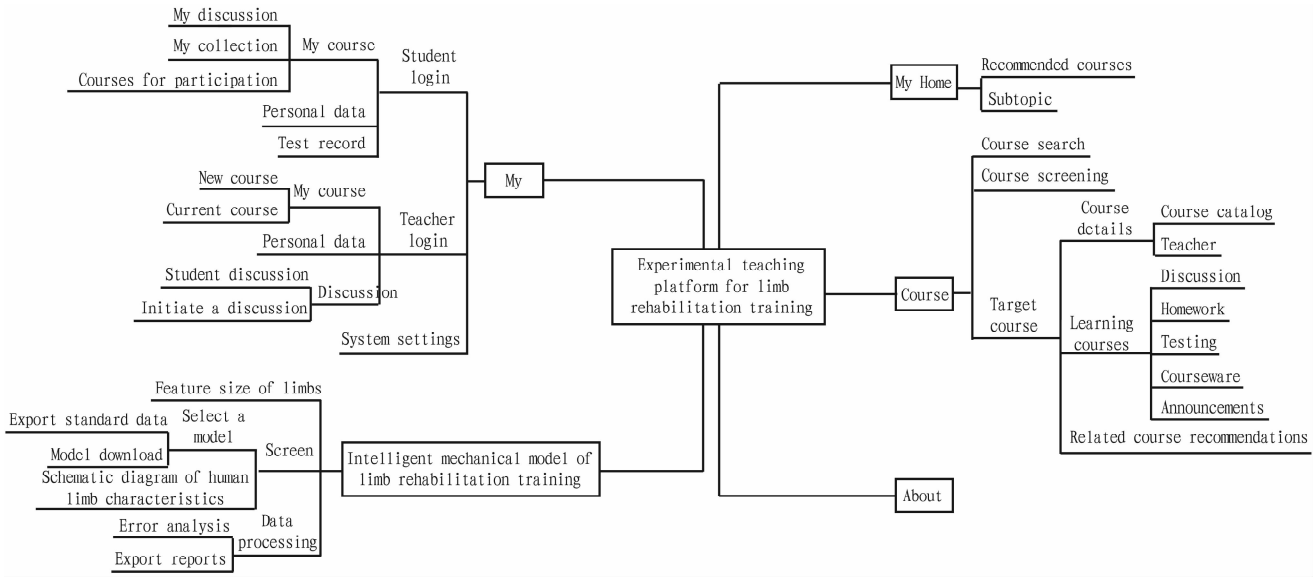

Fig. 1 Schematic diagram of architecture of undergraduate experimental teaching platform for intelligent limb rehabilitation training based on "medical-engineering interdisciplinary crossing"

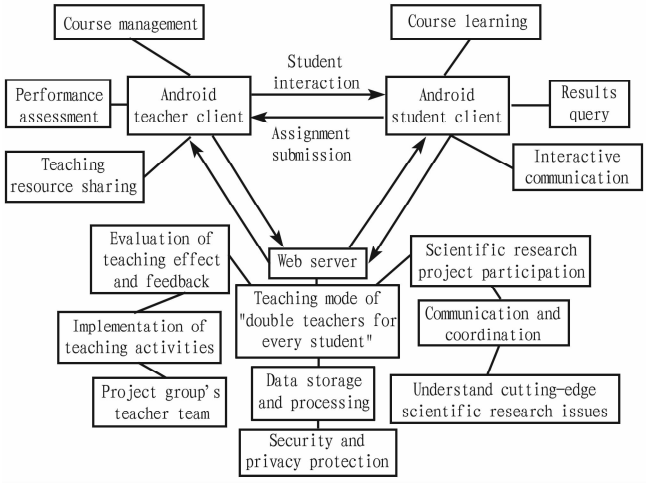

Fig. 2 Schematic diagram of teaching platform architecture

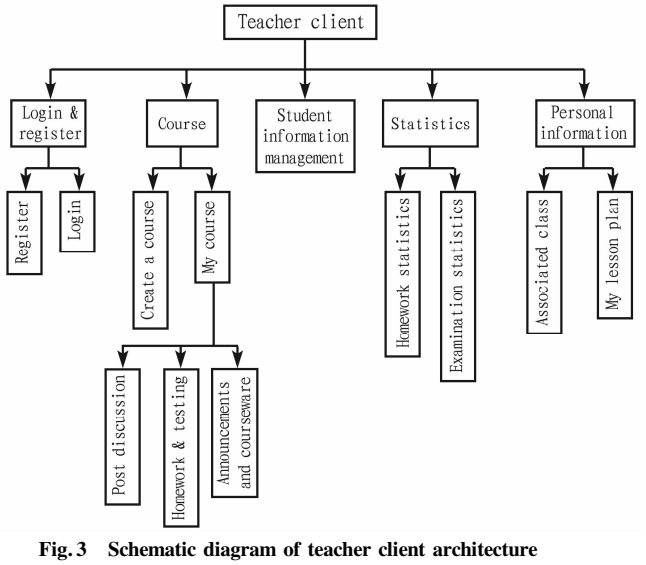

Fig. 3 Schematic diagram of teacher client architecture

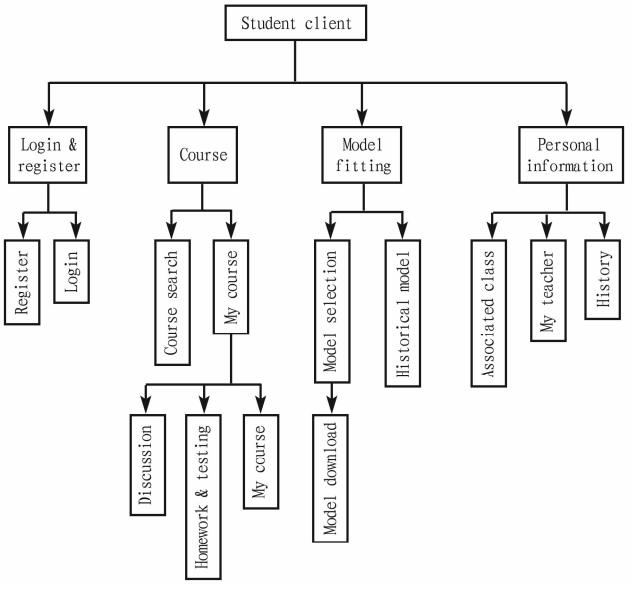

Fig. 4 Schematic diagram of student client architecture

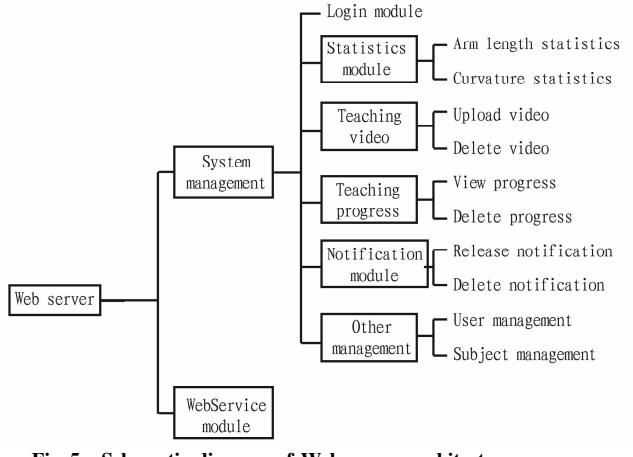

Fig. 5 Schematic diagram of Web server architecture

4.2.2 Deep integration of teaching content and scientific research projects. The experimental teaching content is closely integrated with scientific research projects, so that students can get in touch with and understand cutting-edge scientific research issues while participating in experiments. This teaching mode not only deepens students' mastery of theoretical knowledge, but also stimulates their interest in scientific research and innovative thinking[8].

4.2.3 Implementation of teaching activities. Teaching activities are designed to be practical and interactive, including but not limited to: Experimental design and operation: Under the guidance of teachers and graduate students, students participate in experimental design and operation to improve their practical ability. Participation in scientific research projects: Students have the opportunity to participate in real scientific research projects, experience the scientific research process and cultivate scientific research literacy. Academic exchange and discussion: Academic exchange meetings are organized regularly to encourage students to share experimental results and academic insights.

4.2.4 Evaluation and feedback of teaching effect. The evaluation of teaching effect is an important part of experimental teaching platform. Through the information of students' experimental reports, project results and teachers' evaluation, we comprehensively evaluate the teaching effect. At the same time, we can collect feedback from students and teachers, and constantly optimize teaching content and lecture methods.

4.3 Practical effect and case analysis of the platform Practical case display: Showing a series of students' learning cases in the undergraduate experimental teaching platform for intelligent limb rehabilitation training based on "medical-engineering interdisciplinary crossing", including experimental design, operation process and results display. Data analysis of teaching effectiveness: Using the data collected by the Web server for a quantitative analysis of learning effectiveness, including indicators such as academic performance, participation and satisfaction. Summary of student and teacher feedback: Gathering and summarizing students' and teachers' experience with the experimental teaching platform, including strengths and areas for improvement.

5 Conclusion

By building an undergraduate experimental teaching platform for intelligent limb rehabilitation training based on "medical-engineering interdisciplinary crossing", we have successfully achieved the effective integration of scientific research projects and undergraduate experimental teaching under the background of "medical-engineering interdisciplinary crossing". The mobile learning environment of the platform realizes access to teaching resources anytime and anywhere through Android client, which greatly improves learning flexibility and efficiency, and enables us to efficiently use fragmented time and optimize personal learning plans. The teaching mode of "double teachers for every student" implemented by the platform provides each of students with dual academic support from the teacher team and the graduate team of the project group. This kind of personalized guidance not only deepens students' mastery of professional knowledge, but also promotes the in-depth development of experimental skills and scientific research thinking. By closely combining teaching content with cutting-edge scientific research projects, the platform provides students with the opportunity to participate in practical scientific research. This teaching mode enables students to learn in practice and practice in learning, effectively stimulates their interest in scientific research and innovation ability, and lays a solid foundation for their future academic or professional career. The interactive communication function provided by the platform enhances the academic communication and thinking collision among students, and enhances the classroom interaction and students' participation. This communication mechanism not only exercises students' critical thinking, but also promotes the development of teamwork ability.

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