Exploration of Interdisciplinary Curriculum Reform Practice under the Background of Science and Education Integration

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***Abstract*—With the release of a series of State Council documents such as "Made in China 2025" and "Healthy China Action (2019–2030)", the integration of medical and engineering interdisciplinary fields has become one of the key construction areas of higher education in China. In response to the problem of low coupling between interdisciplinary majors in the current integration of medicine and engineering, and the inability to provide effective support for each other, this article takes the interdisciplinary knowledge crossing course "Medical Data Mining" as an example. Through the teaching mode of integrating science and education, the design concept of medical data mining course is reconstructed, the teaching content is reconstructed, the theoretical knowledge application is increased, the practical skills and scientific literacy of students are improved, and ideological and political education and interdisciplinary vocational literacy education are integrated. Students are guided to regard disease prevention, pain relief, and safeguarding the health rights and interests of the masses as the sacred responsibility of medical workers. A bridge between education, industry, and innovation is built to achieve seamless integration of talent cultivation, industrial development, and technological innovation, and to improve the training mode of scientific and technological innovation talents in the integration of medicine and engineering interdisciplinary fields.**

***Keywords*—interdisciplinary, integration of science and education, course ideology and politics, reform**

I. Introduction

In the "Opinions on Deepening the Reform of Undergraduate Education and Improving the Quality of Talent Cultivation" released by the Ministry of Education in 2019, it was emphasized that undergraduate education should be committed to achieving a deep integration of scientific research and teaching, using scientific research to feed back teaching, and strengthening the function of scientific research in educating people. With the continuous progress in the field of life sciences, there is a trend of interdisciplinary infiltration and comprehensive development. Developing interdisciplinary fields can not only achieve a close integration of theory and practice, but also break down barriers between disciplines, integrate knowledge points from different disciplines, improve students' research quality and ability, and promote academic innovation [1].

The course of Medical Data Mining is a model of interdisciplinary integration, which integrates the essence of multiple disciplines such as medicine, data science, and computer science. This article is based on the concept of integrating science and education in this course. By optimizing the course knowledge system, designing reforms for integrating science and education, and constructing a diversified evaluation system, a positive cycle between teaching, research, and engineering practice is formed, exploring innovative solutions for interdisciplinary curriculum reform in medical engineering integration [2].

II. Reform of Integrated Teaching of Science and Education

A. Optimize the Knowledge System of Integrating Curriculum, Science, and Education

Based on the actual scientific research projects and needs of hospitals and enterprises, continuously enrich and update teaching content with the latest scientific research achievements. There are two strategies to achieve deep integration of scientific research results into curriculum teaching [3, 4]: firstly, adopting a problem oriented and closed-loop transformation approach, where teachers directly introduce the latest research results of their research team into the classroom, using problems as a link to form a knowledge transmission system that is interconnected. Taking the research project "Research on Building a Colorectal Cancer Immune Microenvironment Recognition and Immunotherapy Evaluation Model Based on Big Data Technology" as an example, the problem to be solved is extracted from the project background, and new knowledge and methods to be used

Manuscript received September 23, 2024; accepted February 7, 2025; published July 4, 2025.

to solve the problem are further proposed in a problem oriented manner. Based on the new problems and methods, the project will produce new achievements. This teaching method, which focuses on practical research projects and guides students step by step, enables them to directly engage with the forefront of scientific research, enhancing the practicality and pertinence of learning. Secondly, implementing a systematic integration of hierarchical objectives, teachers extensively collect and screen scientific research results based on the teaching syllabus and objectives, systematically integrate them according to the logic and hierarchy of teaching, and construct a structured teaching content framework [5]. The expected learning outcomes of "Medical Data Mining" include mastering the data preparation before machine learning algorithm modeling, feature engineering for screening and constructing machine learning algorithm indicators, different categories of machine learning algorithms, mastering the processing methods of multi-source heterogeneous data such as clinical diagnosis and treatment data, electronic medical record archive data, and imaging data, as well as knowledge of reading, preprocessing, and visualization of medical images, texts, and other data. To achieve the expected learning effect of the course, in addition to sorting out the basic knowledge in the textbook, it is also necessary to focus on the key points of each chapter and rely on the technology project management information platforms of important national central cities such as Beijing, Shanghai, and Guangzhou to timely obtain the latest project proposals, application guidelines, etc., which can be used to guide the technical implementation in teaching.

By combining these two paths and modes, the teaching content can be kept updated and dynamic. Students can not only systematically grasp knowledge, but also understand the latest developments in scientific research, help students establish a connection between scientific research and teaching, improve innovation ability and practical skills, and achieve a win-win situation between education and scientific research [6, 7].

B. Curriculum Science Education Integration Teaching Reform Design

To deepen the integration of science and education, innovative design will be carried out for the course of "Medical Data Mining". Firstly, establish the teaching knowledge objectives and ideological and political education objectives of the curriculum, and then update the curriculum outline to incorporate elements of ideological and political education. Deeply explore the teaching content, explore the integration points of professional knowledge such as medicine, data science, and computer science with ideological and political education [8], create representative ideological and political teaching cases, optimize teaching courseware, adopt innovative teaching methods, carefully design the core teaching links of ideological and political education, adopt diversified teaching methods, and ensure the subtle influence of ideological and political education goals. In the implementation of teaching, by setting up a scientific literature sharing session, students can grasp the latest developments and methodologies in the field of medical data mining, and integrate cutting-edge technologies and achievements in scientific research into the course content, thereby enhancing students' learning enthusiasm and making the teaching content more realistic and vivid. In addition, a comprehensive ability development system covering "cognition skills practice" should be constructed, integrating practical engineering cases and scientific research and development projects into teaching, with a focus on cultivating students' practical abilities to solve complex engineering problems [9, 10]. The specific implementation plan is shown in Fig. 1.

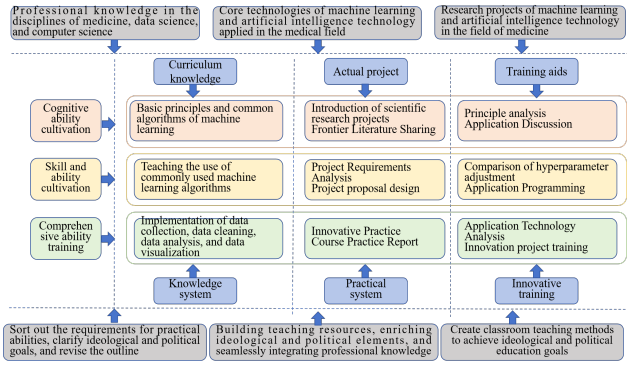

Fig. 1. Design scheme for the integration of science and education in the course of medical data mining.

In the process of education, the cultivation of cognitive ability, skill ability, and comprehensive ability is crucial. The cultivation of cognitive ability can be achieved through systematic learning of course knowledge, enabling students to master basic theoretical knowledge and concepts. In the process of teaching theoretical knowledge, scientific research projects and sharing of cutting-edge literature can be introduced, allowing students to understand the application scenarios and how to apply knowledge. Through auxiliary training activities such as seminars, lectures, and case analysis, students can expand their horizons and improve their thinking abilities. The cultivation of skills and abilities focuses on practical operations, through the design of practical projects such as courses, laboratory work, internships, and scientific research, as well as workshops, skill competitions, simulation exercises, and other auxiliary training to enhance students' practical operation abilities. The cultivation of comprehensive abilities requires the integration of interdisciplinary course content. By participating in college student innovation and entrepreneurship projects, subject competitions, and comprehensive course practices, students can work in a multidisciplinary context. Through auxiliary training activities such as teamwork, leadership training, and project management, teamwork and leadership abilities can be developed.

C. Build a Multi-dimensional Evaluation Index System to Dynamically Monitor the Effectiveness of Collaborative Education

In order to continuously enhance the vitality of the integration of science and education, a multi-party

evaluation index system with six dimensions of "innovation ability, knowledge transmission and acquisition, team collaboration, practical ability, social influence, and continuous improvement" will be constructed based on project application documents and project achievements during the final assessment [11]. Through detailed decomposition and quantitative scoring, the effectiveness of education will be dynamically monitored to promote the comprehensiveness, development, and personalization of talent cultivation under the integration of science and education [12]. As shown in Fig. 2, innovation ability is evaluated from the perspectives of creativity, problem-solving, and interdisciplinary integration, and is examined through the innovation points and expected target content of the project application; Knowledge transmission and acquisition are evaluated from the perspectives of accuracy, timeliness, and effectiveness of teaching methods, and are examined through the main research content and technical route content of the project proposal; Team collaboration is evaluated from the perspectives of communication skills, leadership abilities, and task allocation, and is assessed through the preliminary research foundation, team members, and division of labor content in the project proposal; Practical ability is evaluated from the perspectives of problem-solving ability, practical operational skills, and the application of theoretical knowledge, and is assessed through project outcomes; Social impact is evaluated from the perspectives of participation, influence range, and social recognition. It is examined through the economic and social benefit analysis content of the project application, including market prospects, profit forecasts, and achievement transformation; Continuous improvement is evaluated from the perspectives of data-driven, improvement plan, and improvement effect evaluation, and is examined through the implementation progress plan section of the project proposal. Through multi-faceted and multidimensional evaluation, on the one hand, it can objectively and comprehensively evaluate students' learning effectiveness, and on the other hand, it can improve students' research and design abilities and academic writing skills, laying a solid foundation for their future career development.

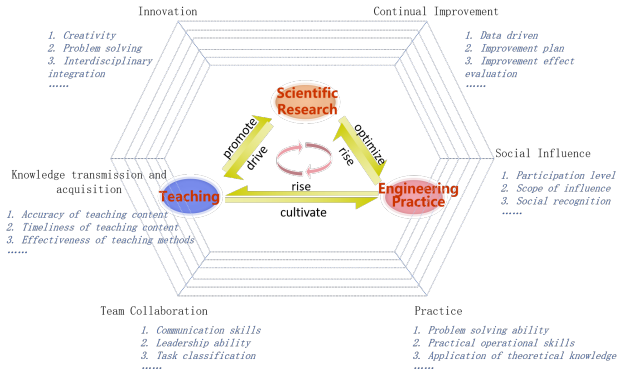

Fig. 2. Multi-dimensional application effect evaluation index system.

D. Implementation of the Integration of Science and Education Reform in Teaching

In the current teaching implementation process, teachers have adopted a series of innovative teaching strategies, closely integrating scientific research projects with classroom teaching to cultivate students' learning interests and practical problem-solving abilities. Firstly, the teacher organizes the scientific research projects they have led or participated in based on health and medical big data to construct disease assisted diagnosis and treatment models, and shares the actual engineering problems in the projects in the classroom, guiding students to apply their learned knowledge for in-depth analysis, and organizing students to form project teams to focus on tackling these problems. This teaching method greatly stimulates students' enthusiasm for learning, allowing them to deepen their understanding and application of knowledge through discussions, self-study, and research. In the practical stage of the course, teachers further explain in detail the techniques and methods applied in scientific research projects, and demonstrate the specific implementation of these techniques and methods through practical cases. In this process, students not only achieve knowledge transfer and reuse, but also explore new rules, construct new models, and propose new methods by analyzing real data, applying machine learning and artificial intelligence technologies, thus exercising their innovative thinking and practical operation abilities.

Extracurricular activities require students to collect and construct research literature on disease diagnosis models based on health and medical data. Encourage students to engage in group learning and share their literature findings within the group. This activity not only promotes students' understanding of current medical data analysis and disease diagnosis technologies, but also cultivates their ability for independent research and teamwork. Through literature collection and group learning, students can be exposed to the latest research trends, understand how to apply data science technology to the medical field, and enhance their mastery and application ability of professional knowledge. The literature sharing session further enhanced students' communication skills and expression abilities, while also stimulating their interest and enthusiasm for scientific research work.

III. The Application Effect of the Integration of Science and Education in Teaching Reform

A. Student Benefits

During the implementation of the course, students are encouraged to use their spare time to collect research literature related to the course, study in groups, and share in class. During the sharing process, students can timely understand the latest research results and broaden their academic horizons. By sharing literature, students demonstrate respect and recognition for academic research, and also learn how to correctly cite and refer to others' research results, following academic norms.

Before the end of the course, a survey questionnaire was used to collect students' true feelings about integrating scientific research education into the course. Students gave unanimous praise for the teaching method of integrating science and education, especially the introduction of scientific research literature sharing activities in teaching. On the one hand, it allows students to be exposed to the latest research results and academic viewpoints, thereby expanding their knowledge breadth and depth; On the other hand, allowing students to experience the joy and challenges of academic research, stimulating their interest and motivation in learning, promoting self-directed learning, and the student evaluation results of the integrated science and education curriculum reform are shown in Table I.

TABLE I. STUDENT EVALUATION OF THE INTEGRATION OF SCIENCE AND EDUCATION CURRICULUM REFORM

Questions	Type	Total	Counts
1. Do you think it's a good idea to add a research literature sharing section in teaching? A. Yes, it is B. No	Single choice	26	A = 26
2. Do you think the sharing of scientific research literature can help improve learning outcomes? A. Very helpful B. It's helpful to some extent C. Not very helpful D. No help at all	Single choice	26	A = 26
3. Which form of scientific literature sharing do you prefer? A. Group discussion and sharing B. Teachers share the latest research findings C. Students share their research findings	Multiple choices	26	A = 25 B = 25 C = 26
4. What is the frequency of the scientific literature sharing session that you would like to have? A. Once a week B. Once every two weeks C. Once a month D. One	Single choice	26	A = 26
5. Are you willing to actively participate in the scientific literature sharing session? A. Yes, it is B. No	Single choice	26	A = 26

After two rounds of integrated science and education curriculum teaching, students have solidified their theoretical foundation knowledge and been exposed to cutting-edge academic research results, cultivating their interest and understanding of academic research. During the final assessment, students are able to combine their professional knowledge with research methodology, and through discussion and collaboration, complete the application, implementation, and completion of the course's "research project" – The assessment of the third level project. In the preparation and implementation process of the third level project, students constantly propose new research ideas, methods, and plans, master the skills required to solve related problems in scientific research work, and be able to think logically in an orderly manner when facing practical problems, making scientific and reasonable research plans, laying a good foundation for their future academic and career development. In addition, students applied for 9 college innovation and entrepreneurship projects based on the third level curriculum projects, of which 2 were recommended as national level innovation and entrepreneurship projects and 1 was recommended as provincial level innovation and entrepreneurship projects. On this basis, the project was further optimized and improved, and won the first prize in the 3rd Intelligent Manufacturing Science Popularization and Creative Innovation Competition in Liaoning Province, the second prize in the iCAN Innovation and Entrepreneurship Competition in Liaoning Province, and the first prize in the Microsoft "Innovation Cup" Global Student Science and Technology Competition Provincial Competition.

B. Curriculum Construction Status

In order to achieve the integration of classroom teaching and scientific research, the "Medical Data Mining" course team has repeatedly discussed and carefully polished the course content, and adopted the innovative teaching concept of using scientific research to drive teaching and teaching to support scientific research. The course construction has shifted towards the combination of learning and thinking, and the integration of knowledge and action. After a new round of integrated design and implementation of science and education, rich teaching resources have been established in both in class and out of class activities, including 5 comprehensive teaching cases, 15 project-based applications, 15 project deliverables, 12 research literature sharing PPTs, and original research literature. This course has been rated as an "excellent case of integration of science and education, integration of science and innovation", "excellent experimental teaching case", "excellent teaching case of ideological and political education in school level courses in 2023", and "excellent teaching case of ideological and political education in school level courses in 2022" by the school.

C. Professional Construction Status

The teaching reform of integrating science and education has been practiced and explored in the teaching of the course "Medical Data Mining" in the 2022 and 2023 academic years, respectively. After two rounds of teaching, the course has achieved significant results in ideological and political education and practical ability cultivation. Students' enthusiasm for learning is high, and they have transformed their knowledge into achievements, achieving good results in innovation and entrepreneurship projects and subject competitions. In the past two years, there have been 47 academic competition projects related to the integration of medicine and engineering in the field of intelligent healthcare and health services, accounting for 76% of the total; There are 74 innovative and entrepreneurial projects in the field of intelligent healthcare and health services related to medical engineering integration, accounting for 70% of the total. In terms of scientific research, 5 medical engineering integration research projects have been approved, and

school enterprise scientific research cooperation has been established with 4 enterprises.

IV. Discussion

A. The Necessity of Interdisciplinary Curriculum Integration Reform

As a typical interdisciplinary field, the knowledge system of "Medical Data Mining" is a comprehensive integration of knowledge from multiple disciplines and fields. By carrying out the integration of science and education and integrating advantageous scientific research achievements into practical teaching, on the one hand, it can solve the problem of the disconnect between theory and practice, and on the other hand, it can cultivate students' scientific thinking and scientific sentiment. Scientific research achievements are closely related to the development strategy of the country and the actual needs of society. In the process of implementing the curriculum reform of integrating science and education, it is necessary to cultivate teachers and students with the ideal belief of loyalty to serving the country, the scientific attitude of daring to explore, the enterprising spirit of continuous innovation, and the serious and rigorous scientific research attitude [13], further strengthen the ideological and political construction of the curriculum, and solve the problem of insufficient value shaping.

B. Problems and Shortcomings

The construction and development of interdisciplinary fields is an effective way to improve students' research quality and enhance their research abilities. How to promote the research development of universities based on interdisciplinary fields is a concern for many universities at present. In the process of integrating science and education through the interdisciplinary course of Medical Data Mining, two major problems have been encountered: a lack of construction experience and a funding gap [14]. The essence of interdisciplinary studies is to integrate and draw on theories and methods from multiple different disciplines. This requires academic leaders to have forward-looking thinking, keep up with the latest trends in scientific development, attach importance to team building, and continuously improve the teaching quality and research level of the teacher team through efficient collaboration to jointly develop and implement teaching plans [15, 16]. By recruiting team members who meet specific educational qualifications, professional titles, and age requirements, knowledge complementarity and collaborative development in different disciplinary fields can be achieved. In the initial stage of interdisciplinary construction, universities need to provide necessary financial support to promote the construction of infrastructure and platforms, thereby promoting the maturity of interdisciplinary studies and the improvement of research capabilities. In addition, it is crucial to establish a special fund to motivate and support researchers to strengthen interdisciplinary exchanges, understand international cutting-edge technologies, and master advanced scientific and technological knowledge.

V. Conclusion

The course of "Medical Data Mining" adheres to the educational philosophy of "student-centered, problem driven, and continuous optimization", and is committed to stimulating students' comprehensive participation and ensuring that they can obtain practical opportunities in teachers' scientific research activities. The course aims to enable students to experience a complete process from theoretical learning to practical application, from knowledge mastery to problem solving, helping them grow from simple course learners to professional talents with practical skills, laying a solid foundation for future scientific research work. In the teaching process, an academic paper sharing session has been added to provide students with academic enlightenment and training; Attract outstanding undergraduate students to join the mentor's research team, and encourage teachers and students to participate in innovation and entrepreneurship cooperation projects together; Encourage students to refer to research projects and academic papers during course assessments, cultivate research methodologies, and enhance problem-solving abilities. Through this teaching model, the curriculum not only imparts knowledge, but also emphasizes the comprehensive development of students, aiming to cultivate high-level, application-oriented future leaders with innovative spirit and practical ability, and provide excellent professional talents for the field of medical data mining.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Meiqin Wang conducted the research and wrote the paper; Depeng Dong and Kefei Shen analyzed the data; Ningning Li and Fengdong Sun designed the figures; all authors had approved the final version.

Funding

This research is supported by Liaoning Provincial Education Science Planning "14th Five Year Plan" Project "Research and Practice on Digital Empowerment of Interdisciplinary Construction in Medical Engineering" (JG22DB049); Liaoning Provincial Education Science Planning "14th Five Year Plan" Project "Integrated Design and Practice of Medical Information Engineering Talent Training System" (JG21DB036); Basic Research Projects of Liaoning Provincial Department of Education (JYTMS20231866) and Dalian Neusoft University of Information Science and Technology Innovation Fund (TIFP202306).

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