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Research on the Teaching Reform of Biomedical Major from the Perspective of Industry-Education Integration

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Abstract: As a strategic emerging industry, the high-quality development of the biomedical industry is in urgent need of support from high-quality applied talents. Industry-education integration, as the core path to break the barrier between talent training and industrial demand, provides an important direction for the teaching reform of the biomedical major. Based on the core connotation of industry-education integration, this paper analyzes the current problems existing in the teaching of the biomedical major in terms of talent training positioning, curriculum system, practical teaching, and teaching staff. Combined with the industrial development needs, specific teaching reform strategies are proposed from five dimensions: accurately positioning training objectives, constructing an industry-education collaborative curriculum system, building a diversified practical platform, establishing a "double-qualified" teaching team, and improving the quality evaluation mechanism. The aim is to realize the in-depth integration of the education chain into the talent chain, industrial chain, and innovation chain, and cultivate biomedical professionals who meet the needs of industrial development.

Keywords: Industry-education integration; Biomedical major; Teaching reform; Talent training; Practical teaching

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1. Introduction

With the rapid integration and development of biotechnology and the pharmaceutical industry, the biomedical industry has become one of the fastest-growing industries globally and a key strategic emerging industry nurtured in China [1]. The *14th Five-Year Plan for the Development of the Biomedical Industry* clearly proposes to strengthen talent support for the biomedical industry, promote the collaborative talent training between universities and enterprises, and cultivate high-quality professionals with innovative and practical abilities. As a key carrier connecting biomedical education and industrial development, the teaching quality of the biomedical major directly determines the quality of talent training, which in turn affects the core competitiveness of the industry [2].

Industry-education integration emphasizes the in-depth connection between education and industry. Through school-enterprise collaboration, resource sharing, and complementary advantages, it realizes the precise matching between talent training and industrial demand. Currently, the teaching of the biomedical major

in China still has problems such as the disconnection between talent training and industrial demand, weak practical teaching links, and insufficient industrial experience of the teaching staff, which make it difficult to meet the industrial demand for talents in high-quality development. Therefore, exploring the path of teaching reform for the biomedical major from the perspective of industry-education integration has important theoretical significance and practical value.

2. Core connotation of industry-education integration and its adaptability with the biomedical major

2.1. Core connotation of industry-education integration

Industry-education integration refers to a talent training model in which the education system and the industrial system realize the in-depth integration of education and training with industrial development through resource integration and functional collaboration [3]. Its core connotation lies in breaking the barrier between education and industry, integrating industrial demand into the entire process of talent training. Through school-enterprise cooperation in building curriculum systems, sharing teaching resources, forming teaching teams, and evaluating training quality, the talent training objectives, teaching content, and practical links are highly consistent with industrial development needs. The essence of industry-education integration is to realize the organic connection between the education chain, talent chain, industrial chain, and innovation chain, and ultimately cultivate high-quality applied and skilled talents who adapt to industrial development needs [4].

2.2. Adaptability between industry-education integration and the biomedical major

The biomedical major is a typical interdisciplinary subject, covering biology, medicine, pharmacy, engineering, and other fields, with strong practicality, applicability, and innovation. The development of the biomedical industry relies on the breakthrough of cutting-edge technologies and the application of practical technologies, which places extremely high requirements on talents' practical ability, innovative ability, and industry adaptability. Industry-education integration has a natural adaptability with the characteristics of the biomedical major: on the one hand, the industrial sector can provide universities with the latest technical trends, real production scenarios, and practical teaching resources, helping universities adjust teaching content in a timely manner and improve the pertinence of practical teaching; on the other hand, universities can provide enterprises with talent support and scientific research services, helping enterprises overcome technical difficulties and promote industrial upgrading. Therefore, industry-education integration is an effective path to solve the disconnection between talent training and industrial demand in the biomedical major, and an inevitable choice to improve the quality of professional teaching [5].

3. Current problems in the teaching of the biomedical major

3.1. Fuzzy talent training positioning, disconnected from industrial demand

Currently, the talent training positioning of the biomedical major in some universities is vague, failing to accurately position it in combination with the needs of regional industrial development. On the one hand, some universities pay too much attention to the imparting of theoretical knowledge, and the training objectives tend to be academic research-oriented talents, ignoring the industrial demand for applied and skilled talents; on the other hand, the training objectives of some universities lack pertinence, failing to formulate differentiated training programs according to the characteristics of subdivided fields of the biomedical industry (such as biopharmaceuticals,

medical devices, clinical testing, drug research and development, etc.). This vague training positioning leads to the mismatch between graduates' knowledge structure and ability quality and enterprise needs, resulting in the coexistence of "difficulty in enterprise recruitment" and "difficulty in graduate employment" [6].

3.2. Lagging curriculum system, out of sync with industrial technology development

The curriculum system is the core carrier of talent training. The current curriculum system of the biomedical major has an obvious lag. Firstly, the curriculum setup is dominated by theoretical courses, with a low proportion of practical courses. Moreover, the content of practical courses is mostly verification experiments, lacking comprehensive and design experiments closely combined with industrial reality [7]; secondly, the update of curriculum content is not timely, failing to fully integrate the cutting-edge technologies of the biomedical industry (such as gene editing, cell therapy, biological preparation research and development, the application of artificial intelligence in the biomedical field, etc.) and industry standards (such as GMP, GSP, GLP, etc.) [8]; thirdly, the correlation between courses is not strong, with problems such as repeated knowledge points and loose systems, making it difficult to form a complete knowledge system and ability training chain. This lagging curriculum system leads to the disconnection between the knowledge learned by students and industrial reality, making it difficult to adapt to the needs of the rapid development of industrial technology [9].

3.3. Unreasonable structure of teaching staff, insufficient industrial experience

The teaching staff is the core guarantee for improving teaching quality. The current teaching staff of the biomedical major has obvious structural problems [10]. Firstly, the proportion of "double-qualified" teachers is low. Most teachers teach directly after graduating from universities, lacking work experience in biomedical enterprises, and have insufficient understanding of industrial reality, technical trends, and job requirements, making it difficult to carry out targeted practical teaching. Secondly, the research direction of the teaching staff is disconnected from industrial demand. The scientific research work of some teachers focuses on theoretical research, failing to carry out applied research in combination with industrial reality, and it is difficult to transform scientific research achievements into teaching resources; thirdly, the teacher training mechanism is imperfect. Universities lack systematic industrial practice training plans for teachers, making it difficult for teachers to update their knowledge structure and improve their practical teaching ability in a timely manner.

4. Paths of teaching reform for the biomedical major from the perspective of industry-education integration

4.1. Accurately positioning training objectives to connect with industrial demand

Based on the core requirements of industry-education integration, the biomedical major should accurately position talent training objectives in combination with the needs of regional industrial development [11]. Firstly, carry out extensive industrial research to deeply understand the development status, subdivided fields, technical needs, and job requirements of the regional biomedical industry, and jointly formulate talent training programs with industry associations and leading enterprises; secondly, clarify the training positioning, and formulate differentiated training objectives for the subdivided fields of the biomedical industry, such as applied production and technical talents for biopharmaceutical enterprises, R&D auxiliary talents for medical device enterprises, and testing technical talents for clinical testing institutions; thirdly, strengthen the ability-oriented training, integrate the practical ability, innovative ability, and professional quality required by the industry into the training objectives, and build a talent training system with "solid theoretical foundation, outstanding practical

ability, and excellent professional quality."

4.2. Constructing an industry-education collaborative curriculum system to integrate industrial elements

Taking industry-education integration as the core, construct a collaborative curriculum system closely connected with industrial demand [12]. Firstly, optimize the curriculum structure, increase the proportion of practical courses, organically connect practical courses with theoretical courses, and form a curriculum chain of "theoretical learning–practical application–innovative improvement"; secondly, update the curriculum content, jointly develop courses with enterprises, and integrate the cutting-edge technologies, industry standards, and actual enterprise cases of the biomedical industry into the curriculum content. For example, integrate GMP specifications and actual cases of biological preparation production into the course "Biopharmaceutical Technology," and integrate cutting-edge gene editing technologies into the course "Genetic Engineering"; thirdly, construct a modular curriculum system. According to the job requirements of subdivided industrial fields, set up professional core modules, directional characteristic modules, and practical innovation modules, allowing students to choose module learning according to their own interests and career plans, and improving the pertinence and flexibility of the curriculum; fourthly, promote the integration of interdisciplinary courses. Combined with the interdisciplinary characteristics of the biomedical industry, add interdisciplinary courses related to artificial intelligence, big data, and engineering to cultivate students' comprehensive abilities.

5. Guarantee measures for the teaching reform of the biomedical major from the perspective of industry-education integration

5.1. Policy guarantee

Actively strive for relevant government policy support to provide policy guarantee for industry-education integration teaching reform [13]. Firstly, relying on national industry-education integration policies, declare projects such as industry-education integration majors and industry-education integration training bases to obtain policy and financial support; secondly, promote local governments to introduce targeted support policies, encourage school-enterprise cooperation in talent training, scientific research and innovation, and provide tax incentives, subsidies and other incentive measures for enterprises participating in cooperation; thirdly, establish a school-local coordination mechanism, strengthen communication and coordination with local governments and industry competent departments, and promote the integration of biomedical industrial resources and educational resources.

5.2. Mechanism guarantee

Establish and improve the school-enterprise collaborative talent training mechanism to ensure the smooth progress of industry-education integration teaching reform [14]. Firstly, set up a school-enterprise cooperation leading group, composed of university leaders, enterprise responsible persons, and industry experts, to coordinate talent training, curriculum construction, practical teaching and other work; secondly, formulate school-enterprise cooperation management systems, clarify the rights and obligations of both parties, standardize the cooperation process, and ensure the smooth implementation of cooperation projects; thirdly, establish an interest-sharing mechanism, realize the mutual benefit and win-win situation of both schools and enterprises through scientific research cooperation, technical services, talent transportation, etc., and enhance the enthusiasm of enterprises to participate in industry-education integration.

5.3. Resource guarantee

Strengthen resource integration to provide resource guarantee for industry-education integration teaching reform [15]. Firstly, integrate university teaching resources and enterprise production resources to realize the sharing of laboratories, training bases, scientific research equipment and other resources; secondly, promote enterprises to provide teaching cases, technical data, internship positions and other resources for universities, and universities to provide talent support, scientific research services and other resources for enterprises; thirdly, introduce social resources, and jointly participate in talent training and teaching reform with industry associations, scientific research institutes and other institutions to enrich teaching resources.

6. Conclusion

Industry-education integration is the core path to promote the teaching reform of the biomedical major and improve the quality of talent training. Currently, the teaching of the biomedical major has problems such as fuzzy talent training positioning, a lagging curriculum system, weak practical teaching, insufficient industrial experience of the teaching staff, and a single quality evaluation mechanism, which are difficult to meet the needs of industrial high-quality development. From the perspective of industry-education integration, the reform paths, such as accurately positioning training objectives, constructing an industry-education collaborative curriculum system, building a diversified practical platform, establishing a "double-qualified" teaching team, and improving the quality evaluation mechanism, can effectively realize the in-depth integration of the education chain and the industrial chain, and improve the pertinence and effectiveness of talent training. At the same time, policy guarantee, mechanism guarantee, and resource guarantee can provide strong support for the smooth progress of teaching reform. In the future, the biomedical major should continue to deepen industry-education integration, constantly optimize the teaching reform plan, cultivate more high-quality professionals who meet the needs of industrial development, and provide solid talent support for the high-quality development of China's biomedical industry.

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(2) 2025 Research Project on the Construction of Industry-Education Integration Community and Municipal Industry-Education Consortium of the National Biotechnology Vocational Education Teaching Steering Committee: "Research on the Collaborative Training Path of Biomedical Talents from the Perspective of Industry-Education Integration—Practice Based on Municipal Consortium and Industry Community" (GTTXM202522)

(3) The Third Batch of School-Level Curriculum Team Teaching Method Special Research Project of Suzhou Polytechnic Institute of Agriculture: "Curriculum Reform and Exploration of Higher Vocational Pharmaceutical Biotechnology Major Under the Background of High-Quality Development" (2024SNY0164)

(4) Special Research Project on Party Building and Ideological and Political Education of Suzhou Polytechnic Institute of Agriculture: "Research on the Practice of Establishing Grassroots Model Branches in Higher Vocational Colleges" (SNDJSZ2024301)

(5) Suzhou Industry-Education Integration Key Major

Disclosure statement

The authors declare no conflict of interest.

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