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Research and Practice of the Reform of Training Model for Pharmaceutical Engineering Talents

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Abstract: In the past two decades, the higher education of China's pharmaceutical-related profession has experienced a period of rapid development. At present, there are more than 200 colleges and universities offering pharmaceutical engineering programs nationwide, covering chemical pharmaceuticals, biopharmaceuticals, traditional Chinese pharmaceuticals, and pharmaceutical preparations. However, in terms of content and form, it is mainly for the cultivation of research-oriented talents, training of practical talents related to actual jobs, and application-oriented talents who can immediately take up posts after graduation are relatively weak. This paper points out the problems existing in colleges and universities in cultivating talents and also provides direction for our work. We have made useful explorations from the reform of the personnel training system to the creation of universities, industries, and companies to cultivate talents. We have built a talent training model that focuses on industry-oriented first-line pharmaceutical excellence engineers.

1. Introduction

The pharmaceutical engineering profession is a cross-disciplinary engineering major in the fields of chemistry, pharmacy (traditional Chinese pharmacy) and engineering with the goal of cultivating technical personnel engaged in pharmaceutical manufacturing engineering, and belongs to the chemical and pharmaceutical categories in the same category as chemical engineering and technology. From a professional point of view, the specialty is a wide-caliber professional covering a wide range of applications such as chemical pharmaceutical engineering, biopharmaceutical engineering, and modern Chinese medicine pharmacy engineering. It not only has a full "pharmaceutical" taste, but also has a major similarity with the engineering profession at present; the universities and colleges that set up pharmaceutical engineering in China are distributed throughout the country. There are great differences in the background and environment of the

school. If we adopt a fixed training mode in accordance with the traditional school-running model, it is hard to avoid the monotony of many schools. Therefore, how to cultivate talented individuals who can meet the needs of enterprises according to their own background and conditions for running schools is a major issue that urgently needs to be solved in colleges and universities. This article has made reforms and attempts in personnel training programs, practical teaching modes, and the joint training of school-enterprise cooperation, and so on, which has formed the professional theory and practice both emphasis and the characteristics of the first-line engineers to train the pharmaceutical industry.

2. Development and Goals of Pharmaceutical Engineering

With the implementation of China's accession to the WTO and GMP and other quality management practices, China's pharmaceutical industry will directly participate in the international pharmaceutical market competition, and pharmaceutical companies must form a combination of economies of scale, increase their strength, and take a collective, modern production and management approach; With knowledge of new processes, new technologies, new dosage forms, and production process management and control engineering, and on this basis, it is reasonable to carry out technological transformation of old products and development and production of new products in order to achieve better economic and social benefits. However, pharmaceutical professionals who only know the pharmaceutical preparations and production process knowledge can no longer meet the requirements of the development of modern pharmaceutical production enterprises. Pharmaceutical manufacturing companies need to be able to understand the knowledge of pharmaceutical preparations, production process quality control knowledge, and modern pharmaceutical engineering technology complex talents. The study found that the main reasons leading to the small scale, outdated equipment, ageing varieties, low production efficiency, high raw material energy consumption, high cost, and weak competitiveness are the lack of professional and technical personnel, especially the lack of pharmaceutical engineering and technical personnel. The compound talent who knows not only pharmaceutical preparations, production processes, and quality control but also knows how to apply engineering technology is almost blank. Due to the lack of technical strength, the old products of pharmaceutical companies, the technical transformation of old workshops, the development of new products, the scale-up of pilot plants, production and the design of new workshops and new factories (according to GMP requirements) are facing many difficulties, and it is even more difficult to meet the needs of large-scale development.

The focus of cultivating talents should be engineering application. Therefore, in terms of personnel training and professional orientation, schools should fully consider the needs of pharmaceutical companies for talent cultivation, set up specialties in accordance with the development of the pharmaceutical industry, adjust professional orientation, and reasonably adjust the training objectives, curriculum system, teaching content,to make good service to the pharmaceutical industry. While continuing to meet market demands, the school itself can also achieve faster development and improvement. Starting from this orientation, our undergraduate education firmly grasps the meaning of “engineering application type”. Engineering problems are the final problems faced by students of pharmaceutical engineering. The main issues involved are the manufacturing, separation, preparation, process control of pharmaceuticals and quality management laws and regulations. Therefore, from the technical point of view of the project to develop personnel training program, determine the training mode and build the teaching system, while paying attention to theoretical basic knowledge, we should pay more attention to cultivating students' engineering technology capabilities, combine production, study and research, or school-enterprise cooperation, and strengthen practical training for students' engineering practices,

emphasizing the cultivation of innovation and entrepreneurship.

3. SWOT Analysis of Pharmaceutical Engineering

In order to judge the status of the pharmaceutical engineering profession more accurately, we must promptly grasp the good opportunities in the context of China's education, systematically implement education and teaching reforms, and strive to enhance the core competitiveness of pharmaceutical engineering, based on the situation analysis method that is SWOT method (Strengths, Weaknesses, Oppor -Tunities, Threats,SWOT),to make a detailed analysis of the internal and external environment and the strengths, weaknesses, opportunities, and threats of the current pharmaceutical engineering industry in China.

3.1. The Advantages of Pharmaceutical Engineering

(1) The rapid rise of China's pharmaceutical industry is a powerful driving force for the development of pharmaceutical engineering. Since the reform and opening up, China's pharmaceutical industry has developed rapidly and has gradually become one of the world's pharmaceutical powerhouses. Its total output is second only to the United States and accounts for the second largest in the world. Under such strong development momentum, there is an increasing demand for talents with diverse developments in production, management, and scientific research, which will bring vitality to the development of the pharmaceutical engineering profession. As universities play an important role in school-enterprise cooperation, pharmaceutical engineering and pharmaceutical companies achieve the goal of complementary advantages, resource sharing, and common development. The pharmaceutical engineering profession continues to innovate with the development of pharmaceutical companies and promotes the core competitiveness of pharmaceutical engineering.

(2) The construction of special disciplines is the only way to improve the core competitiveness of pharmaceutical engineering. The progress of the discipline depends on the rapid development of the profession, and the development of pharmaceutical engineering depends on the construction of the discipline of pharmaceutical engineering. The two are complementary and inseparable. With the establishment of special discipline systems and subject groups, pharmaceutical engineering majors in universities and colleges have gradually formed their own characteristics and advantages, thereby enhancing their core competitiveness.

3.2. The Disadvantages of Pharmaceutical Engineering

(1) Although there are nearly 5,000 pharmaceutical companies in China, most of them are small in scale, single in variety, and insufficient in R&D (research and development) funds. Although they can actively cooperate with universities, there are often cases of shortage of funds, disconnection between talents and R&D products, making the school-enterprise cooperation unworthy or incompetent. Pharmaceutical companies have a demand for pharmaceutical engineering talent, but they cannot afford it and cannot keep it.

(2) At present, the talents trained in pharmaceutical engineering are mostly theoretical and single-type. This is inconsistent with the purpose of employing pharmaceutical talents who understand all pharmaceutical preparations, production processes, quality management, and modern engineering techniques. As a result, the main reasons are the training programs and professional practice settings. Therefore, the teaching reform of the pharmaceutical engineering profession due to the current situation is imperative.

3.3. Steady State Optimization Control Method of Pharmaceutical Engineering Process

In the actual industrial process, the offline optimization method is an idealized method, and the originally designed conditions are most likely not optimal in the actual production. To solve such problems, we can adopt computer online steady state optimization, and system optimization with parameter estimation integration (ISOPE) is an effective solution to the object-model mismatch problem. Using a convenient and efficient derivative estimation method is crucial to the proposed steady-state optimization algorithm, The estimation method of the actual process derivative matrix is currently included: the finite difference method, For small sizes, The Noiseless case is fast and efficient, But once the environment changes or the scale is large, It will take more time consuming and have more errors; Double control optimization method, Ability to estimate the values very quickly, And do not need to change the set variables multiple times, The limitation is that the matrix must be non-singular, Therefore, the initial value is required, If a conditional number is introduced to improve the method, Most likely the need to solve a non-convex optimization problem, More difficult; The Broydon algorithm, Avoid calculating the partial derivatives, Generally it can be applicable to the estimates of the actual derivatives, But the BR matrix is relatively complex, Each update requires measuring the current output value for initialization; Dynamic Model recognition, It is an effective approximate method for estimating the derivative, Especially suitable for slow processes, It is divided into linear models and nonlinear models. These algorithms may in some cases increase the burden on ISOPE algorithms, thus reducing the convergence rate.

Assuming that the functions of all the optimization problems are continuous differentiable, generally, the steady-state optimization control problem of a real industrial process can be described as:

$$\begin{Bmatrix} \min Q(v, y) \\ s.t. y = F(v) \end{Bmatrix} \tag{1}$$

Min Q,s.t.y is the process setpoint and the actual system output respectively, F (v) represents the input-output description of the actual process, and vmax, vmin represents the lower and upper bounds of the setpoint respectively.

4. Pharmaceutical Engineering Innovation Talents Training Reform Plan

4.1. Through the Organic Combination of Various Quality Education, Improve Students' Humanistic Qualities

The cultivation of innovative talents must first cultivate students' abilities and capacity, and be good at cooperating with others. They should actively encourage students to develop healthy teamwork and practical work styles and enhance their sense of social responsibility. To this end, the college strives to combine the qualities of professionalism, innovation, humanism, psychology, communication, and management in teaching. It develops and trains its students in all aspects and establishes a more scientific quality education curriculum system. For example, the college has carried out a series of teaching researches such as research on improving the core competitiveness of pharmaceutical engineering, five minutes before class, recommendation science, quality education lectures, and research and practice on the application of case classes in drug toxicology courses. Five minutes before lectures, recommended science, one factory per lesson, and one medicine per lecture series were advanced. Let students clarify the purpose of learning, broaden their horizons, and get out of a wonderful life, so as to provide guarantees for the cultivation of highly capable and highly qualified personnel.

4.2. Improve students' Experimental Skills by Opening up Laboratories

In order to meet the goals of thick foundation, wide caliber, strong ability, high quality and wide adaptability, the College established a pharmaceutical engineering open laboratory on the basis of provincial-level school-enterprise construction engineering R&D centers and pharmaceutical engineering pilot bases. Graduation design laboratory is open to students. Before students enter the open lab, they first fill out an experiment application form (universally formulated by the college) and can enter the experiment only after approval by the college. The open lab is open to students from the third week to the fifteenth week of each semester. It is jointly managed by the project leader and the tutor. Students entering the open lab must register and read the open lab instructions before entering the lab for experimentation. After the completion of the experiment, write a standardized experimental report or research paper. Experimental projects can be basic experimental operations, scientific research and product development, focusing on cultivating innovative spirit and teamwork spirit, improving hands-on practical ability, and mastering scientific research methods.

4.3. Participate in Teacher Research Projects to Cultivate Students' Innovative Ability

The spirit of innovation refers to the ability to use the knowledge, information, skills, and methods to develop new problems and new perspectives, as well as the ability to innovate with the will, confidence, courage, and wisdom of reform and innovation. Practical ability refers to the ability to combine hands-on, brain-braining with practical knowledge in the areas of scientific research, production labor, business management, and cultural life, combining theoretical knowledge, book knowledge, and work practice. In order to cultivate applied innovative pharmaceutical engineering talents, to enable students to enter professional fields as soon as possible, and in conjunction with the Undergraduate Innovative Research Fund project issued by the Academic Affairs Office of Jiamusi University, the College actively explores scientific research training under the guidance of instructors, and provides scientific research practices opportunity for students. Students voluntarily register and use their spare time during weekends and holidays to complete research training under the guidance of their instructors.

4.4. Strengthen the Construction of Practice Bases and Personnel Innovation Training Base

Promote the combination of innovative talent cultivation and social practice to improve students' overall social quality. Taking education as the mainstay, scientific research as the support, and horizontal integration as the orientation, exploring education + certificate personnel training mode, taking the road of integration of production, education, research, and forming a school-running characteristic of cultivating innovative pharmaceutical application talents. To further improve the laboratory construction and teaching practice base transformation and the establishment of pharmaceutical engineering training base work, to build a practice-training system of learning-practice-academic trinity. Focusing on the cultivation of students' abilities in teaching, we have added teaching contents such as experimental methodologies and design studies. At the same time, we have increased the number of hours of comprehensive and design experiments and integrated the cultivation of innovation, practical and comprehensive abilities into the entire teaching process. In the junior students, we pay attention to basic skills training and production cognition practice, and strengthen comprehensive ability training among senior students. At the same time, we provide practical opportunities for students to practice training bases and strengthen the supervision of graduation design links for talent cultivation, providing guarantee for the wide adaptability of personnel training. Form a learning-practice-learning-linked,

theoretical-practice-combination-educational model that fosters application-oriented professionals with strong practical skills.

4.5Analysis of the Talent Training Model of Pharmaceutical Engineering

Table 1. Composition of the capacity

Basic capacity	Learning ability, language expression ability, information ability, etc.
Special ability	Special competence for a career: knowledge, skills, experience, and attitude
Expand capacity	Self-reflection and analysis ability, sustainable development ability and innovation ability

As is seen from Table 1, the model aims to develop learners with all the abilities required to engage in a given industry. These capabilities specifically include four aspects: knowledge, experience, attitude, and feedback. When all four aspects reach a certain standard, constitutes a "special ability", the special ability is reflected in the form of several learning modules. Several special abilities go through different combinations and constitute different "comprehensive abilities", and "professional ability" is composed of different comprehensive abilities. Emphasize the recombination and stratification of the ability.

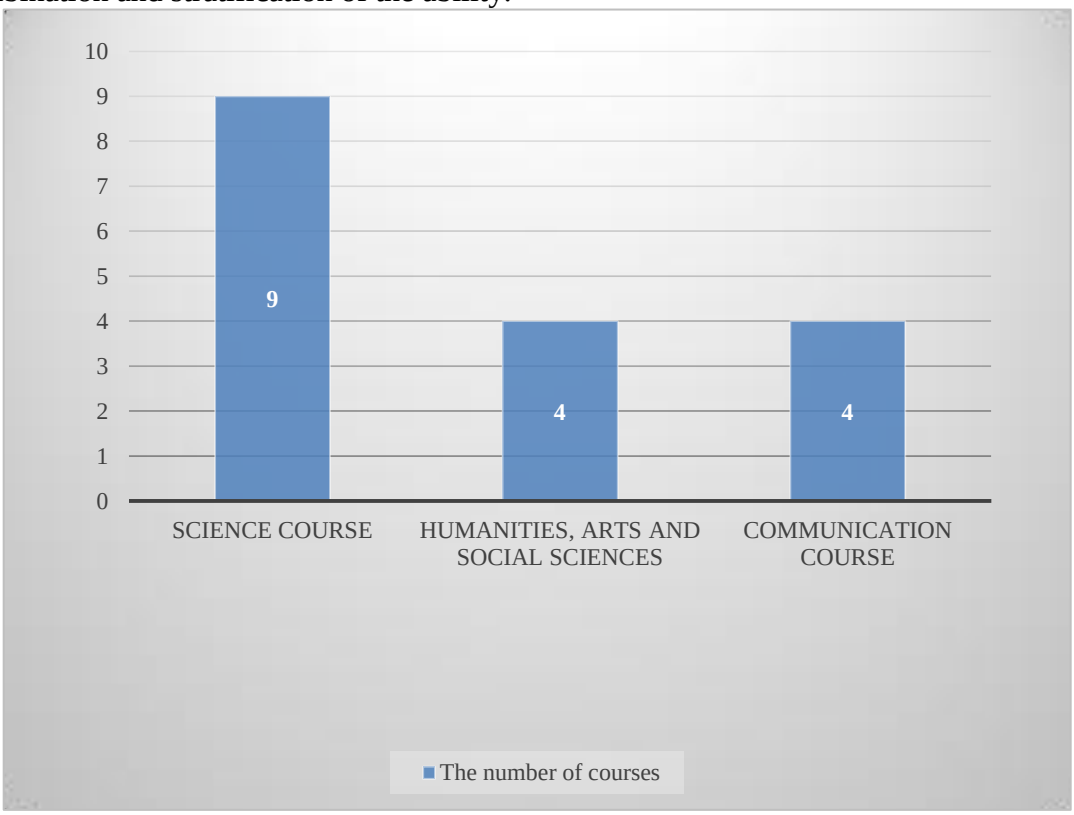

Figure 1. Number of core courses

As can be seen from Figure 1, the natural science courses have 6 basic natural science courses, 2 science and technology restricted elective courses and 1 experimental courses, which introduce the basic elements of the scientific research and academic research methods, including the foundation and skills of the experiment, mathematical analysis methods and the logical thinking mode of the experimental facts. Promote students to conduct critical learning of their own knowledge, study the

better interpretation of natural phenomena and things, and the thinking and operation methods of the better use of technology. The Humanities, Arts, and Social Sciences classes feature eight courses covering three classes of distributional, focused, and elective courses. The purpose of the course is to enable students to have a broad understanding of human society while developing language and writing skills; a systematic understanding of the knowledge of human culture, the thinking of human activities, a deeper and comprehensive understanding of society, politics and economy; and a sensitivity to the exchange of senses and self-expression. Four courses are set up to ensure that students can receive due training in cultural and sports writing, language communication and common manuscript writing in professional fields.

5. Summary

Faced with the fact that a large number of institutions of higher learning set up the pharmaceutical engineering profession, and the social and market demands for talents continue to increase, how to improve the quality of pharmaceutical engineering professionals is imminent. Through the establishment of personnel innovation training grounds, open laboratories, graduation design laboratories, and training of undergraduates with basic experimental skills and innovative training, the author finds that students can discover their potential, enhance self-confidence. In the middle of the activity, the students adopted hands-on activities and used their brains to combine book knowledge with practical experience to broaden their horizons, cultivate students' learning ability, thinking ability, practical ability and innovation ability, and achieved various aspects of their development. The goal of cultivating innovative talents in pharmaceutical engineering has been accomplished.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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