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Discussion on the Upgrading Path of Engineering Programs in Local Applied Universities for New Economy

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Abstract: *How to upgrade traditional engineering programs are the common challenges faced by Chinese universities under "Emerging Engineering Education (3E)" perspective. But there is a lack of relevant theoretical research. We choose the sample of reform practices in Beijing Institute of Petrochemical Technology (BIPT) and take a thoroughly investigation into it, hoping to find out a solution to the problems appeared in "3E" practice. Also, we are looking forward to providing some open conclusion to the construction and implementation paths of the upgrading traditional programs in Chinese local universities.*

Keywords: *Emerging Engineering Education, Program Transformation and Upgrading, Chinese local universities*

1. Introduction

Emerging Engineering Education is an important decision made by the Chinese Government to promote the training of engineering and technological talents in response to the challenges of international competition in the future[1].According to "the Fudan Consensus", the main task of local universities is to upgrade traditional engineering programs and serve the development of regional new economy[2].Compared with 985 universities, the discipline structure of local universities is relatively single and they don't have sufficient competitiveness in developing interdisciplinary. So They only hope to maintain their unique advantages in external competition by upgrading traditional engineering programs[3].But the dilemma they faced is that most of traditional programs are lack of the driving force for transformation and upgrading. And there are significant obstacles to implemented the transformation and retreat mechanism. From the perspective of theoretical research, when we searched on CNKI with the keyword "3E", most of them focuses on the discussion of new program and relatively little research on the transformation of traditional programs. This also leads to a lack of sufficient theoretical guidance and experiential reference for local applied universities to a certain extent. Overall, the upgrading of traditional programs in local universities that meet the requirements of "3E" is highly distinctive and worthy of in-depth research.

2. The Urgency of the Upgrading of Traditional Engineering Programs in Local universities

2.1 It Meets the Need for Building an Education Superpower.

Currently, China is in the process of building an education superpower, which requires universities to adjust their disciplinary structures in a timely manner to meet the needs of national construction and development. "The Fudan Consensus" clearly proposes to build a "new structure" of program that combines "3E" program and traditional engineering program[4].The Chinese Ministry Of Education has issued a document which proposed that universities should "optimize and adjust about 20% programs by 2025 and develop a batch of new programs that are suitable for new technologies, new industries, new formats, and new models". The local Applied university is a major component of undergraduate university in China. It is highly necessary for them to upgrade traditional engineering programs and enhance their ability to serve new economic development [5].

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2.2 It Meets the Need for the Upgrading of Regional Industry

The new economy in the future requires "3E" talents with strong engineering practice ability, innovation ability, ability to solve engineering application problems, and international competitiveness. They not only have profound academic knowledge in a specific discipline, but also should have the characteristics of "interdisciplinary integration"[6].Obviously, traditional engineering programs are no longer able to meet these requirements and challenges. So, there is an urgent need for local universities to upgrade their traditional engineering programs and seek new growth points in emerging education[7].

2.3 It Meets the Need for The Development of Local universities

The construction of "3E" is an important pivot for local universities' development. It provides a lever for local applied universities to enter social production centres and enhance the coupling between program chains and industrial chains. The "local" characteristics of local universities determine that they should take measures to break through the inherent boundaries between traditional engineering programs and strive to cultivate new program growth points that is more oriented towards external need.

3. The Six Types of Upgrading Modes for Traditional Engineering Programs

According to a number of statistical data, we know that most of local universities in china adopt the "Engineering+" model to upgrading traditional engineering programs [8]. They are mainly embodied in the following six ways.

3.1 Engineering + New Direction

Exploring new training directions on the basis of traditional programs is a common way of program transformation. For example, by adding new training directions that match the development trend of the new economy, such as green and low-carbon, energy conservation and environmental protection and so on, local universities can promote traditional program to shift from serving traditional industries' development to leading the forefront of future industries.

3.2 Engineering + New Concept

The second mode is encourage traditional engineering programs to expand to emerging high-tech fields such as intelligent materials, advanced energy, safety engineering, and biomedicine, etc. This will strengthen the relationship between the program chain and the industrial chain.

3.3 Engineering + New Curriculum

The third mode is encourage those advantageous engineering programs to strengthen cooperation with emerging industries aiming to increase the forefront of courses, optimize the curriculum system, and thereby improve the quality of talent cultivation for regional industrial clusters.

3.4 Engineering + New Projects

The fourth mode is integrate new technologies such as big data, the internet of things, and artificial intelligence into traditional engineering program through project-based teaching. In this way, not only their students can immerse themselves in specific engineering situations and experience specific engineering positions during their actual participation in projects, but also the universities will achieve an overall improvement in the quality of talent cultivation.

3.5 Engineering + Experimental Class

The fifth mode is to concentrate the cultivation of students from different engineering programs in the same administrative class, aiming to explore new programs through the integration and infiltration of different programs. The net result is that the original boundaries between different programs no longer exist and the new knowledge system and thinking paradigm will be built to support the construction of new programs.

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3.6 "Engineering + Industry College"

This kind of exploration is unique. It thoroughly breaks through the traditional organizational barriers of departments and transfers existing programs to industrial colleges, aiming to explore new directions and build a collaborative education community for engineer talent.

4. A Case Study on the Program Upgrading in Local universities

Beijing Institute of Petrochemical Technology (hereinafter referred to as BIPT) is one of the first pilot universities approved by Chinese Ministry of Education for the "Excellent Engineer Education and Training Program", and has been committed to building a high-level applied university with distinctive characteristics. Based on its own "local and application-oriented" educational positioning, BIPT aims to serve the development of emerging industries in Beijing. In recent years, it has closely focused on key elements such as teachers, courses, textbooks, and industrial colleges, strengthened the upgrading of existing traditional engineering programs in relevant fields such as medicine and health, new energy, and artificial intelligence, etc. BIPT has established a dynamic program adjustment mechanism for the development of regional new industries, and explored an effective implementation path for the upgrading of traditional engineering programs for regional new economic development. The characteristics of this program upgrading are mainly reflected in the "five emphasizes": emphasizing on dynamic adjustment, emphasizing on interdisciplinary intersection, emphasizing on new technological development, emphasizing on new industry demands, and emphasizing on new integration of industry and education. This is mainly achieved through expanding the development connotation of traditional engineering programs, setting up new interdisciplinary programs, revising the curriculums for undergraduate talent, opening "3E" experimental classes, strengthening co-operation with government institutions and enterprises to jointly build industrial colleges, and establishing a program quality assurance mechanism that is oriented by "standards + certification/evaluation".

4.1 Improve the Demand-Oriented Dynamic Mechanism of Program Adjustment

In order to better serve the industrial upgrading in Beijing, BIPT optimized programs based on market demand, by establishing a program warning and exit mechanism based on factors such as number of applicants, acceptance rate, graduation rate, and signing rate. According to the above assessment results, it will provide three options for programs: warning card, yellow early warning card, and red early warning card. A yellow early warning card indicates that educational quality of this program is no longer meets the needs of Beijing's economic and social development, and its enrolment plan will be reduced. A red early warning card indicates that the program will be suspended or revoked. Through this plan, BIPT has achieved the "reduction" development of non-advantageous programs, promoted the connotation transformation or proactive upgrading of traditional programs, and formed a virtuous cycle of dynamic adjustment of program structure.

4.2 Implementation Path for the Upgrading of Traditional Engineering Programs in New Economy

4.2.1 Expand the Development Connotation of Traditional Engineering Programs

Since 2017, BIPT has continuously added 14 undergraduate programs, aiming to promote the upgrading of traditional advantageous engineering programs. For example, since 2016,the "Information Management and Information Systems" program in BIPT has established a data analysis direction and offered courses such as introduction to data mining. In 2018,BIPT stopped the enrolment of the "Information Management and Information Systems" programs and added two programs: "Data Science and Big Data Technology",as well as "Big Data Management and Application".

4.2.2 Create New Programs through Cross-Disciplinary

In recent years, BIPT has independently established a number of interdisciplinary programs by promoting the intersection of "science + engineering" "engineering + engineering" and "engineering + humanity". For example, BIPT established the "Applied Statistics" program in 2017 and established the "Exhibition" program in 2020. And based on this, in 2023,BIPT proposed an "Artificial Intelligence+" interdisciplinary development Strategy to promote openness and collaboration between program clusters.

4.2.3 Revise the Training Plan of Engineering Talents

In order to promote the cultivation of "3E" talents, in 2023,BIPT revised the undergraduate talent training plan and deeply optimized the curriculum system, aiming to make it closer to the forefront of technology, with cross disciplinary characteristics, and emphasize on the cultivation of practical

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engineering abilities. Firstly, BIPT required the inclusion of the "WuYu" into the talent training. Secondly, it required to fully integrate ideological elements into the curriculum. Thirdly, BIPT clearly required to integrate industry elements into curriculum and highlight "new knowledge, new technologies, new processes, new cases, and new processes" in educational process. Fourthly, BIPT required to integrate green and low-carbon education into various courses, and construct a multi-integrated characteristic practice system such as "profession + xx practice" or "innovation and entrepreneurship+ xx practice". In 2023, BIPT added a total of 73 general education elective courses and 83 professional elective courses, including "artificial intelligence+""+security emergency" and "green and low carbon".

4.2.4 Establish "3E" Experimental Classes

BIPT established the "ZhiYuan '3E' Experimental Class" in 2023.This class enrolled candidates from disciplines such as Chemistry and Medicine, materials, mechanical, and computer science, as well as artificial intelligence. It aimed to explore an excellent engineering talent training model that meets the needs of industrial development in Beijing by integrating traditional professional knowledge with artificial intelligence technology. In order to further promote this reform, BIPT encouraged teachers to break down disciplinary barriers and strengthen cross-college co-construction of courses in three ways:1) establishing interdisciplinary teaching teams;2) sharing teacher resources across colleges; 3) sharing course resources across colleges. It has also formed a cross team which is constitute of 18 teachers from 8 teaching units and 12 programs. Through the collective preparation of this interdisciplinary course group, they have fully tapped into the ideological resources in professional courses and developed a series of courses, such as "Exploring Beijing" "School History, Culture and Professional Education", "Information Technology" "Safety Emergency Management" and "Dual Carbon".These have formed a rich and distinctive course resource repository for student in BIPT.

4.2.5 Co-Construct Industrial College by University-Government-Enterprise

In order to make its talent cultivation more suitable for regional development needs, BIPT has changed its previous model of cultivating talents within its walls by breaking through the barriers between industry and education and fully placed its talent cultivation within the framework of government- university- enterprise co-operation. For example, its School of Safety Engineering closely cooperates with the emergency management bureau to jointly build the "Modern Industry College of Safety and Emergency", and cultivate emergency talents urgently needed for emergency management in Beijing. Its School of New Materials and Chemical Engineering has signed a strategic cooperation agreement with the Daxing District Government to establish the "Biomedical and Health Industry College", which aims to cultivate talents meet the needs of regional biopharmaceutical and health industrial development. Its School of Information Engineering has jointly established the "Huike Big Data Industry College" with "Huike Education Group" and "Alibaba Cloud" to serve the development needs of information industry in Beijing. And its School of Economics and Management, along with Beicai Education Group and the Beijing E-Commerce Centre Construction Office, jointly established the "E-Commerce Industry College".

4.2.6 Establish a Quality Assurance Mechanism Based on "Standards + Certification/Evaluation"

Due to reasons such as path dependence and fixed interests, the upgrading of traditional engineering programs is very slow and difficult. BIPT has established a quality assurance mechanism with "standard+ certification/evaluation" empower program upgrading. BIPT has conducted twice rounds of internal evaluations for all undergraduate programs since 2014 and taken the lead in exploring the "standard+ certification/evaluation" model to promote program upgrading. On this basis, BIPT adopted different evaluation methods for the development of different stages of program construction, and established a comprehensive and closed-loop undergraduate program evaluation system. For example, it carried out expert evaluation for newly established program to improve the program admission mechanism. It established a "Six-In-One" classroom teaching evaluation system that included student evaluation, instructional supervision, peer evaluation, expert evaluation, and management cadre evaluation for improving classroom teaching quality. In order to assess the compatibility between its training quality and social needs, it will entrust Michael's Company to evaluate the quality of undergraduate cultivation when students graduated from BIPT. And when students graduated from BIPT for four years, it will entrust Michael's Company to conduct follow-up evaluations on students to assess their professional competence and the employer's satisfaction. When a program has three batches of undergraduate graduates, BIPT will conducts an internal evaluation to assess the level of professional education by itself. BIPT also takes teaching basic status data and higher education basic status data as the starting point to build a regular monitoring database for program construction. By designing a comprehensive evaluation mechanism for programs throughout the entire cycle, BIPT aims to guide programs to focus on application-oriented connotation construction and optimize its program's structure.

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5. Reform Effectiveness and Conclusions

5.1 Program Construction Achievements

The construction of the "3E" program in BIPT has achieved results. Since 2013,it has added 15 programs, suspended 13 programs and revoked 1 program. At present, it has 7 programs that have passed the national engineering education program certification, 8 national first-class undergraduate program construction sites, 3 Beijing key first-class programs, and 13 Beijing first-class undergraduate program construction sites. BIPT's program structure has been greatly optimized and successfully achieved upgrade.

5.2 Quality of Talent Cultivation

BIPT has achieved remarkable results in cultivating applied talents.The employment rate of its undergraduate graduates remains high,with 98.68% in 2019,90.69% in 2020,and 95.74% in 2021.A third-party survey shows the monthly income of graduates from BIPT was 852 yuan in 2017, 999 yuan in 2018, and 1015 yuan in 2019.After graduated for four years,the monthly income of graduates from BIPT was 3084-yuan in2014,3097-yuan in 2015,and 3932-yuan in 2016.This means it has achieved precise two-way docking between the development of programs and industries.

5.3 Regional Service Capabilities

Through the deep integration of industry and education, BIPT has effectively solved some key technical problems faced by enterprises in the region and continuously improved its contribution to serving the upgrading of high-precision and cutting-edge industries in Beijing. Its achievements have received attention from their counterparts and local government departments. The China Education Daily reported in depth on the innovative model of talent cultivation in the field of safety engineering in BIPT, which was titled "local demand points are the growth points of universities".The Beijing Daily, titled "closely meeting the needs of the capital and realizing the development of university characteristics", extensively reported on the development path of the safety engineering program in BIPT.

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