

Research on the capacity of teacher in applied undergraduate education from the perspective of integration between industry and education

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Abstract: In the pursuit of China's ambitious social and economic restructuring, the development of a proficient workforce demands a substantial pool of skilled professionals. A promising avenue to achieve this goal is by harnessing the potential of teachers from applied undergraduate education (AUE) colleges who possess dual abilities. This study critically analyzes the current state of AUE teacher team construction by exploring three dimensions: policy support, case analysis, and model summary adopted qualitative research methods. Through this research, pertinent issues in the existing process of building an AUE teacher team have been identified, with a particular focus on challenges related to abilities, industry-education cooperation, evaluation systems, and innovation. The research identifies issues in the current process of building an AUE teacher team related to abilities, industry-education cooperation, evaluation systems, and innovation. Solutions to these problems like improve training mechanism, deepen industry-education Cooperation, establish a comprehensive evaluation system, and promoting interdisciplinary collaboration and comprehensive quality education are also proposed. By nurturing an adept AUE teacher team, the country can bolster its prospects of sustainable growth, innovation, and socio-economic prosperity.

1. Introduction

China is currently undergoing a crucial phase of economic restructuring and social development, which demands a significant number of skilled individuals with practical abilities and innovative thinking. However, a certain gap exists between the traditional education system and the needs of the industry, leading to an incongruity between graduates' capabilities and demands. In recent years, the government has recognized that integrating industry with education did play an important role in cultivating applied talents and promoting industrial upgrading. Consequently, it has issued several policies to support this development. In 2010, "The National Medium- and Long-Term Education Reform and Development Plan (2010-2020)" emphasized the importance of integrating industry with education. The plan clarified the positioning for applied talents, encouraged cooperation

between colleges and industries, strengthened practical teaching as well as internship programs. In 2015, "Opinions on Deepening Innovation Entrepreneurship Education Reform to Promote Double Creation Demonstration Base in China" clearly defined overall requirements for deepening this reform along with specific tasks. These included strengthening college-enterprise cooperation, establishing joint training mechanisms, and promoting deep integration among production-study-research sectors. In 2017, "Several Opinions on Deepening Industry-Education Integration" was officially issued which clarified policy connotations as well as institutional frameworks for deepening industry-education integration. This document extended such integration from vocational education to higher education making it a national strategy. As a result of these new moves towards application-oriented transformation driving colleges to meet economic-social developmental needs and provided strong support.

Scholars have analyzed the construction of AUE teacher teams from different perspectives such as teacher training, teaching abilities, cooperation and evaluation ^[1]. 1) Teacher Training. Liu focuses on issues related to individual teacher development, including training, career advancement, and professional competence to enhance the overall quality of teaching staff ^[2]. Xu believes that rapidly improving the "dual-capacity" of teachers is crucial for AUE colleges' transformation and talent cultivation ^[3]. Chen suggests building a "dual-teacher" team in AUE colleges by strengthening training, communication, management, systems and incentive mechanisms ^[4]. Billett advocates for greater support and promotion of applied education by educational institutions and policymakers ^[5]. 2) Teaching abilities. Researchers are exploring teaching methods and strategies that are suitable for applied undergraduate education. These include project-based teaching and practice-oriented teaching, which aim to enhance students' practical abilities ^[6-7]. Zhu focuses on interdisciplinary and cross-disciplinary education to cultivate applied talents with comprehensive abilities and interdisciplinary literacy ^[8]. Wang explores the implementation of interdisciplinary education to develop students' comprehensive abilities and problem-solving skills ^[9]. Wang and Zhong focus on practice-oriented teaching methods, emphasizing the combination of theory and practice to improve students' practical ability ^[10]. 3) Cooperation. Zhang attaches great importance to the close cooperation between education and industry, and enhances students' vocational abilities through college-enterprise cooperation projects and practical teaching activities ^[11]. Que believes that the key to high-quality development of applied undergraduate education lies in building a platform for the coordinated development of industry, academia, and research ^[12]. 4) Evaluation. Chen analyzed the assessment system for teachers in 30 applied undergraduate colleges and identified issues with overemphasizing quantitative standards, weak connections to teaching, and insufficient application research ^[13]. According to Ying, the development of application research and social service capabilities should be an important indicator for evaluating young teachers' innovative abilities ^[14]. Du studied data and case from surveys on the development of over 300 AUE college teachers. The findings revealed a lack of definition and evaluation criteria for teacher practical abilities, indicating a need for reforming teacher evaluation systems ^[15].

In summary, although some progress has been made, there are still limitations in the research. Specifically: 1) There is a lack of empirical research. The existing studies rely on literature reviews and theoretical discussions without support from empirical research and practical cases. Therefore, the reliability and practicality of conclusions need further verification. 2) Regional specificities exist due to the differences in backgrounds and development stages among regions. As a result, the above research results may have limitations for other regions. 3) Some studies use simple methods for data collection and analysis deliberation without detailed explanations or arguments which may affect their reliability and persuasiveness. Therefore, empirical research, a broadened perspective, and the adoption of multiple methods are necessary to thoroughly investigate issues in constructing AUE teaching team.

Constructing a team for applied undergraduate education (AUE) has become crucial in the current context. However, these teams are facing several issues: Firstly, some colleges have a significant gap between their teachers and the requirements of AUE's positioning and talent training. Secondly, some colleges are slow to promote the transformation of their teachers' knowledge, abilities, and qualities. Thirdly, due to rigid personnel management systems, single channels for teacher recruitment, and outdated evaluation systems, AUE colleges also face difficulties. In fact, currently teachers have become a shortcoming in the development of high-level AUE colleges constructing and have some difficulties in cultivating high-quality applied talents. Strengthening the construction of an AUE teaching team is crucial to meet the needs of industrial development and cultivate applied talents. In light of industry-education integration, this study aims to explore effective ways to build an AUE teaching team that can respond to the demands of AUE. By analyzing existing policies, models, and practical cases while summarizing current issues, this study provides valuable references for promoting the development of an AUE teaching team which help to catalyze the development of a competent workforce that aligns with the evolving needs of China's restructuring goals.

2. Basic Requirements for AUE Teachers

The teachers in AUE colleges differs from that of other universities due to subject characteristics, teaching objectives, practical experience, school-enterprise cooperation, teaching methods and career orientation. Teachers in AUE colleges usually specialize in professional fields related to specific industries and professions such as engineering, medicine and business. Therefore, the teachers need to combine theoretical knowledge with practical application to help students apply what they have learned to actual work. AUE colleges also require their teachers to possess certain practical experience and provide guidance on problem-solving through real cases. To cultivate talents who can solve problems in real scenarios, these colleges focus more on scenario applications in teaching content and methods. Additionally, closer cooperation with relevant industries is necessary for understanding the latest developments and demands of the industry so as to provide students with practical opportunities and employment guidance. Educational approaches such as case analysis, experimental operation, and project practice are also essential for cultivating talent at AUE colleges. Furthermore, vocational literacy, ethics, and skills are emphasized by these institutions so that students can adapt well into workplace and qualified well for society and industry.

3. Current Situation of AUE Teachers from the Perspective of Industry-education Integration

3.1. Policy support

With the rise of higher education, local AUE colleges have become a crucial component of China's higher education system. These institutions aim to cultivate applied talents and serve their communities, making their teaching unique. In recent years, China has implemented policies to enhance teachers' practical abilities. The "Twelfth Five-Year Plan for National Education Development" proposed in 2012 to "promote cooperation between universities and enterprises and strengthen practical training for teachers," which began focusing on training issues. In 2015, the Ministry of Education, the National Development and Reform Commission, the Ministry of Finance jointly issued the "Guiding Opinions on Some Local Colleges to Transform into Application-Oriented Ones." This document clearly required strengthening the construction of a "dual-teacher" team by selecting teachers to train in enterprises; enhancing teachers' initiative through reforms such as teaching evaluation, performance assessment, title promotion, salary

incentives; and promoting school-enterprise exchanges. In February 2019, the State Council released its "Implementation Plan for National Vocational Education Reform" (also known as "Vocational Education 20"), further emphasizing that teachers from AUE colleges should have experience in enterprises while improving their practical abilities. To support this goal, policies such as enterprise rotation training programs were put in place.

3.2. Case study

Chinese colleges have been actively implementing strategies to build AUE teacher teams. Through partnerships with enterprises, the invitation of enterprise mentors, and other methods, these colleges have effectively enhanced the practical skills. This has led to a better integration between education and industrial needs while also cultivating applied talents that meet social requirements. As a result, these institutions have successfully cultivated graduates who are well-equipped to meet the demands of society, providing support for students' career and promoting social innovation.

3.2.1. College-industry cooperation

1) Nanjing Vocational University of Industry Technology

Nanjing Vocational University of Industry Technology is China's first public undergraduate vocational university, offering 23 vocational undergraduate majors and 46 specialized associate degree programs with a focus on equipment manufacturing industries. The professional cluster includes general equipment technology, special equipment technology, industrial internet technology, and manufacturing equipment design, management services, trade circulation. The school combines education with industry by exploring talent training models that integrate industry and education through college-enterprise cooperation. The "dual-teacher classroom" teaching model is frequently used at here. This model combines practical operation guidance from enterprise staff with theoretical explanations from university to improve students' practical operation ability while strengthening their mastery of theoretical knowledge. Through implementing the "Training Program" for teacher, the school continuously strengthens its connection with regional industries. An expert database consisting of industry professors and technicians has been established for program making, discipline construction, textbook compiling and evaluation to achieve multi-party throughout. Relying on its co-built platform of integration of industry-education for cultivating talents, Nanjing Vocational University of Industry Technology regards both university and enterprises as main bodies for cultivating talents, and effectively facilitated connection between talent cultivation and enterprise needs. This mode not only enhances students' job adaptability but also promotes two-way interaction communication between university and enterprises. Finally, a team with teaching skills and research productivity has been formed based on this mode.

2) Ningbo Polytechnic

Ningbo Polytechnic is actively establishing professional groups that are focused on industrial development. The school has collaborated with industry enterprises to establish 11 "Master Workshops". Additionally, it has created several industry colleges such as the "Digital College," "Cross-border Supply Chain Industry College," "Haitian Intelligent Equipment Industry College," and "Bodi Film and Television Industry College". To strengthen the supply of high-quality human resources in Ningbo, the college collaborates with large-scale enterprises like Haitian Group, Geely Automobile, Ningbo Zhoushan Port, China Paper Corporation to carry out continuing education and on-the-job skills training projects. Furthermore, it partners with Haitian Plastics Machinery Group - Asia's largest injection molding machine production base - to jointly build the "Haitian Vocational Skills Training School." This collaboration between schools and enterprises aims at cultivating

talents in manufacturing. As part of the collaborative education process between schools and enterprises, the college encourages teachers to conduct in-depth "research on production lines" with enterprises. This approach helps solve key industry problems and building a teaching team that excels at educating and research. For instance, the School of Chemical Engineering has transformed enterprise technology innovation projects into teaching and developed a training mode. By working together to develop essential professional courses, establishing advanced practical training facilities, and sharing educational resources, the college have successfully realized the integration of talents and resources.

3.2.2. Talent Introduction

1) Shenzhen Technology University

Shenzhen Technology University has established close partnerships with prominent local enterprises, leveraging the industrial advantages of Shenzhen. The university integrates its teachers into corporate practice through joint training programs, internship bases, and other methods to enhance their practical skills. Currently, there are over 200 full-time teachers at the university; approximately 65.1% of them have overseas study or work experience while 40% have taught or conducted research at renowned universities both domestically and internationally such as Technical University of Munich in Germany, Berlin Institute of Technology, Augsburg University of Applied Sciences, Alan University of Applied Sciences and Nanyang Technological University in Singapore. More than 20 German professors have been introduced as consultants and visiting professors to improve the school's discipline construction and talent training program. A significant proportion (up to 65.1%) of full-time teachers possess enterprise or industry-related backgrounds. Moreover, about half of newly recruited teachers hold senior executive or engineering technician positions for over five years in enterprises or related fields. Additionally, the university has hired more than forty technical directors and R&D elites from well-known companies such as Huawei Technologies Co., Ltd., Han's Laser Technology Industry Group Co., Ltd., DJI Innovations Co., Ltd., ZTE Corporation Shenzhen Metro Group Co., Ltd. and China General Nuclear Power Corporation as full-time teachers.

2) Shanghai Institute of Technology

Shanghai Institute of Technology employs various methods to attract exceptional talent from both domestic and international. These methods include online and offline job fairs, high-end forums for industry-education integration, a mechanism for communication between industry elites and school teachers, and direct recruitment channels. The university has introduced personnel management systems such as high-level talent introduction methods, flexible introduction management regulations, distinguished researcher appointment methods. The university also implements a talent strategy to optimize its teaching staff structure. These measures provide human resources support towards building Shanghai Institute of Technology into a better university.

3.2.3. Platform for Talent Growth

1) Tianjin Vocational Institute

Tianjin Vocational Institute is actively building a platform for the growth of skilled talents. In 2019, they formulated "Trial Measures for Training Instructors at Tianjin Vocational Institute" specifically for practical training instructors. This included setting specific position and emphasizing skills. To highlight the characteristics of technical talent, technical skill are deemed to much important than papers and research projects. Green channels have been opened to hire skilled teachers such as technical experts or winners of technical competitions. After years of training and recruiting national-level technical experts, significant progress has been achieved in building a team

that embodies the spirit of craftsmen while passing down their skills to students; this has created an excellent atmosphere that values skills. Currently, several expert-type talents such as skillful masters, national-level craftsmen and technical experts are being added to the school's dual-teacher team. Many teachers have also received titles as highly-skilled.

2) Tianjin University of Technology and Education

Tianjin University of Technology and Education has implemented a "dual-teacher" training program for vocational school teachers who want have PHD degree. This program began enrolling students in 2013. The objective is to recruit in-service teachers with master's degrees in engineering and establish a "4+3" talent cultivation model that integrates content from both engineering and educations. The term "4+3" refers to three types of supervisors - supervisors from academic, vocational college and enterprise, as well as three types of bases: on-campus bases, enterprise bases, and vocational college bases. Additionally, there are three types of practices: engineering practice, teaching practice, and innovation practice. Finally, there are three combinations that include professional knowledge with training skills; technical innovation with engineering design; experience form workplace with theoretical research. Graduates often become leading figures in vocational colleges due to their outstanding talents developed through this interdisciplinary training system.

3.3. Model

There are several models for constructing AUE teaching team. The industry-oriented model emphasizes integrating industrial demand with teaching content to cultivate applied talents that meet industry requirements. Teachers must understand the development of industry and technological, and integrate cases and project experience into their teachings. The practice-oriented model focuses on cultivating students' practical abilities and application skills, requiring a teacher with rich experience who can guide students in participating in actual projects, internships, and training programs to enhance their practical abilities. In the expert-oriented model, the experts from industry who is most needed by the college that can combining actual industry experience with teaching. Meanwhile, the international cooperation model encourages collaboration with outstanding foreign educational institutions while introducing resources and advanced educational concepts. Therefore, it is necessary for AUE colleges to strengthen teacher team and improve their adaptability to various types of models.

4. Discussion

Although some progress has been made in building AUE teacher teams, there are still areas that require improvement.

4.1. Inconsistent Teacher Abilities

Since AUE colleges have expanded rapidly, resulting in an increase in the number of teachers, the proportion of "Dual-teacher" has also risen. However, there is a significant difference among them. Although young full-time graduates who enter colleges possess solid theoretical literacy, professional knowledge, and certain practical skills, they often lack innovative teaching abilities due to their limited work experience. On the other hand, older teachers may have longer and rich practical or entrepreneurial experience but lack academic qualifications and professional knowledge reserves. This limitation inevitably restricts students' mastery of knowledge and skills.

4.2. Limited Cooperation between Industry-education

Although many schools have established partnerships with enterprises, there are still a need to strengthen the depth and breadth of such cooperation. It is important to build closer connections between teachers and enterprises, and expand opportunities for project collaboration. This will ensure that teachers' practical experience can match the latest industry demands.

4.3. Insufficient Evaluation System

AUE colleges face a "roadblock" in transformation, that is, the contradiction between the teacher system based on academic qualifications and the practical-oriented talent training mode. AUE colleges that focus on practical applications face a significant obstacle in their transformation process. This challenge arises from the conflict between the teacher system, which is based on academic qualifications, and the practical-oriented talent training mode. Many teachers are trained by traditional academic universities and are out of touch with industry needs. Relying solely on academic achievements and teaching evaluations as primary indicators but overlooks contributions made in areas such as practical teaching, industry cooperation, and innovation capabilities. It is crucial to establish a more comprehensive, scientific, and flexible evaluation system for AUE teacher that encourages active participation and contribution to AUE.

4.4. Inadequate in Innovation

The main objective of AUE colleges is to improve students' practical abilities, innovation and skills. To achieve this goal, it is essential to integrate professional development with the students. This can be done by reforming and innovating traditional teaching methods so that students can acquire relevant skills comprehensively. However, limited by educational concepts, inadequate teaching facilities, and proper teaching practice bases, some teachers in AUE colleges have difficult to implement innovative and reformative teaching methods which ultimately affect the practical outcomes for students.

5. Recommendation

To address the issues and deficiencies in building AUE teacher team, colleges must prioritize long-term plan and meet the needs to cultivate applied talents. AUE colleges should take charge of overall planning for teacher development which includes providing career planning, indicating directions and paths, and guiding teachers to achieve mutually beneficial outcomes.

5.1. Improve Training Mechanism

It is important to establish a teacher training mechanism that focuses on the career development of teachers. This can be achieved by providing more opportunities for industry training and internships, which will enhance the cultivation of teachers' practical experience and skills. When collaborating with enterprises for the first time, forms such as "part-time teaching," "enterprise mentorship," "resident engineer," or "guest lecturer" are encouraged to hire engineering experts to participate in teaching. To truly motivate technicians, flexible and innovative employment mechanisms are necessary. For external recruitment of technicians-especially those who are scarce in emerging majors - personalized employment agreements are necessary to formulate. In addition to ensuring policies and funding guarantees for technicians, individual demands should also be fully considered so that they can find their own development space while serving colleges and talent

cultivation. Preferential policies such as priority access to academic qualifications upgrading or major scientific research project applications can be provided. Technical experts from enterprises can be hired as teachers but maintain their styles, thinking habits, and action modes. At the same time, AUE colleges need to implement and expand their autonomy over employment decisions.

5.2. Deepen industry-education Cooperation

It is important to establish a long-term stable cooperative mechanism that integrates industry, academia, and research. This can be achieved by carrying out project cooperation that ensures teachers' practical experience is closely connected with industry needs. The integration of industry and education often leads to the creation of various forms of practical platforms such as studios, engineering technology R&D centers, collaborative innovation centers, industry colleges. These platforms integrate talent cultivation, scientific research, technological innovation, achievement transformation and social services into one entity while gathering high-quality resources from all parties involved. These provide an excellent training platform for AUE teachers, who should work in these platforms with dual identities as "teachers + engineers" while serving talent cultivation, technological innovation and industrial transformation upgrading. Platforms set up within colleges can serve all teachers in relevant majors; those platforms outside colleges can invite visiting engineers each year to work together while clarifying the requirements so that to improve their practical abilities through specific real processes.

5.3. Establish a Comprehensive Evaluation System

Teacher evaluation is a crucial tool for guiding and directing the development of teachers. Its primary function is to promote effective teaching, scientific research, social services, and other abilities through comprehensive evaluation. In designing and formulating teacher evaluation systems for AUE colleges, it is essential to reflect their "applied" orientation by highlighting multiple elements such as the effectiveness of talent cultivation, application-oriented research feeding back into teaching, transformation of scientific research achievements and research ability.

To ensure objectivity in evaluators' subjectivity, it is important to introduce multi-subjects when conducting evaluations. Each has its own emphasis when formulating evaluation standards jointly with industry enterprises or other government functional departments. Colleges focus on talent cultivation, educational reform innovation as well as the commercialization of research findings while industry enterprises even other government functional departments emphasize service for industry enterprises or local economic. An integrated assessment standard for teachers in AUE college based on establishing effective competition incentive mechanisms that construct a mechanism environment where "rewarding excellence while punishing laziness" applies.

5.4. Promoting Interdisciplinary Collaboration and Comprehensive Quality Education

Establishing teaching models to promote interdisciplinary collaboration and enhance the quality of education is necessary for teacher's career. This includes encouraging teachers to engage in interdisciplinary cooperation and building teams. According to teaching skills, research capabilities, practical skills, and innovation etc., a modular approach can be set up to provide targeted training. Different training programs can be conducted for different types of teachers, for example the teachers who are in academic-oriented, technical services and innovation supports might needed.

6. Conclusion

Skilled teachers from AUE colleges play a vital role in China's social and economic restructuring. This study identifies challenges in building the AUE teacher team, including abilities, industry-education cooperation, evaluation systems, and innovation. Proposed solutions involve improving training, deepening cooperation, establishing evaluation systems, and promoting interdisciplinary education. Nurturing an adept AUE teacher team will bolster sustainable growth, innovation, and socio-economic prosperity.

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