Methods and practice of graduate education system with the integration of scientific research and education

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ABSTRACT

The integration of scientific research and education is to blend harmoniously two missions of knowledge innovation and talents training, to link closely two tasks of new knowledge discovery and cultural inheritance, and to unify effectively two working modes of science and education. This is of great significance not only to improve teaching quality, but also to cultivate high-end innovative talents. School of Electronic, Electrical and Communication Engineering (SEECE) at University of Chinese Academy of Sciences (UCAS) appropriately implements the strategy to combine research and education among graduate education and teaching. It explores the teaching system characteristics of the integration of scientific research and education from all aspects of curriculum system, teaching staff, teaching quality and teaching administration, to further optimize the curriculum system, to effectively guarantee the teaching quality, and to standardize the teaching management. All these offer profitable references for relevant theoretical research and innovative talents training.

Keywords: integration of scientific research and education; teaching quality; curriculum system; teaching staff; teaching supervision

With the development of society and economy and the advancement of the country's modernization, higher education has put forward new requirements on talents training, making the quality of higher education a world-wide concern. Since the 21st century, Chinese society, economy, and higher education have developed at a fast pace, and the quality problem has been made more prominent. The Compendium of the National Mid-Term and Long-Term Education Reform & Development Project (2010-2020) also points out that the task of higher education development is to lay emphasis on improving the overall quality. In order to step up from a large higher education country to a strong one, it is important to constantly improve the quality of teaching and education. One of the criteria to evaluate the quality of both education and talents training of a university, teaching quality has become the core issue of our country's higher educational institutions and the quality of talents training. It is the social focus but also a difficult part of deepening the reform of higher education.

Scientific research and education are two sides of an entity of a first-class university. The School of Electronic, Electrical and Communication Engineering (SEECE) at University of Chinese Academy of Sciences (UCAS), through the integration of scientific research and education, effectively transforms its own unique advantages of knowledge innovation into the cultivating innovative talents. The SEECE actively explores the teaching system and talents training modes with the characteristics of integrating research and education in order to foster the leading scientific and technological talents with both virtues and knowledge, in pursuit of scientific dreams, dedicated to scientific career and aspired to serve the country, in addition, excellent contributions to be made to our innovative country and the development and progress of human civilizations. This is a positive attempt to achieve the connotative development of higher education.

1. Necessity of Initiating the Teaching System of the Integration of Scientific Research and Education

1.1 Theoretical Support of Talents Training of the Integration of Scientific Research and Education

The rational emphasis on scientific research and implementing the unity of research and education, as the cornerstone of modern university development, has permeated into all aspects of the systems of modern universities. Currently the pattern of training talents in our higher education values imparting knowledge and skills, relies heavily on old ways of classroom teaching, therefore it neglects the most important matter of scientific research in education. The integration of scientific research and education is determined by the nature of scientific research. The educability of scientific research is primarily manifested in cultivating scientific methods, innovative thinking and exploring spirit to improve the talents' abilities to discover and solve problems in the process of talents training. Improving the overall higher education quality becomes involved in improving the contribution of scientific research to talents training and transforming the advantages of scientific research into the talents cultivating, thus good quality higher education with high standard of scientific research becomes an unavoidable yet must-be-addressed significant problem. Conducting the construction of teaching system of the integration of scientific research and education, automating teachers' educating way of scientific research, stimulating the postgraduates' interest and initiative to participate in scientific research and promoting collaborative innovation of educating with teaching and scientific research are the

necessary ways to explore the combined pattern of the integration of scientific research and education.

1.2 Practical Needs of Improving Quality of Education

The UCAS is an educational institution focusing on graduate education. It has always been the pathfinder of the modern university rationale and mode of integration of scientific research and education. When it was initialized as a university in 2012, it established its concepts of "integration of scientific research and education, essence of educating people, collaborative innovation, and service to the country". The UCAS is closely in line with management system, staff team, cultivating system, and scientific research of more than 100 research institutions affiliated with Chinese Academy of Sciences, dedicated to rise as a world-class higher educational institution with Chinese characteristics.

In this background, the integration of scientific research and education in SEECE is sponsored by the Institute of Electronics, co-founded by 12 institutes including the Institute of Acoustics, the Institute of Electrical Engineering, etc. It has three first-class disciplines including Information and Communication Engineering, and Electronic Science & Technology and Electrical Engineering, educating and teaching 3,300 graduates under 57 cultivating units. Every year more than 600 new graduates are distributed in 26 research institutions in different regions of the country, facing difficulties and challenges as the following: more cultivating institutions, broad professional directions, lack of cutting-edge curriculum system, needs of teaching incentive mechanism for high-level scientific research personnel and unparalleled teaching proficiencies, which impedes the quality of cultivating graduates. With the strategy of integration of scientific research and education, how to format the curriculum scientifically and rationally, how to build a high-level teachers' team and how to improve the in-class teaching effect are the conditions to improve the graduates teaching quality.

2. Characteristics of Graduate Teaching System with the Strategy of the Integration of Scientific Research and Education

2.1 Persisting in Moral Education and Strengthening Value Guidance of Serving Country with Science and Technology

Scientific research itself is a highly effective and very persuasive form of teaching. Education via scientific research is to educate with conceptions, under the contexts and in the process. Education in the scientific research should play its full role, and gradually the teaching mode is established by linking the curriculum with scientific research. By means of organizing the graduates to visit the research institutions, to converse with the outstanding scientific and technological personnel, they are encouraged to employ the advanced devices and the resources of key state laboratories and the key provincial and ministerial laboratories and the engineering centers to stimulate their interests in scientific research, and further to promote their initiatives and enthusiasms for learning, to develop their scientific research exploration spirit and innovative thinking. In addition, in view of the phenomenon of some current graduates' unclear aims, lack of integrity and the hard working spirit, the activities of making lectures on national defense education by academicians, goodwill tree planting and "three samenesses" social practice, graduates eat, live and work together, are held to cultivate the graduates' deep

patriotism, to strengthen their social responsibilities and to root the holdfast belief in struggling to realize the Chinese dream.

2.2 Constructing Curriculum System with Characteristics of the Integration of Scientific Research and Education

Constructing curriculum system is the basis for the construction of graduate teaching system. Scientific and rational curriculum system is the foundation for improving teaching quality and talents training quality. The curriculum system of the integration of scientific research and education has the adherence to cultivate graduates and program development as the point of departure, the classes are designed according to the professional needs, and the curriculum organization and classroom teaching follow closely the leading field of scientific and technological development.

The curriculum reflects the development of current situations and the future tendency of the relevant fields, guiding the graduates to start their scientific research work in the world of science and technology. With the reference to the graduates' curriculum system of the same discipline, attention is to be paid to core curriculum construction, and the practicality and leadership of curriculum contents are constantly enhanced. Professional core courses are the necessary route for graduates to master systematically the holistic knowledge system, theoretical framework, development history and current situations of this discipline. It is the required course for this subject. With the integration of scientific research and education as the entry point and by organizing the distinguished scientific and technical personnel and staff such as academicians, the outstanding young, major project leaders for curriculum construction symposium, the core professional courses are added from top to bottom, and the difficulty extent and depth degree of the existing core courses are increased. As a result, hundreds of holistic and scientific specialized curriculum system comes into shape, laying a solid foundation for the graduates to carry out scientific research and bring up the core competitive power. In the meanwhile, the original curriculum system is combed one by one to greatly improve more than 90% curriculum quality by optimizing and eliminating the similarly repeated courses and those courses whose teaching contents are sub-standard. On the other hand, the practical teaching part is increased. The laboratory conditions are created for graduates to initiate engineering development and technical practice by making use of advantageous scientific research devices. This effectively solved the problem of disconnection between teaching and research, achieving the seamless connection between education and scientific research, which plays an important role in developing postgraduates' practical and innovative capabilities.

Scientific research has always been concerned about the latest cutting-edge fields. Plenty of flexible topics, knowledge- intensive, 8-10 credit hour courses are newly set up through integration of science and education. Such courses can blend continuously the latest scientific research findings into the courses content, providing new ideas, new materials and new methods and improving regularly the curriculum quality and increasing its level, enabling the postgraduates to acquire the newest technological innovative conceptions, ideas and fruits, which stimulate their curiosity and interest in active studying, also enabling them to understand better application of the theoretical knowledge.

2.3 Constructing a Staff Team Characteristic of Integration of Scientific Research and Education

The team of teachers is essential for the construction of the teaching system. The teachers' professional proficiency, teaching level and their willingness are important factors to determine the teaching quality. The UCAS has adopted the teaching posts employment system with the purpose to attract academicians who excel in their work and have dedication and put the mother country in their hearts. Zhongli Ding, president of the UCAS, has put forward that turning the knowledge creators into knowledge disseminators can actually improve the teaching quality, can foster the students' scientific spirits and innovative consciousness, and making them new knowledge creators.

2.3.1 Establishing the Mechanism of Integration of Scientific Research and Education, Attracting Outstanding Research Institutes Staff onto the Teaching Platform

The difficult and important part in building a team of teachers' characteristics of integrating science and education is how to induce high-level scientific researchers to implant teaching and talents cultivating into their minds. They are confronted with real problems such as heavy tasks of scientific research, and balance of research and teaching if they are required to teach. However, by solidifying humanistic care, ceaselessly improving teaching and the performance appraisal mechanism of laying equal valence on research and teaching, also by strengthening the incentive measures and leaning the policy and resources towards the frontline teachers, a large number of excellent researchers have stepped onto the teaching platform, becoming knowledge disseminators.

The key of education via scientific research is to transform the teachers' research findings or the latest scientific and technological problems into teaching resources by way of knowledge and learning. This demands the teachers to possess advanced research experiences and abilities, rigorous attitudes towards research and active academic thinking. The well-known experts including the university leader & academician Yirong Wu, vice-director Tao Song, researchers Chibiao Ding and Shefeng Yan whom take the lead in setting up courses, which involves more than 100 outstanding researchers of the co-founded research institute active in research to get involved in teaching work, being turned from knowledge creators to knowledge disseminators. At the same time, the college continuously perfects performance evaluation and interests-oriented measures, optimizes the allocation of resources, and links the enrollment quota, teachers excellency appraisal with the quality of course teaching, links the teaching workload with performance assessments, which contribute to better stimulating their enthusiasm and initiative in teaching.

2.3.2 Forging the Brand Training Program of "Activity Day for Integration of Scientific Research and Education"

How to assist the research staff active on the frontline research to be transformed from the excellent knowledge creators into knowledge sowers is the priority in building teaching staff resources. Regarding the problems of the research institute teachers' strengths in research yet weakness in teaching and uneven teaching capabilities, the interchange activities with conspicuous themes and distinctive features are regularly organized, and nearly one hundred teachers show up in the activities every time.

2.4 Establishing the Supervision mechanism to *i*mprove Teaching Ability

2.4.1 *Forming a Unique Classroom Quality Supervision Mechanism of Multi-Angle, All-Round and Multi-Layer*

Good or bad classroom teaching depicts vividly the teaching quality, reform of curriculum teaching is the core of improving talents cultivating. Since 2015, the college has established a high-level supervision team composed of veteran professors from Peking University and Tsinghua University. They are not only rich in teaching experience, in love with education career but they have profound and original understanding of teaching. Through firmly carrying out pre-class demonstrations, in-class supervision, after-class tutoring, and experts centering on classroom teaching and teaching practice, the whole teaching procedures are guided and superintended, furthermore, problems and shortcomings are promptly discussed. All these have improved significantly the teaching level. The mechanism is unanimously recognized by teachers and graduates. The supervision has raised the teaching level excellence rate from 57% to 77%. Meanwhile, 97% of teachers have expressed their approval of the work to guarantee the teaching quality, believing their teaching skills and manners have been promoted to a great extent, regarding the supervision experts as their "guide" and "hearty friends" in their teaching. The graduates have also the feedbacks that the important and difficult teaching points are clear and the teachers' teaching level has been greatly improved. This mode builds a platform of learning and communication for the on-the-job teachers. More significantly, it seeks a new approach of guidance and cultivation.

2.4.2 *Forming Standardized and Orderly the Integration of Scientific Research and Education Management Mode & Constant Normalized Improvement Mechanism*

Teaching management is one of the important elements affecting teaching quality. The SEECE enrolls nearly 600 students annually, for them the centralized teaching pattern is adopted, leading to complexity and massive workload of teaching organization. The teaching supervision, as an advantageous measure, has played a huge role in improving integrated science and education teaching quality and school management. By means of supervision, against the phenomena of casual class replacements and suspensions, the college has detailed and implemented a series of rules and regulations in teaching management. These rules and regulations include: fostering the training and management teaching assistants, the real-time managing of the tracking system is started, the timely classroom feedbacks mechanism is founded, and the problems affecting the teaching effect are solved. These measures push continuously the teaching management for the better and making it further standardized and systemized. Both the teachers and graduates jointly participate in the teaching quality guarantee mechanism by discovering problems, taking part in diverse ways and improving regularly, which enhances the integrated science and education teaching system perfect and lifts the teaching quality, therefore giving further impetus to the holistic management level of the college.

3. CONCLUSIONS

The reform and practice based on the integration of scientific research and education system has advanced the graduates' scientific and research innovative abilities in the SEECE at

UCAS. In the past five years, 3,575 graduates finished their degrees here, among whom there are nearly 2,000 PhDs. They published more than 6,000 SCI/EI papers in the course of studying. Some papers are published in famous journals and are highly appraised by international colleagues. As many as 26 are credited with excellent doctoral dissertation by Chinese Academy of Sciences, and many graduates win the excellent doctors' honorary titles of Beijing, Shanghai and the first-class academic societies. More than 100 graduates' academic fruits are translated into practical products, which are put into use in the major special national projects and major tasks of our country's aviation, aeronautics, electronics, etc. All these have yielded outstanding economic and social benefits, and played the crucial role in satisfying the national strategic demands. The quality of graduates is widely commended by society. The majority of them have entered into research institutions, higher educational units and enterprises well-known at home and abroad. They are positively recognized by the employers and colleagues both inside and outside China.

To meet the new situations and requirements of national education and teaching reform and development, the integration of scientific research and education system established by SEECE at UCAS aims at morality nurturing, and agglomerates the wisdom and strength of bountiful remarkable frontline scientific and technological personnel, stimulate their enthusiasm and creativity in teaching and education so that a large group of innovative top talents will be brought up. They can be rooted in their motherland, to serve society and its people, and this can also lay a solid foundation for creating world-class achievements. The system has advanced rationale, appropriate means and powerful measures, and consequently significant teaching fruits. It is a beneficial probe and application of the model of deep integration of scientific research and education, which is of great guiding and practical value in nurturing innovative high-tech talents, offering useful lessons and references to improve the cultivating quality of graduates. The SEECE attaches importance to the essential role of teaching quality in talents training, it keeps on endless exploration and innovation. The new ideas are introduced into the working manners in accordance with the discipline attributes and concrete practice. Ceaselessly improving the integration of scientific research and education system has come into shape step by step.

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