



Construction of a Postgraduate Teaching System with Deep Integration of Innovation and Entrepreneurship Ability Cultivation for Microelectromechanical Systems Major

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Abstract: Strengthening the cultivation of the innovation and entrepreneurship abilities for postgraduate students is a practical need for the country to implement the innovation driven development strategy, and also an inevitable requirement for establishing an innovative country. This paper discusses some problems faced by the cultivation of the innovation and entrepreneurship abilities for postgraduate students. Based on the research on the construction of the curriculum system of postgraduate students majored in Microelectromechanical Systems (MEMS) in Southeast University, P.R. China, this paper presents the ideas and plans for the construction of the teaching system integrating the cultivation of innovation and entrepreneurship abilities. By promoting the implementation of this plan, the discipline of MEMS in Southeast University has made some achievements in the cultivation of innovative and entrepreneurial talents. A survey indicates that 37.7% of the postgraduate students from the discipline of MEMS expressed a willingness to start their own businesses within 5 years after graduation. At the same time, over 35.9% of the postgraduate students stated that they have certain or good innovation and entrepreneurship abilities and potentials. This can provide useful reference for the cultivation of innovation and entrepreneurship abilities of postgraduate students in other universities.

Keywords: Postgraduate Student, Innovation and Entrepreneurship, Curriculum System

1. Introduction

If the undergraduate students have a theoretical and spiritual foundation for innovation and entrepreneurship, then postgraduate students, especially doctoral students, have added a material foundation for innovation and entrepreneurship. However, the current entrepreneurship rate for postgraduate students in P.R. China is below 2.0%, far lower than the 20%-30% entrepreneurship rate in developed countries [1-3]. Therefore, many universities in P.R. China have begun to recognize the importance of cultivating graduate the innovation and entrepreneurship abilities for postgraduate students [4-7]. Graduate students have a good level of scientific research and foundation, and have the ability to carry out higher-level entrepreneurial activities. Strengthening the cultivation of the entrepreneurial spirit and ability for postgraduate students can guide them to better transform professional knowledge and skills into social

productivity, making them a core new force in innovation and entrepreneurship. Currently, there is not much systematic research on the construction of the teaching system for cultivating innovation and entrepreneurship abilities in the postgraduate stage, and the construction of the system for cultivating innovation and entrepreneurship abilities in postgraduate stage still faces many problems [4-8]. Firstly, a mature curriculum system for cultivating innovation and entrepreneurship abilities for postgraduate students (including masters and doctoral students) has not yet been formed. At the same time, there is a lack of integration between the cultivation of innovation and entrepreneurship abilities and professional curriculum education, and there is a clear disconnect between them. This not only requires the integration of teaching content, but also includes whether teachers have the ability, experience, and background to integrate them. Finally, the awareness of cultivating innovation and entrepreneurship ability is not enough, the

atmosphere of entrepreneurship is not as strong as expected, and the evaluation mechanism of the teaching system for cultivating innovation and entrepreneurship ability is far from perfect. Based on the research on the construction of the curriculum system of postgraduate students majored in MEMS in Southeast University, P. R. China, this paper presents the ideas and plans for the construction of the teaching system integrating the cultivation of innovation and entrepreneurship abilities for postgraduate students. By promoting the implementation of this plan, the discipline of MEMS in Southeast University has made some achievements in the cultivation of innovative and entrepreneurial talents. It can provide useful reference and inspiration for the cultivation of innovation and entrepreneurship abilities for postgraduate students in other universities.

2. Ideals and Plans for the Construction of a Teaching System

In response to the inherent characteristics of postgraduate education and the problems in the current system for cultivating innovation and entrepreneurship abilities, it is necessary to fully utilize educational resources both on and off campus, use scientific educational methods, cultivate innovation awareness and entrepreneurial spirit, enrich their entrepreneurial knowledge, stimulate the entrepreneurial interest, and encourage graduate students to use their research and development achievements as entrepreneurial conditions to achieve academic entrepreneurship. We have proposed the following general ideas for the construction of a teaching system for deep integration of innovation and entrepreneurship ability cultivation, as shown in Figure 1.

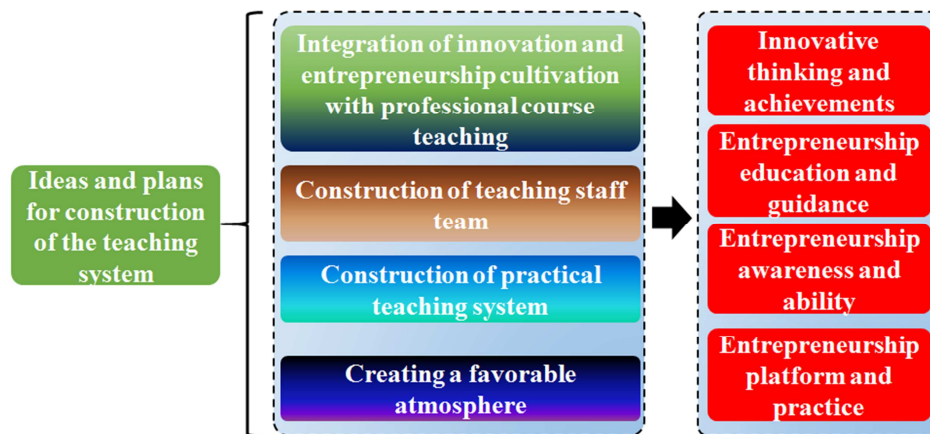


Figure 1. Schematic diagram of the construction ideas and plans for the teaching system of deep integration, innovation and entrepreneurship ability cultivation.

2.1. Deep Integration of Innovation and Entrepreneurship Ability Cultivation with Professional Course Teaching

Due to the limited curriculum and limited class hours for postgraduate students, it is necessary to integrate innovation and entrepreneurship concepts into theoretical curriculum teaching in order to organically integrate academic education and innovation and entrepreneurship education [9-10]. The postgraduate student course system of MEMS major at Southeast University is mainly divided into public basic courses, professional academic courses, and practical teaching courses. (1) The School of Management of Southeast University offers the course "Fundamentals of Innovation, Entrepreneurship, and Management". The course mainly focuses on entrepreneurial thinking and enterprise management, guiding postgraduate students to understand the economy and society, market and enterprise, cultivating their innovation and entrepreneurship ideals, and stimulating their entrepreneurial intentions. (2) Based on the professional characteristics of MEMS major, leveraging the advantages of engineering postgraduate students in technological innovation, scientific research innovation and entrepreneurship contents related to the digital micromirror devices from Texas Instruments [11-12], all silicon MEMS

resonators from SiTime [13-14] and MEMS inertial measurement unit from Bosch [15] have been added to professional courses such as "Introduction of MEMS", "Silicon Micro/nano Manufacturing Technology" and "Microsystem Design", Cultivating the ability to identify the market value of innovative technology and to carry out entrepreneurship by using innovative technology. This will be helpful to improve the innovation and entrepreneurship ability of postgraduate students.

2.2. Construction of Teaching Staff for the Cultivation of Innovation and Entrepreneurship Ability

The cultivation of the innovation and entrepreneurship abilities for postgraduate students requires a diverse teaching team with profound professional knowledge and excellent innovation and entrepreneurship abilities. Relying on the key laboratory of the Ministry of Education of MEMS, the discipline of MEMS of Southeast University continues to strengthen the training and recruitment of highly educated talents with strong theoretical basis and rich practical experience, especially highly educated talents with work experience in world famous scientific and technological innovation enterprises, which enrich the experience

background of the innovation and entrepreneurship of the staff group. At the same time, the cultivation of innovation ability and entrepreneurial awareness of all teachers has been strengthened, encouraging the teachers to receive innovation and entrepreneurship guidance, participate in the Science and Technology Town Mayor's Group to serve as the Deputy Town Mayor in charge of science and technology work in the local government, to act as the deputy director of the Science and Technology Bureau in the district-level government of Nanjing City, to act as the deputy general manager of science and technology in enterprises, and to participate in high-level talent entrepreneurship competitions. Furthermore, by actively carrying out industry university research cooperation with enterprises, the pace of scientific research achievements implementation has been promoted, and the innovation and entrepreneurship literacy and guidance ability of the teachers has been efficiently improved. Finally, entrepreneurs with graduate guidance abilities have been actively hired to serve as part-time entrepreneurial guidance teachers at schools actively hire entrepreneurs and entrepreneurs with graduate guidance abilities to serve as part-time supervisors for entrepreneurship at the key laboratory of the Ministry of Education of MEMS.

2.3. Construction of Practical Teaching System Highlighting the Cultivation of Innovation and Entrepreneurship Ability

Based on the MEMS Key Laboratory of the Ministry of Education, an innovation research platform for graduate students has been build, creating a strong academic atmosphere for innovation and entrepreneurship. Postgraduate students are encouraged to carry out innovation and entrepreneurship practice activities under the joint guidance of internal and external supervisors, combined with scientific research projects of the supervisors. By strengthening the cooperation between university and enterprise, the integration of industry and education, practical platforms have been established, such as school enterprise joint research and development centers, providing carriers for introducing enterprise practice in course teaching and entrepreneurship guidance. By using lectures and salons as the main carriers, famous entrepreneurs and experts from the innovation chain, capital chain, and industrial chain are invited, especially by fully utilizing the rich alumni resources, to share topics related to innovation and entrepreneurship. The topics include but not limited to the forefront of technology and industrial development, technology achievement exhibitions, economic and industrial policy interpretations. This is useful to expand the entrepreneurial ideals and technology entrepreneurship resources. We actively organize the application of graduate research innovation and entrepreneurship projects, and encourage postgraduate students to choose innovative research topics related to their supervisor's research direction. Also, we organize graduate students to participate in various subject competitions and entrepreneurship competitions in large scale, such as the Internet plus Innovation and Entrepreneurship Competition, National College Student

Integrated Circuit Innovation and Entrepreneurship Competition, Micro/Nano Sensing Technology and Intelligent Application Competition, Southeast University Global Alumni Innovation and Entrepreneurship Competition, and other innovation and entrepreneurship competitions and activities. These practical experiences have laid a good foundation for postgraduate students to carry out practical innovation and entrepreneurship after graduation. Postgraduate students are supported to carry out various simulated entrepreneurship, entrepreneurship training, etc. Various competition teams and award-winning teams are organized to conduct roadshows within the MEMS Key Laboratory of the Ministry of Education, this can stimulate the interest of teachers and postgraduate students in innovation and entrepreneurship activities, and play a good inheritance role. Teachers and students can accumulate richer experience.

2.4. Creating a Favorable Atmosphere for Cultivating Innovation and Entrepreneurship Ability

The environment is crucial for cultivating the innovation and entrepreneurship abilities for postgraduate students. The effectiveness of the training is determined by whether a good innovation and entrepreneurship education atmosphere can be created. We actively organize postgraduate and undergraduate students to team up and participate in various innovation and entrepreneurship competitions based on their respective disciplinary advantages and strengths. Good interaction within the team allows postgraduate students to immerse themselves in entrepreneurial practice, to transform scientific research results into products, and thereby enhance their interest in innovation and entrepreneurship. The supervisor is the core of the research team. In order to encourage the supervisor to play a more important role in the cultivating process of the innovation and entrepreneurship abilities of the postgraduate students, the achievements of innovation and entrepreneurship education have been included in annual performance assessment and awards of the supervisors. On the other hand, the graduate evaluation system has also been reformed, not only scientific research papers are adopted as an evaluation indicator. Innovation and entrepreneurship achievements are included and play important role in the postgraduate student evaluations such as national scholarships, alumni scholarships, and "Three Good Student", and their weights are highlighted. By collaborating with Southeast University Science and Technology Park, Jiangning Economic and Technological Development Zone and other relevant science and technology innovation platforms, postgraduate student innovation and entrepreneurship education are efficiently carried out, and joint research with high-quality enterprises on potential graduate projects are conducted.

3. Achievements of Teaching System Construction and Implementation

The Key Laboratory of MEMS of the Ministry of

Education implements the construction of the postgraduate teaching system for deep integration innovation and entrepreneurship ability cultivation for more than 10 years, achieving fruitful results. Over the past 10 years, a total of 46 postgraduate students in this field have received national scholarships. Over 600 papers in high-level journals such as Nature, Science, and IEEE Trans have been published. More than 50 papers have been published by IEEE MEMS, a top international conference in the field of MEMS, and IEEE Transducers. 6 teachers from the Key Laboratory of MEMS of the Ministry of Education have been appointed as Deputy Director of Science and Technology, Deputy Mayor of Science and Technology, and other local government positions. 8 teachers have been awarded various innovation and entrepreneurship competitions, and 7 high-end talents with work experience in first-class domestic and foreign enterprises such as Intel Corporation (USA) have been newly recruited. At the same time, we continue to hire off-campus supervisors with senior professional titles from more than 30 companies, including Wuxi Huarun CSMC Technologies Corporation and Wuxi Xinganzhi Semiconductor Co., Ltd., to guide postgraduate student course practice and innovation and entrepreneurship. With the continuous improvement of the innovation and entrepreneurship abilities of postgraduate students, their enthusiasm for participating in innovation and entrepreneurship competitions continues to rise, and they have achieved excellent results. Over the past 10 years, graduate students have won 44 national innovation and entrepreneurship competitions, including the China Youth Science and Technology Innovation Award, the Xiaoping Science and Technology Innovation Team, the Challenge Cup, and the National College Student Integrated Circuit Innovation and Entrepreneurship Competition. We cultivated more than 20 core company founders such as Yang Yongjun (Chairman of Hebei Meitai Electronic Technology Co., Ltd. a listed company), Liu Tongqing (Chairman of Wuxi Xinganzhi Semiconductor Co., Ltd.), Liu Junwen (Chairman of Nanjing Yuangan Microelectronics Co., Ltd.), Yang Gang (General Manager of Jiangsu Dongwei Perception Technology Co., Ltd.), and Shen Guangping (General Manager of Wuxi Guolianxinchuang Private Equity Investment Fund Co., Ltd.). At the same time, more than 60 key company founders, including Lan Zhikang (Deputy General Manager of Nanjing Gaohua Technology Co., Ltd., a listed company). In 2023, a survey was conducted among 92 postgraduate students randomly selected from the Key Laboratory of MEMS of the Ministry of Education. It was found that the innovative and entrepreneurial spirit and awareness of postgraduate students in the laboratory have been relatively prominent. 37.7% of the postgraduate students expressed a willingness to start their own businesses within 5 years after graduation. At the same time, over 35.9% of the postgraduate students stated that they have certain or good innovation and entrepreneurship abilities and potentials.

4. Conclusion

In view of some problems faced by the innovation and entrepreneurship ability cultivation of postgraduate students, we proposed a teaching system construction idea and plan integrating the cultivation of innovation and entrepreneurship ability for the MEMS major of Southeast University. By promoting the implementation of this plan, the innovation and entrepreneurship spirit and awareness of postgraduate students have been improved. At the same time, the innovation and entrepreneurship abilities and potentials of the postgraduate students have been improved. It can provide useful reference for the cultivation of innovation and entrepreneurship abilities of postgraduate students in other universities.

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