

Research on the organic integration of professional education and innovation & entrepreneurship education under the background of the new engineering

Jing Li, Wen-jing Du, Jian Gao*
Panjin Vocational & Technical College, Panjin, China

Abstract. New engineering is put forth in China's higher education in an active response to a new round of scientific & technological revolution and industrial revolution. Facing the needs of national strategic development, innovation & entrepreneurship education, under the background of new engineering construction, must be integrated into the whole process of talent cultivation in colleges and universities. In this paper, the computer major in higher vocational education is studied to explore the organic integration of professional education and innovation & entrepreneurship education from such aspects as the goal of talent cultivation, course system, teaching content and teachers, and the practical effect of the integration of professional education and innovation & entrepreneurship education is expounded taking the innovative design of students in the course "Internet of Things Technologies" as an example.

Keywords. New engineering, Internet of Things Technologies, professional education, innovation & entrepreneurship education, talent cultivation, integration of professional education and innovation & entrepreneurship education.

1. Introduction

After the national strategy of "mass entrepreneurship and innovation" was proposed in the *Opinions of the State Council on Policies and Measures to Vigorously Promote Mass Entrepreneurship and Innovation* in 2015, it was pointed out in the *Implementation Opinions of the General Office of the State Council on Deepening the Reform of Innovation and Entrepreneurship Education in Institutions of Higher Learning* that: colleges and universities should promote the organic integration of professional education and innovation & entrepreneurship education according to the positioning of talent cultivation and the goal of innovation & entrepreneurship education, adjust the professional course setting, explore and enrich the innovation & entrepreneurship education resources of various professional courses, and strengthen innovation & entrepreneurship education during the impartation of professional knowledge. In 2017, to proactively respond to a new round of scientific & technological revolution and industrial revolution, and support and serve major national strategies, such as the innovation-driven development, "Made in China 2025" and "Internet plus", the Ministry of Education held a seminar on the development strategy of higher engineering education in Fudan University, in which it discussed the engineering talent cultivation in the new era, formally put forward the concept of "new engineering", and formed "Fudan Consensus", "Tianjin University Action", "Beijing Guide" and so on. Since then, the construction of new engineering has been carried out in colleges and universities across China. New engineering requires that engineering and technical personnel have higher innovation & entrepreneurship ability and crossover integration ability, as well as the ability to solve practical industrial problems. To this end, colleges and universities should change their existing teaching models and deeply integrate professional education with innovation & entrepreneurship education, and strengthen students' innovation spirit, entrepreneurship awareness and innovation & entrepreneurship ability while cultivating their professional skills, thus developing a number of advanced skilled and applied professionals with social responsibilities and practical ability.

Under the background of new engineering construction, to cultivate innovation & entrepreneurship talents that meet the needs of local social and economic development, our school has carried out the teaching reform of the organic integration of innovation & entrepreneurship education and professional education in all professional scopes, with courses as the research object, fully explore and enrich the innovation & entrepreneurship education resources of various professional courses, and strengthen the cultivation of students' innovation awareness and entrepreneurship spirit in the process of teaching professional courses, thereby developing professional education and innovation & entrepreneurship education simultaneously.

2. Analysis of problems in reform of innovation & entrepreneurship education

Since the national strategy of "mass entrepreneurship and innovation" was proposed, higher vocational colleges have carried out the reform of innovation & entrepreneurship education, and classified the innovation & entrepreneurship course as a compulsory general course in talent cultivation, which plays an important role in improving the quality of talent cultivation, promoting the employment and entrepreneurship of graduates and serving the national economic development. However, there are also some prominent problems that cannot be ignored.

2.1. Deficient depth and breadth in innovation & entrepreneurship education

At present, the innovation & entrepreneurship education in higher vocational colleges is mainly carried out in the following two ways. The first is "general" innovation & entrepreneurship formative education, in which full-time counselors and teachers for student work set up basic compulsory courses such as "career planning", "innovation &

entrepreneurship education”, “career development and employment guidance” and “SIYB entrepreneurship training” for students of all majors to make them understand the basic theories, knowledge, methods and process of innovation & entrepreneurship, and cultivate their innovation spirit and entrepreneurship awareness. The second is “embedded” innovation & entrepreneurship integrative education, in which professional teachers guide students to make technical innovation on the basis of mastering professional skills according to the characteristics of disciplines, aiming at some students of this major and a few cross-major students who are interested in this. Colleges and universities establish various innovation & entrepreneurship bases, maker spaces, EMSPACE and others for college students to provide creative space and technical support for excellent students who are interested in technical innovation. By setting up a number of technology frontier and industrial trend courses that closely integrate teachers’ disciplines in academic research innovation, transfer and transformation of scientific research achievements, and docking and application of property rights and technical services in the new era, colleges and universities provide technical, training, consultation, operation management and other guidance for students’ innovative projects to encourage and guide students to carry out technical innovation and independent entrepreneurship. Besides, each major will also organize and tutor students to participate in various innovation & entrepreneurship competitions, such as “Challenge Cup” Competition, “Internet plus” College Students’ Innovation & Entrepreneurship Competition, National College Students’ Innovation & Entrepreneurship Training Program, and China College Students’ Entrepreneurship Competition, according to the characteristics of each major. During the preparation of competitions, students complete the training on topic selection in the application of innovation & entrepreneurship projects, as well as on the writing of relevant contents, such as the project significance, research content and problems to be solved, research basis and implementation plan, in the application form under the guidance of teachers and with the help of network materials, so that they will have a full understanding of innovation & entrepreneurship projects and can solve the urgent problems that need to be solved in current life and society using advanced technologies, showing practicability and innovation.

The “general” innovation & entrepreneurship formative education, a compulsory course for all students, is of strong universality and fundamentality, among other characteristics, but it is less professional and targeted, is less effective in the cultivation of students’ innovation awareness, entrepreneurship spirit and innovation & entrepreneurship ability, lacks the “professional” and “vocational” innovation & entrepreneurship continuing education for students who have entrepreneurial intentions and who have chosen to start their own business, and is of insufficient depth of innovation & entrepreneurship education; the “embedded” innovation & entrepreneurship integration education is strongly professional and targeted, yet it is of small coverage, cannot meet the needs of comprehensively cultivating innovative talents under the background of new engineering, and is of insufficient breadth of innovation & entrepreneurship education.

2.2. Deviation of conception in innovation & entrepreneurship education

Influenced by traditional education concept, most of students believe that the goal they should realize in college is to learn professional knowledge and skills well and obtain a diploma, while innovation & entrepreneurship is a matter that graduates and excellent students need to consider, and has nothing to do with themselves. Therefore, they are not interested in the innovation & entrepreneurship education courses, and they study them without thinking deeply, only for the purpose of passing the examination and getting credit. Students can easily understand innovation, but their understanding of entrepreneurship is often too narrow; they generally think of entrepreneurship as self-employment. In fact, it also has another meaning, namely the process in which a person uses his knowledge, skills and resources as well as information, opportunities and other things he discovers, overcomes the stereotype, creates new ways, new situation and new performance of working with creative thinking and arduous efforts, and makes breakthroughs in his career, so as to achieve his pursuit or goal [1]. For all students, giving full play to their professional expertise, working creatively, making breakthroughs and maximizing the value in their future jobs also belongs to innovation & entrepreneurship. Therefore, innovation & entrepreneurship ability has become a quality that contemporary college students must have.

At present, most professional teachers have not realized the importance of innovation & entrepreneurship education, believing that it is a matter for individual departments of the college and has nothing to do with professional education; some even think that it has limited effect on talent cultivation, without realizing the connotation and requirements of cultivating students’ innovation and entrepreneurship ability in innovation & entrepreneurship education [2-3]. Based on the goal and requirement of new engineering construction for the cultivation of engineering talents, professional teachers must explore and summarize potential innovation & entrepreneurship thoughts and spirit in courses in their professional teaching, deeply integrate innovation & entrepreneurship education with professional education, and integrate innovation & entrepreneurship education into the whole process of talent cultivation, thus providing talent support for promoting high-quality development.

3. Methods for integration of professional education and innovation & entrepreneurship education

Professional education and innovation & entrepreneurship education are mutually complementary, so they must be deeply integrated. Only when integrated with professional education can innovation & entrepreneurship education realize the cultivation of the innovative thinking and entrepreneurship spirit; only when integrated with innovation & entrepreneurship education can professional education enable students to apply their professional knowledge to their career development. Taking the research and practice of the cultivation of the innovation & entrepreneurship ability of

students majoring in computer in our college, this paper explores the path of organic integration of discipline professional education and innovation & entrepreneurship education in higher vocational colleges.

3.1. Integration of the goal of talent cultivation

In order to better integrate innovation & entrepreneurship education into the daily teaching of computer major, we should pay attention to the transformation of the education concept, take the concept of innovation & entrepreneurship education as a new concept of the teaching of computer major and the training of students' independent innovation, entrepreneurship and divergent thinking as one of the training objectives of professional education. While focusing on the role of innovation & entrepreneurship education in professional education, we should also carry out innovation & entrepreneurship education in the whole process of talent cultivation of professional education [4].

The goal of talent cultivation of computer major in higher vocational colleges is to cultivate applied professionals needed by the society and enterprises. Students are required to have profound basic professional knowledge, good knowledge structure and broad knowledge vision, as well as innovation awareness and thinking, and entrepreneurship spirit, ability and quality. In the professional education, the cultivation of professional ability is the basis, and that of innovation & entrepreneurship ability is the expansion. Teachers are required to pay attention to the practicality, openness and innovation in professional teaching. Project teaching is a method integrating professional education with innovation & entrepreneurship education, where teachers only need to put forward project requirements, and project information, planning and implementation are independently completed by project teams. Project members, under the leadership of the leader, search for data, make the plan, implement the project and accept the project, and thus accumulate professional knowledge and skills during this process. Meanwhile, we should also cultivate students' innovative thinking and critical thinking, enlighten their thinking of technical, service and management innovation, and stimulate their questioning and exploratory spirits. We should start from the needs, with the problem solving as the goal, to improve students' teamwork and coordination ability and their ability to analyze and solve problems. The innovation & entrepreneurship education should be focused in the whole process of the training of professional skills to realize the integration of the talent cultivation goals of professional education and innovation & entrepreneurship education.

3.2. Integration of innovation & entrepreneurship education into the professional education system

There is a lack of innovation & entrepreneurship training in conventional professional education. Students are only able to simply use knowledge, but their ability to digest the knowledge, solve complex professional problems and innovatively use the knowledge is poorly trained. To respond to a new round of scientific & technological revolution and industrial revolution and meet the national development strategic needs, applied talent cultivation should focus further on the ability to "solve complex problems" from the ability to "simply use the knowledge". To this regard, it is necessary to integrate innovation & entrepreneurship education into the professional education system, thereby forming a professional innovation course system that is integrated with professional education [5].

A professional innovation course can be formed by adding innovation & entrepreneurship education elements in a traditional professional course, or is a new professional cutting-edge technology course. Its prominent feature is to take the training of students' personality spirit, mentality, and ability and quality as the core. Professional innovation courses are carried out in the whole process of professional training, and are arranged according to the progressive training of ability. In the first academic year, "general" basic innovation courses are set up, which mainly focus on the training of innovative thinking and the guidance of entrepreneurship awareness. In the second academic year, "embedded" synthetic innovation courses are set up, which integrate the teaching of innovation & entrepreneurship theories with professional course theories, the teaching of innovation & entrepreneurship practice with professional practice, and the innovation & entrepreneurship activities and workshops with the second classroom, so as to train students to recognize and understand complex professional problems, gradually develop ideas and methods to solve these problems, and finally put forward new ideas and views, as well as train their innovation & entrepreneurship comprehensive practice ability by all members, in the whole process and in an all-round way. In the third academic year, "professional" or "vocational" applied innovation & entrepreneurship courses are set up, which mainly provide theoretical and technical support on practical level for students who have entrepreneurial intentions or have decided to start their own business, help them transform innovation achievements into technological products, and promote the successful incubation of innovation projects.

3.3. Integration of teaching contents of professional education and innovation & entrepreneurship education

Under the overall planning of the professional innovation course system, it is necessary to analyze the teaching content of each professional course, integrate project modules, explore innovation & entrepreneurship elements related to the course according to the content and characteristics of the course, optimize the teaching design and integrate it into the content teaching, and integrate the training of innovation awareness, entrepreneurship spirit and innovation & entrepreneurship ability in the explanation of professional knowledge and the training of professional skills [6].

The innovation & entrepreneurship content of computer major may come from real engineering projects of enterprises, scientific research projects of teachers and transformation of their scientific research achievements, vocational skill competitions, and innovation & entrepreneurship competitions, such as "Internet plus" [7]. When choosing a project, teachers need to consider the professional technology required by the project, as well as the possibility that whether students can think while doing and practice while learning and whether they can be trained in creative thinking and

divergent thinking during the implementation of the project. In recent years, the college has carried out the reform of project teaching, in which all courses of the computer major are designed by integrating theory with practice and roles of project team members are set up according to the professional post. Based on real enterprise projects, a real working environment and real post responsibilities, students are well trained in their ability of analyzing and solving problems, ability of teamwork and coordination, attitude of overcoming difficulties and challenging themselves, spirit of creation and criticism, innovation & entrepreneurship ability and other aspects. Team members make joint efforts to complete the project, so that students can feel recognized in their value, the charm of the major and the joy of the creation.

3.4. Establishment of high-quality teaching staff for integration of professional education and innovation & entrepreneurship education

According to students' characteristics, innovation & entrepreneurship education can be divided into four categories, as shown in Figure 1. It shows that professional teachers should be dominant in other three categories other than "general" formative education. Therefore, innovation & entrepreneurship education is not a matter of a certain kind of teachers or a department, but a responsibility of professional teachers of all disciplines.

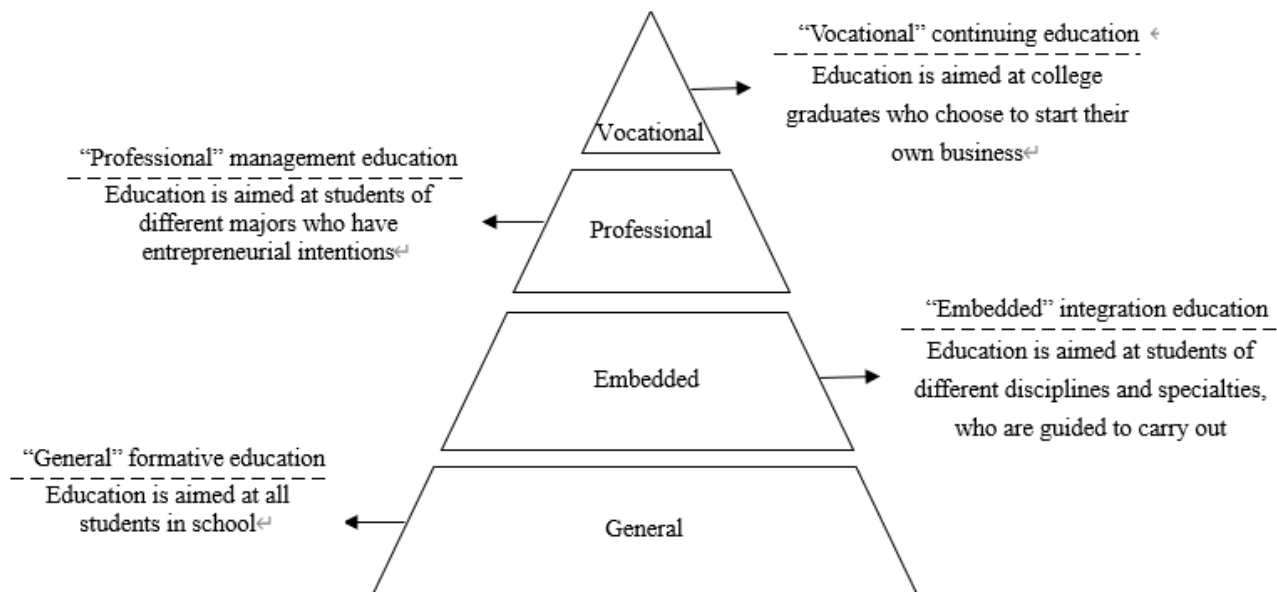


Figure 1. Classification of innovation & entrepreneurship education

We will cultivate professional teachers in school. To realize the deep integration of professional education and innovation & entrepreneurship education, the key is to improve professional teachers' ability consciousness. At present, most of them have not realized this, and they only pay attention to the explanation of professional knowledge and skills in their teaching, and yet ignore the training of students' creative and critical thinking. Many teachers know little about the innovation & entrepreneurship education, so they will not involve such content in teaching. To improve professional teachers' understanding of innovation & entrepreneurship education, a variety of activities such as publicity, promotion, inspection and exchanges are carried out on the Ministry of Education, provincial and school levels, so as to make more teachers understand the concept, skills and methods of innovation & entrepreneurship, and apply innovation & entrepreneurship knowledge to their professional teaching to train students' entrepreneurship concept, thinking, ability and spirit on the professional level, thus promoting students' lifelong career development. On the basis of the original "general" formative education, "embedded" integration education is carried out deeply and comprehensively to ensure that the innovation & entrepreneurship education is realized in all professional fields and benefits all college students [8].

We will hire entrepreneurship tutors from outside the school. To carry out "professional" or "vocational" innovation & entrepreneurship education among students who have entrepreneurial intentions or have chosen to start their own business, teachers should master both professional knowledge and other related knowledge such as marketing, management and economics, and, more importantly, have an in-depth understanding of the entrepreneurial process and enterprise operation. Therefore, the teaching goal cannot be achieved only by professional teachers and innovation & entrepreneurship teachers in the school. Thus, it is considered to establish a contingent of part-time teachers consisting of entrepreneurs, investors or other people succeeding in starting their business, who have rich entrepreneurial experience, to provide guidance in "professional" or "vocational" innovation & entrepreneurship, and targeted suggestions on the project selection, entrepreneurial process, enterprise operation and other entrepreneurial practice contents.

We will strengthen the construction of full-time teachers. Professionalization is the core quality of innovation & entrepreneurship teachers. In the era of information and intelligence, innovation & entrepreneurship teachers should keep learning, requiring that they should not only have extensive general knowledge, but also have professional knowledge enabling them competent for teaching and can help and guide students in all aspects. China should establish training bases for teachers of innovation & entrepreneurship education to improve their professional level. Colleges should normalize

the employment conditions, qualifications and working content of innovation & entrepreneurship teachers, and improve their vocational level. Professional training and vocational management are carried out to strengthen the construction of full-time teachers.

Higher vocational colleges improve the ability of professional teachers and innovation & entrepreneurship teachers by such activities as school training, increase the entrepreneurial guidance by employing excellent entrepreneurs from all walks of life, gradually strengthen the construction of the contingent of innovation & entrepreneurship teachers of all majors, striving to establish an outstanding teaching contingent that integrates professional education and innovation & entrepreneurship education.

4. Practical results of integration of professional education and innovation & entrepreneurship education

The “Internet of Things Technologies” is a course for capacity development set up for the computer major in our college, and the teachers have been the tutors of the Internet of Things Technologies Application Event of the Higher Vocational College Group of the National Vocational College Skills Competition in recent years. In the teaching reform of the integration of professional education and innovation & entrepreneurship education in the college, teachers, based on their years of experience in competition guidance, introduce competition events into teaching and combine professional education with social needs, so as to fully mobilize students’ interest in learning and willingness to explore. Based on the actual needs of the campus life and study, students independently design the supermarket self-service shopping cart, restaurant intelligent plate checkout management system, library gate environmental monitoring system and others under the guidance of teachers, realizing the recognition of students to their own value and making themselves more targeted to their future career planning. Taking the library intelligent gate environmental monitoring system as an example, this paper displays students’ innovation awareness and creative ability [9].

In the construction of the smart campus, a library intelligent gate environmental monitoring system is designed in order to provide students with a comfortable reading environment. The temperature and humidity sensor, light sensor and noise sensor are used to acquire the environmental parameters around the library in real time, and then send them to the monitoring cloud platform via the data transmission system, to realize the real-time monitoring and control of the environment of the library. The human body infrared is combined with the gate (electric drive pusher); when the human body infrared module detects someone arriving, the gate will be automatically opened, otherwise, closed; when the temperature and humidity are higher or lower than the threshold, the fan will be automatically turned on to adjust the temperature and humidity; when the light intensity is lower or higher than the threshold, the lighting system will be turned on or off automatically; when the noise is higher than the threshold, the alarm system in the library will be turned on. The library is intelligently managed by monitoring and controlling the environment in real time [10].

System composition and function realization. The system mainly consists of three functional modules, namely data acquisition, data transmission and data processing. In the data transmission module, the temperature and humidity sensor, light sensor and noise sensor acquire the environmental parameters in real time, and then transmit the data to the ZigBee sensor; the ZigBee sensor transmits the data it receives to the data processing module through such devices as ZigBee coordinators, routers and gateways (which constitute the data transmission module). The data processing module mainly realizes the following functions:

(1) Human body infrared detection and gate control. Two relays are installed on the gate to open and close the gate, and DATA-A and DATA-B in module 4150 are connected to DATA-A and DATA-B in the gateway, and the gateway is connected to PC via the route to realize the control over the hardware.

(2) Intelligent fan control. The two ZigBee modules are a sensor and a coordinator. All kinds of sensor signal lines are connected to the four-input ZigBee sensor that has been programmed, and then the serial communication line of the coordinator is connected to the USB port of the gateway to make the data obtained by the gateway transmitted to the PC terminal. To ensure the communication effect, an antenna is specially installed. The system composition is shown in Figure. 2.

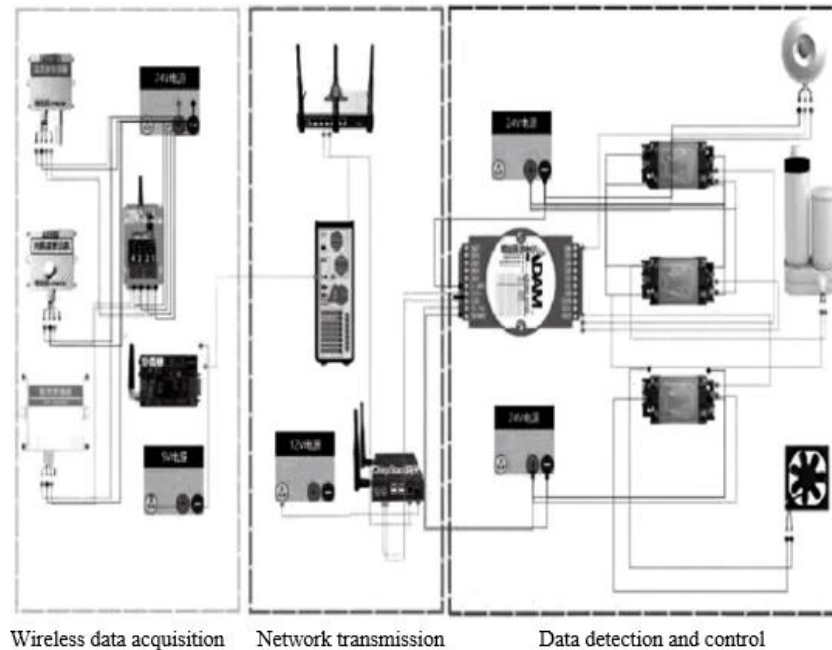


Figure 2. Composition of intelligent gate environmental monitoring system

Mobile control. Functions such as login, control and inquiry are realized through the API interface provided by the cloud platform.

(1) Login function. The AccessToken that returns after successful login is saved locally in SharedPreferences for subsequent inquiry and control.

(2) Control function. The function of data monitoring real-time display is provided after you log in the main interface; the opening and closing of the gate (electric drive pusher) can be controlled by clicking the “Open” and “Close”, and the gate animation will also switch accordingly; the history list interface will be displayed by clicking the “History Record” button.

(3) The function of filtering inquiries by conditions is supported, and the results are displayed in a list.

5. Conclusion

For the construction of new engineering, diversified and strongly innovative talents are needed to adapt to the future development trend. Under the background of such social needs, innovation & entrepreneurship education in colleges and universities becomes particularly important. We should set the overall objective of innovation & entrepreneurship education based on such elements as the positioning of the school, professional characteristics and social needs and integrate it into the professional education objective system, realize the integration of innovation & entrepreneurship education and professional education in the course system, course content, teachers and other aspects of professional education, and complete the training of innovative thinking and the application of innovative methods in professional learning. Teaching practices prove that the integration of innovation & entrepreneurship education and professional education is conducive to all students, students’ willingness and ability of thinking about and exploring the solution of problems are significantly improved, the classroom is gradually transformed into the mode of “being guided by teachers and dominated by students”, and the quality of talents is significantly improved.

References

- [1] GUO Xiu-zhe. Research on the Deep Integration of Innovation and Entrepreneurship Education and Automobile Maintenance Professional Education under the New Course Concept[J]. 时代汽车, 2022, 19(22):92-93.
- [2] WANG Hong-cai, LIU Juan-ying. Core Difficulties and Breakthrough Points of Innovation and Entrepreneurship Education in Universities[J]. China Higher Education, 2017, 53(Z2):61-63.
- [3] YE Tai-bao, DONG Ke. Research on Problems and Strategies of Innovation and Entrepreneurship Education in Chinese Universities[J]. Modern Business Trade Industry, 2019, 40(10):145-147.
- [4] HE Shun, ZHANG Bo, WANG Feng-ling, et al. Reform Exploration of the Internet of Things Engineering in Innovation and Entrepreneurship Education[J]. Internet of Things Technologies, 2018, 8(1):118-120.
- [5] JIANG Wen-bo, GENG Qiang, CHEN Xian-jun, et al. Research and Practice on the Construction of Internet of Things Technologies Innovation and Entrepreneurship Base[J]. Internet of Things Technologies, 2017, 7(9):105-107.
- [6] LI Wen-xiu, BI Ying, YU San-san, et al. Practical Exploration of Innovation and Entrepreneurship Education under the Background of New Engineering[J]. Higher Education in Chemical Engineering, 2018, 35(2):1-5.
- [7] WU Jun-feng. Building an Application-oriented Office System Closely Integrated with Local Economy and Society[J]. China Higher Education, 2017, 53(18): 51-53.

- [8] WU You-long, YANG Zhong, XU Nan, et al. Exploration and Practice of Talent Training Model for Innovation and Entrepreneurship of Internet of Things Engineering in New Application-oriented Universities[J]. Internet of Things Technologies, 2020, 10(2):115-116.
- [9] LIU Xiao-ning, CAI Jing-lei. Practical Exploration of Innovation and Entrepreneurship Education Under the Background of New Engineering[J]. The Theory and Practice of Innovation and Entrepreneurship, 2019, 2(4):147-148.
- [10] WANG Xin, JIANG Feng, SUO Zhong-yuan, et al. Research on the Mode of Integration of Innovative Entrepreneurship Education and Material Forming Professional Education in the Context of the New Engineering[J]. Journal of Jilin Institute of Chemical Technology, 2021, 38(2):28-31.