

COLLABORATIVE EDUCATION MODEL ON GIS MAJOR UNDER THE PROFESSIONAL CERTIFICATION OF ENGINEERING EDUCATION

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ABSTRACT:

Engineering education professional certification is a training model for engineering professionals based on international models. This paper discusses the inspiration of domestic and foreign engineering education practice to talent training in China. Based on the core elements of engineering education professional certification, we propose a closed-loop collaborative education model for study and research with "four integrations-two innovations-one education reform" as the core elements. This may be helpful to train the technological ability of students of GIS major. The exploration and practice of talent training in our school have achieved good results in talent cultivation, providing ideas and cases for exploring student-centered talent training.

1. INTRODUCTION

Engineering education professional certification is an internationally accepted quality assurance system for engineering education. Since 2004, a large number of engineering majors in domestic universities have successively passed the assessment and carried out engineering certification education, realizing the internationalization of engineering education in China. Three core concepts of professional certification in engineering education: student-centered, outcome-oriented instructional design, continuous improvement of quality assurance mechanism. Combining the current situation and needs of cultivating the large number of engineers in China, the country has put forward an action plan for the construction of emerging engineering education. Since 2017, the construction of emerging engineering education in China has gone through the trilogy of "Fudan Consensus", "Tianda Action" and "Beijing Guideline". Its core concept is to establish a multi-subject engineer training responsibility community, which has realized the development of emerging engineering education from concept to action (Xiao 2020). Among them, the "Beijing Guideline" requires that the construction of emerging engineering education should improve the multi-subject collaborative education mechanism, and deeply promote the integration of industry-university and school-enterprise cooperation (Wang 2018). In this background, this paper takes geospatial information system (GIS) major as a sample, combines the goal orientation of engineering education professional certification and the action path of emerging engineering education. And we explore the design and concrete implementation path of the cooperative education mechanism under the certification of engineering education specialty, which can provide experience reference for the construction of emerging engineering education in China.

The major of GIS is combined with the characteristics of urban spatial information of Beijing University of Civil Engineering and Architecture (BUCEA), aiming at the cultivation of innovative talents, facing the future urban planning, design and construction management, continuously deepening the concept of cultivating innovative engineering talents, practicing the quality concept of "student-centered, output-oriented and continuous improvement", and building a collaborative cultivation model in which the schools, enterprises and teachers are the main training bodies of multi-cultivation.

In the following part of this paper, we will explain the conception of collaborative education model focusing on "teaching-research-application", the reform practice of "school-enterprise-teacher", and the effectiveness of collaborative education of GIS major.

2. STATE OF STUDENT TRAINING IN GEOSPATIAL INFORMATION ENGINEERING

Various colleges and universities in China have successively carried out international engineering certification assessment, and a large number of related majors in colleges and universities have passed the assessment and carried out engineering certification education, realizing the internationalization of engineering education. The talent training mechanism emphasized in engineering education, such as all staff meeting standards, process control, quality control, and continuous improvement, has greatly improved the training mode of engineering talents in China, and improved the quality of talent training. At the same time, the talent training mechanism has also brought some conflicts with China's original training model, training plan and talent training orientation. For these urgent improvement problems, relevant experts and scholars in China have conducted a series

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of explorations: Zhu Fang, Lu Baohe and others have carried out research on the cultivation of practice and innovation ability of safety engineering major in the context of professional certification (Zhu et al., 2015); Hu Yang and Tan Kaixuan conducted a seminar on the construction of off-campus innovative practice base of resource exploration engineering in the context of professional certification (Hu et al., 2015); Li Ying conducted a study on the innovative mode of cultivating engineering practice ability in the context of engineering education (Li 2014); Other scholars, such as Zhang Weijie, Chen Yun, Tian Wei and Xie Pan, have put forward their insights on how engineering education can be better integrated with the original talent cultivation system in China from different focuses (Jiang et al., 2016, Chen 2015, Xie et al., 2010).

The discipline of surveying and mapping science and technology and GIS need to give full play to the advantages of multidisciplinary collaborative innovation, crossover and comprehensive penetration, the joint research ability to solve major scientific and technological problems, strengthen the strength of the discipline's basic research, and promote the crossover penetration of disciplines as well as the rapid development of the disciplines (Chen 2013). Universities in America and Europe that offer GIS majors also take into account the characteristics of their interdisciplinary use to solve comprehensive engineering in terms of curriculum settings (Qing et al., 2018, Zhao et al., 2016). GIS is a major with obvious technology and obvious industry demand. By investigating the training programs and objectives of the mapping engineering and GIS majors of Wuhan University, Nanjing University, Nanjing Normal University, Capital Normal University, Sun Yat-sen University and other universities, Wang Mingchang and other scholars believe that the GIS major should combine industry needs and highlight hands-on practical skills (Wang et al., 2018).

Engineering education certification requires all students to meet the standard, that is, it can not only meet the basic theoretical teaching requirements, but also take into account the needs of multi-level innovative talents for enterprise or social development. However, in the actual educational practice, due to the differences in learning ability, the simplification of teaching content, the rapid change in the society's demand for innovative and entrepreneurial talents, the existing talent training and education model cannot meet the consideration and deep integration of all staff reaching the standard and innovation and entrepreneurship. Especially in recent years, under the background of innovation and entrepreneurship education promoted by the state, colleges and universities urgently need a new training and education model. At present, there are mainly the following problems that need to be reformed and improved:

(1) Lack of continuous updating mode of teaching content. For a long time, theoretical teaching has been more important than practical teaching, which deviates from the engineer training goal of engineering education. The continuous updating of teaching content is not only an important guarantee for graduates to be qualified and smoothly transition to work, but also a basic guarantee for innovation and entrepreneurship. However, the teaching content has long been constructed against the background of the knowledge system of college professor committees or experts, and there is a lack of continuous updating mode of teaching content connected with industrial production.

(2) The phenomenon of hard landing for graduates is obvious. Graduates cannot make a smooth transition with scientific research teams and production enterprises in terms of knowledge reserve and skill level. Most students need secondary intensive training to adapt to their jobs. This is related to the lack of comprehensiveness of the course teaching content and the lack of engineering practice ability. Under the background of engineering certification education, engineering education should return to practice and application, and the skill level should be effectively improved to achieve a smooth transition between graduation and employment.

(3) The innovation and entrepreneurship platform is not obvious. For a long time, theoretical reasoning has been dominant in teaching and research, and there is little practice of innovation and entrepreneurship. The lack of innovation and entrepreneurship platform in teaching and research makes it difficult to carry out practice-oriented integrated teaching mode.

3. IDEAS AND PRACTICE OF THE CLOSED-LOOP COLLABORATIVE EDUCATION MODEL

3.1 Collaborative Education Model of Teaching, Research and Application

Taking the construction of the talent training mechanism for GIS in Beijing University of Civil Engineering and Architecture (BUCEA) as the research object, we deeply analyse the current situation of talent training in this specialty, comprehensively analyse the current situation of the society and enterprises' demand for innovative talents in the new era, and deeply study how to realize the cultivation of engineering ability and innovation ability under engineering certification education, build a closed-loop collaborative education mechanism of "teaching-research-enterprise application" (Figure 1), realize the in-depth integration of engineering certification and innovation and entrepreneurship, and complete the system reform and construction of training programs, teaching resources and teaching management.

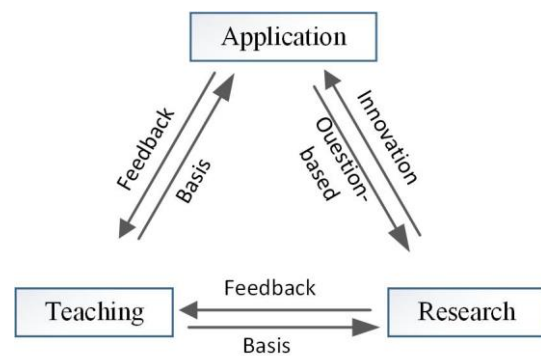


Figure 1. Closed-loop education mechanism of academic and research

3.2 Explore and Practice

Based on the specific situation of BUCEA, we continue to deepen the training of applied innovative talents, carry out theoretical research and exploration, solve the multi-subject collaborative education research and exploration of the talent training model, and solve the problem of insufficient theoretical exploration (Wang 2021). Based on the feedback information of talent training, we build a special course group teaching system integrating specialty and innovation, which

can improve the level of coordination and continuous updating of teaching content. We build a school-enterprise joint laboratory, construct an innovation and entrepreneurship platform, and aim at solving complex engineering practice ability training to promote a smooth transition of talent training and employment. Under the background of engineering certification education, engineering education should be returned to practice and application, and the level of skills should be effectively improved.

(1) Construct a hierarchical and shunting collaborative education model. According to the full compliance requirements of engineering certification education. Taking into account the personal choice of students, the training can be divided into layers according to the classification of engineers or scientific research talents, that is, to strengthen the "application" and jointly "teaching-research" to carry out the collaborative training mode of engineer training. Strengthen "research" and jointly "teaching-research" to develop a problem-oriented integrated scientific research talent collaborative innovation training model (Lin et al., 2019, Lei et al., 2020).

Combined with the current situation of talent training in the GIS major of BUCEA, in the exploration and practice, we take the three core concepts of engineering education certification as the principle, and aim at cultivating applied innovative talents (Li et al., 2019). In practice, explore the

implementation path of "early diverting and setting direction, focusing on layers and implementing, and educating students with multiple subjects". The schematic diagram of the specific implementation path is shown in Figure 2. According to the time series of talent training, students are encouraged to determine their professional direction as early as possible in the third semester of completing general education and professional quality education. Guide students to correctly understand professional characteristics and stimulate academic interest through counsellors, professional teachers, corporate technology lectures, and academic lectures. In the fourth semester, a one-to-one academic tutor system is established for all students, and academic tutors are determined to provide guidance and talent training for students in terms of personal development, mental growth, and academic guidance. In the following 5-6 semesters, 20%-30% of outstanding students will be selected to participate in the research projects of the institute (room) to cultivate students' professional skills. At the same time, according to the needs of the project, some enterprises will participate in it. In the 7th and 8th semesters, according to the needs of students' employment and postgraduate entrance examination, enterprises, colleges, and tutors jointly participate in individualized guidance, so as to cultivate students' innovation and job quality education. Based on this model, hierarchical teaching practice has been explored in professional course teaching, and good teaching effect has been achieved (Du et al., 2020).

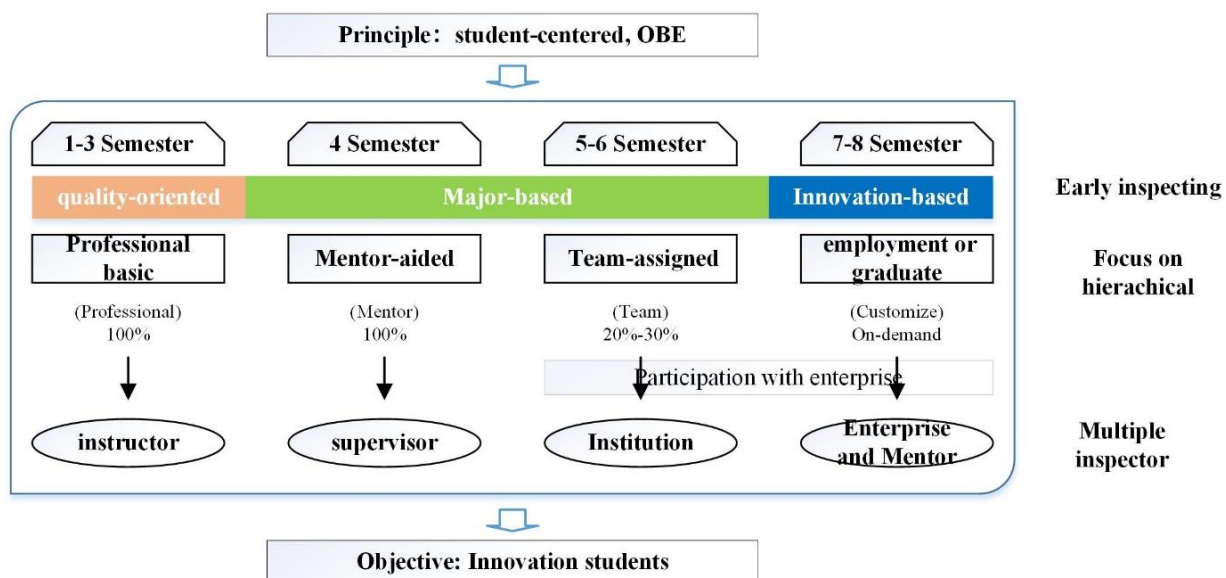


Figure 2. Practice path of stratified shunt collaborative education

(2) Build a collaborative education platform for learning and research with the joint laboratory as the carrier. Construct a joint laboratory of school-enterprise cooperation, establish school-enterprise resource collaboration, fully integrate the hardware resources and human resources of universities, as well as the geospatial data resources and project practice resources of enterprises, and study the collaborative innovation talent training mode oriented to practical engineering problems.

Combined with the current situation of the integration of production and education in GIS major, BUCEA actively uses various school-enterprise platforms to integrate teaching, scientific research, industry, innovation, etc., and strives to

cultivate applied innovative talents. Among them, the collaborative education platform of multiple subjects is shown in Figure 3. Through the multiple subjects of schools and enterprises, the closed-loop talent training model of learning and research, such as the integration of learning and training, the integration of learning and competitions, and the integration of application and innovation, is implemented. In the implementation content and implementation process, take into account the basic knowledge learning and the ability to solve complex problems.

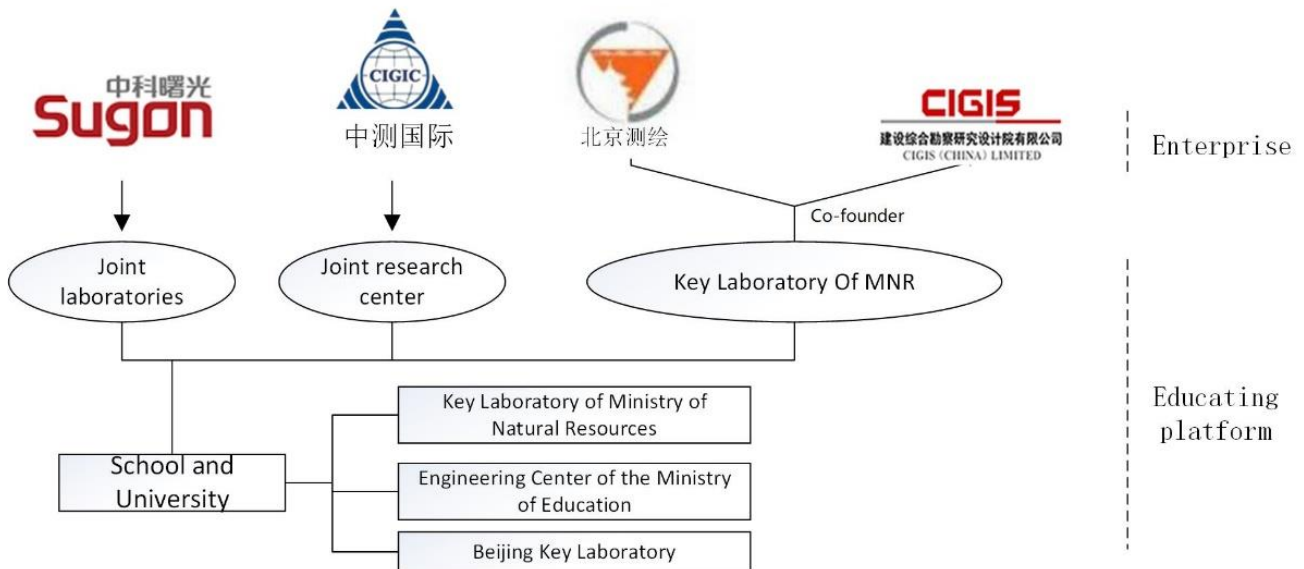


Figure 3. Multi-subject collaborative education platform

(3) Explore the teaching system of characteristic course groups integrating major and innovation. Based on the dual information feedback of scientific research and enterprise application, explore the continuous updating mechanism of teaching content, and build a characteristic course group with deep integration of majors and innovation and entrepreneurship, and cross-integration of geographic information and computer science.

Combined with the characteristics of the GIS major of BUCEA, the urban spatial information "collection-editing-application" is taken as the characteristic of talent training, and the practice training axis of "collection, editing and application" is designed, supplemented by "scientific research in scientific research theory teaching" and "technical practice enterprise application", forming a characteristic course group integrating professional knowledge and innovative application. As shown in Figure 4

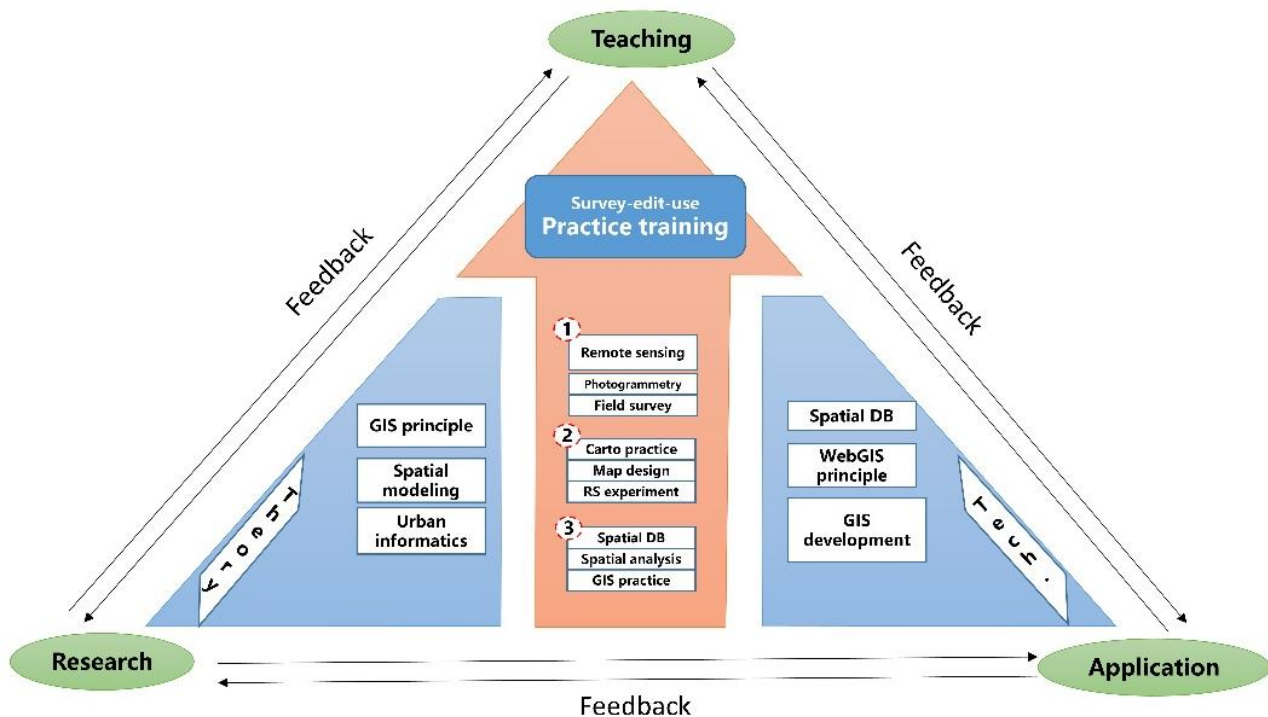


Figure 4. Create a group of courses with unique features

4. EFFECTS AND THINKING

The collaborative education system proposed in this paper has been applied and practiced in the talent training of GIS in BUCEA, and gradually showed the reform effect. In particular, relatively obvious results have been achieved in the improvement of students' ability to solve practical problems, the cultivation of scientific research literacy, the results of academic competitions, and employment, breaking through the contradiction between engineering and scientific research in talent training, and strengthening "research" and "application" blending.

(1) Hierarchical ability training promotes breakthroughs in students' employment and further education

The destinations of graduates majoring in GIS are divided into four categories: further studies/going abroad, one-time employment, freelance employment, and temporary non-employment, as shown in Figure 5. Among the graduates in the past five years, the one-time employment rate of GIS major has remained stable, ranking among the best in the BUCEA's majors,

and has provided a large number of geographic information professionals for the urban planning, construction and management industry. The proportion of studying abroad and studying at home has increased year by year. In 2019, the proportion of advanced studies reached 35.29%, an increase of 8.68%, 6.06% and 1.96% compared with 2016, 2017 and 2018, respectively. However, affected by the epidemic in 2020, the number of people (including the civil servant series in November of the year of graduation) who have not been employed for the past two years has increased. From the analysis of employment destination, the region is dominated by Beijing, supplemented by cities such as Shanghai and Tianjin, which is strongly related to the fact that the students in BUCEA are mainly from Beijing. In terms of industry, it mainly focuses on high-tech enterprises and mainstream units in the industry. For example, in the past five years, graduates have found employment in internationally renowned companies, such as Tencent Group, AutoNavi Software Co., Ltd., Xiaomi Group, and SuperMap Software Co., Ltd., which proves that the high quality and high employment level of the students in GIS major.

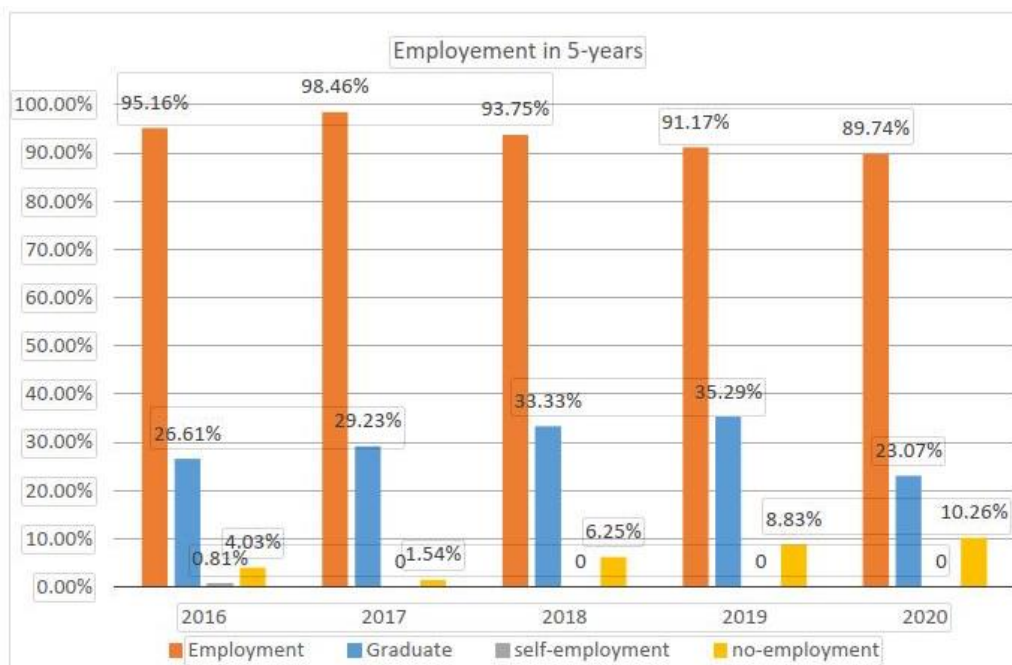


Figure 5. Chart of graduates' whereabouts in recent 5 years

(2) The integration of research, innovation, production and education has achieved results

Student training pays attention to the guidance of research topics, undergraduate students into the team, and the ability to improve and cultivate through the allocation of academic tutors and scientific research tutors. On the other hand, through the implementation of the integration of production and education in recent years, the practical experience of enterprises has been integrated into teaching and personnel training, which has improved students' practical innovation ability. Originally, as a local industry college and a small field major, it was difficult to get a ranking in the national first-level competition, but in recent years, the GIS major has won the silver award of the "Creating Youth" Entrepreneurship Competition, the second prize of "Internet +", and the second prize of "Challenge Cup". The excellent results such as the

first prize and other awards are ranked among the top universities in Beijing, achieving a historic breakthrough in the school's competition performance.

In the competition organized by the industry, the GIS students of BUCEA participated in the National College Students GIS Skills Application Competition, SuperMap Cup National College GIS Competition and ESRI Cup National College Students GIS Development Competition and other competitions, and won a total of 8 collective awards, 32 the individual awards for each person-time, including 3 first prizes, 2 second prizes and 1 third prize (Table 1), have been significantly improved compared with the previous results. Compared with similar sibling universities, our university won the fruitful results.

Year	Project name	Prize level	Grant department
2015	The 4th National College Students GIS Application Skills Competition	first prize	China Association for Geospatial Information Society
	ESRI Cup National Undergraduate GIS Software Development Competition	winner	Chinese Society for Geodesy Photogrammetry and Cartography
2016	The 5th National College Students GIS Application Skills Competition	first prize	China Association for Geospatial Information Society
	The 6th National College Students GIS Application Skills Competition	second prize	China Association for Geospatial Information Society
2017	ESRI Cup National Undergraduate GIS Software Development Competition	third prize	Chinese Society for Geodesy Photogrammetry and Cartography
	The 7th National College Students GIS Application Skills Competition	first prize	China Association for Geospatial Information Society
2019	The 8th National College Students GIS Application Skills Competition	second prize	China Association for Geospatial Information Society

Table 1. Students' Awards in National Industry Competitions (2015-2019)

(3) Professional and entrepreneurial integration and continuous updating to promote professional construction and further improvement

The collaborative education model proposed in this paper encourages teachers to bring scientific research results and innovation and entrepreneurship education into the classroom to achieve the integration of teaching and scientific research, and to continuously update teaching content and teaching methods. Through continuous updating, students' horizons and ability to solve practical problems are expanded, which is more time-sensitive than traditional updating training programs. The improvement effect is obvious, and the collaborative education model has promoted this discipline to be approved in the first batch of Beijing high-precision disciplines in 2019, and the surveying and mapping engineering major in the first batch of national first-class majors in 2020.

5. CONCLUSION

The existing engineering education model is a top-down constituted talent cultivation model, focusing on the systematization of knowledge framework and training program, failing to fully consider students as the training object. Based on the core elements of engineering education professional certification, this paper proposed a closed-loop collaborative education model with industry-university-research. It explores the hierarchy level and features of university collaborative education method, builds a joint laboratory as a practical carrier with the integration of industry, university and institute. The application of the new model has enhanced the students' professional ability, but there are still limitations. For example, how to further enhance students' innovative ability to analyse and solve complex problems? Therefore, the future teaching practice work to further explore the integration of cross-discipline and give full attention on the advantages of education-industry integration.

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