Journal of Trends in Life Sciences
ISSN: 2960-0200

IMPROVING THE CORE COMPETITIVENESS OF STUDENTS MAJORING IN BIOTECHNOLOGY AND BIOENGINEERING BASED ON STEAM MODE

Wang Lu[1], Wang Xiaowu[1,2], Zhang Minxia[1,*]
[1.] *School of Electrical Engineering, Shenyang University of Technology, Shenyang 110870, China;*
[2.] *School of Physical Education, Jimei University, Xiamen 361021, China.*

Abstract: Using the STEAM model to cultivate students majoring in biotechnology and bioengineering in the School of Life Sciences of Beijing Institute of Technology for more than 10 years, the basic connotations are to improve the awareness of responsibility, the scientific spirit of seeking truth from facts, the practical ability of innovation, and the advanced international vision. core competitiveness. Specific measures include: ① do a good job in the top-level design and ensure the direction of educating people; ② implement research-oriented teaching links to strengthen the scientific spirit; ③ increase extracurricular scientific research practice to cultivate innovative potential; ④ develop a global vision in international exchanges and learning ;In the practice of domestic enterprises, exercise innovation ability; ⑤In practice research, increase knowledge, stimulate interest, and establish a sense of family and country. A variety of measures are adopted in the experimental teaching and practical teaching outside the classroom, and the teaching effect is remarkable, in order to provide reference for the cultivation of relevant professional talents.
Keywords: Undergraduates; Core competitiveness; Biotechnology major; Bioengineering major; Innovation

1 THE CONCEPT OF STEAM AND IMPROVING THE CORE COMPETITIVENESS OF STUDENTS MAJORING IN BIOTECHNOLOGY AND BIOENGINEERING

At present, industries closely related to life sciences are still in the development stage, and the demand for talents, especially high-end talents, is still in its infancy. In addition, the enrollment scale of existing and newly established life science colleges in most universities in the early 21st century With rapid expansion, it is becoming more and more important to improve the quality of personnel training for life science majors (such as biotechnology and bioengineering majors). As the core participants in professional construction and student training, how to reform the talent supply-side training mechanism for teachers, how to improve the learning enthusiasm of students majoring in biotechnology and bioengineering, stimulate their innovation potential, and enhance their core competitiveness has become a top priority. It is also a difficult problem that must be paid attention to and solved. To this end, based on the "STEAM" concept, we have built a multi-dimensional comprehensive education system to cultivate and improve students' comprehensive quality and innovation ability, and continuously improve their core competitiveness. This core competitiveness should at least include a strong sense of responsibility (or patriotism), a scientific spirit of seeking truth from facts, a practical ability to be brave in innovation, and an advanced international vision.

1.1 The Essence of the STEAM Education Model

1.1.1 Under the new historical orientation, the focus of personnel training The 19th National Congress of the Communist Party of China announced that socialism with Chinese characteristics has entered a new era
This is the new historical orientation of our country’s development. Under the new historical orientation, colleges and universities should focus on the following aspects when carrying out talent training, especially those in non-popular majors: ①enhance the sense of responsibility of college students and the feelings of family and country; ②increase the number of college students The correlation between courses integrates multi-disciplinary knowledge; ③ builds a bridge between practice and innovation, and stimulates the innovative potential of students; ④ takes professional experimental teaching as the entry point, and continuously strengthens the scientific research quality and innovation ability of college students ; ⑤ Stimulate and mobilize the professional interests of students of non-popular majors through multiple channels and dimensions.
1.1.2 Under the new concept, the main points of educating people
With the rapid development of higher education, it has become an inevitable trend to reform the talent training model based on the STEAM concept. Multi-channel and multi-methods strengthen teachers' understanding of the law of higher education development. It is very important to understand the concept of STEAM education, especially for teachers to reform the education model. The academic recognition and the content integration between courses are the key to solidifying the STEAM training concept. The basic embodiment of STEAM training mode is the interdisciplinary integration of courses. It is not only the development demand of education and teaching methods, but also the realistic

demand of social development and many tasks that require personnel with strong comprehensive ability. Therefore, the practice of STEAM training mode can also be Reduce the time for secondary training of enterprises and improve social benefits.

1.1.3 Under the new goal, the key points of cross-integration

Science and technology are the focus of traditional education and teaching, while engineering is mostly based on theory. Although mathematics knowledge is more involved in engineering courses, there are few opportunities to apply it to practical problems. Therefore, students need to be exposed to reality and discover problems. This process is not to marginalize scientific knowledge, but to apply what you have learned, and in more cases, it can in turn promote theoretical learning. Therefore, the proposal and application of the STEAM concept and the traditional teaching mode are mutually complementary and jointly promoted, and have the effect of 1+1>2 mutual benefit.

In the process of STEAM education, dual teaching goals are emphasized: to achieve the goals of traditional teaching and to have interdisciplinary goals. That is to realize the improvement of one's own STEAM literacy and the innovative development of knowledge, while also emphasizing the non-linear teaching process.

2 EXPLORATION AND PRACTICE OF STEAM TRAINING MODE

2.1 Revise the Training Plan and Strengthen the Integration of Courses

After years of understanding and exploration, we implemented the concept of STEAM when revising the 2016 version of the subject training plan. One is to integrate the typical STEAM course "Biotechnology Research Practice" for biotechnology majors, and "Bioengineering Research Practice" for bioengineering majors, and greatly reduce the total credits from the original 191 credits to 158.5 credits. The second is to require the integration of different courses, flexible learning and application of the concept of STEAM. Specifically: ① Integrate mathematics into various professional courses. By sorting out the typical content in each professional course, the mathematical logic in the existing content is emphasized. ② Emphasize the application of technology in the process of teaching scientific theory, especially the application of technology to theory and practical engineering. ③Emphasis on the role of science in promoting the industry, requiring a few typical examples in important core courses to illustrate the leading role of sustainability in new products and new industries.

2.2 Implement Research-based Teaching and Build Up the Scientific Spirit

We focus on building solid professional skills through research-oriented specialist laboratory courses and project/topic-based dissertation work. Through designed professional experiments such as "Biotechnology Comprehensive Experiment", "Bioengineering Comprehensive Experiment", "Bioseparation Engineering Experiment" and other courses and scientific research reports, students can bid farewell to the teaching methods of conventional experimental courses. Condensate the experimental content that embodies "comprehensiveness, design, and engineering"

The whole class finished in groups, and finally reported collectively, analyzed the experimental results of the whole class and wrote research papers, and once again improved their scientific research quality and technological innovation ability. Graduation thesis work is an important part of realizing the concept of STEAM, especially in the integration and use of existing theories, technologies, and mathematical knowledge. For this reason, the responsible professor team will carefully treat students' topic selection every year and strictly control it. Engineering or a combination of the two, so that what students learn can be close to society and the market.

2.3 Strengthen Extracurricular Scientific Research Practice and Cultivate Innovative Potential

Based on improving students' practical ability and enhancing students' innovative ability, the college continuously promotes the implementation of the "combination of science and education, collaborative education" proposed by the Ministry of Education. Since 2013, the School of Life Sciences and the Institute of Biophysics of the Chinese Academy of Sciences have jointly established the "Bei Shizhang Elite Class", arranging students to carry out professional research at the Institute of Biophysics of the Chinese Academy of Sciences to improve students' understanding of modern biotechnology and product research and development. Encourage students' enthusiasm for learning with the innovative achievements of the national team, and build a strong cornerstone for their further studies with innovative ideas with a wide vision and a high position. At the same time, combined with the extracurricular independent exploration practice mainly based on college students' innovation and entrepreneurship projects (referred to as "Dachuang"), students' ability to refine topics and complete preset content will be cultivated again. Through the extensive mobilization of teachers and student working groups, a high proportion of Students took the initiative to declare, exercise and improve the scientific research potential of the students (Figure 1).

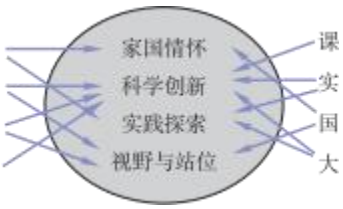

Fig. 1 Core competitiveness and STEAM training

2.4 Increase Opportunities for International Exchanges and Corporate Practice, and Cultivate International Vision Wild and Pragmatic Spirit

Study visits at home and abroad not only improve their innovation potential, but also cultivate their sense of national pride, national identity and the spirit of not admitting defeat and fighting hard. With the support of the school, all students went abroad for short-term (Belarus) or long-term (USA, Thailand) research studies to broaden their thinking, cultivate innovation, and enhance national pride. In addition, when students are organized to take courses such as professional understanding and professional practice in enterprises, and during the period of completing their graduation thesis in the R&D department of enterprises, students are required to focus on established themes and use knowledge such as theory, technology, and mathematics to solve engineering problems encountered, and then fully improve Improve students' understanding of modern biotechnology industry and product research and development, and promote their career choice in the later stage.

2.5 Organize Social Practice and Establish National Feelings

Actively responding to the slogan of "youth serving the country", organize students to carry out ecological scientific research and social practice with the main content of "viewing beautiful China and practicing ecological civilization" every year, leading students into the forefront of China's ecological civilization construction, through wetlands, Scientific exploration in different ecological environments such as deserts and lakes allows students to measure the beauty of China with their feet, contribute scientific wisdom, firmly patriotic responsibility, and pursue the ideal of becoming a talent and serving the country. At the same time, the students went to the grassroots level in rural areas, observed the national conditions, and conducted practical research. They clarified the social responsibility and mission of the times of the double first-class students, and thought about the practical ways to serve the country and social development in the future. This activity not only needs to conduct macroscopic research outdoors, but more importantly, it also needs to explore the biological mechanism behind it, that is to say, to retrieve samples, conduct certain analysis and testing in the laboratory, and based on existing theories Explain the problems found in the ecological research. This kind of problem-based exploration is the same as the product-based exploration of enterprises, and they will echo each other in the process of forming students' understanding of scientific research, gradually stimulating students' interest and understanding of scientific research.

3 CASE STUDIES IN STEAM PRACTICE

Since the 21st century, traditional classroom teaching has undergone tremendous changes. MOOC, Khan Academy teaching mode, split classroom, flipped classroom, research-based classroom, PBL mode, etc. are widely used and accepted by students; at the same time, the traditional training mode is also Changes have taken place, such as the credit system, academy system, individual majors, STEAM mode, etc.; there are phenomena such as unoptimistic student employment and low corporate satisfaction. The collection and analysis of relevant data and the rapid changes brought about by information technology, especially the impact of AI technology and products, have had a profound impact on teachers and students in the field of life sciences. It is objective and inevitable for non-popular majors such as biotechnology and bioengineering to accept and try new education and teaching paradigms including the STEAM training model.

3.1 Training Objectives Focus on Social Needs

How to make the educational concept meet the needs of the society? By studying the laws of educational development, investigating the employment history of students in non-popular majors, and analyzing the reasons, from passive reform to active reform, the educational concept is made to meet social needs. Therefore, the above ideas are used as important topics and references in the process of major construction seminars, training program revisions, curriculum reorganization, and teaching.

3.2 Practical Teaching in the Classroom

3.2.1 Change routine experiments into research-oriented experiments to solve problems such as monotonous courses, insufficient exploration, and unclear problem orientation

First of all, we must implement the concept of STEAM. In the "comprehensive biotechnology experiment", work should be carried out around the preparation and activity of medical lysozyme, including gene detection, induced expression, separation and purification, content and activity determination, crystal formation, etc., involving many theoretical and technical issues; In the "Comprehensive Bioengineering Experiment", Bacillus subtilisin was used as an example to explore; in the "Bioseparation Engineering Experiment", the work was carried out around the biologically active Ganoderma lucidum polysaccharide. On the whole, the problem orientation is clear and the cultivation of scientific research quality is strengthened.

Routine experimental teaching generally uses the same experimental conditions to carry out experiments, and finally writes the experimental reports of each group or individual independently. This method is too mechanical when the cultivation of innovative talents becomes the mainstream, and it does not help to improve their ability. writing ability. We explored the STEAM mode in the "Biotechnology Comprehensive Experiment" in the early stage, and after gaining experience, we promoted it in the "Bioseparation Engineering Experiment" and "Bioengineering Comprehensive Experiment" [4]. The specific method is as follows: each experimental process will involve many conditions, we carry out the orthogonal design according to the method proposed in the "biostatistics" course, each or two experimental groups complete an exploration, and all experimental groups complete the entire design Content, after the experimental results come out, the results of each group will be shared with the whole class; each group will report in the form of PPT and accept the questions from the instructor and students; finally, each student will report according to all the results, the records of the PPT report and the samples of scientific research papers provided Independently write research reports (not traditional experimental reports), so as to exercise students' ability to make PPT and accept inquiries, analyze data and write scientific research papers, which will promote the cultivation of students' scientific research potential. This training mode not only cultivates the scientific research quality of the students, but also cultivates the team consciousness of the students. The condition control of the experimental group is sometimes unique. If the results caused by careless operation and wrong operation are not discovered in time, but only discovered in the final PPT report and discussion session, it will affect the analysis of the entire result, resulting in " Unfortunately, the whole class and individual group members will be greatly touched and affected.

3.2.2 Change from extensive to precise and improve the standardization of experimental operations

Solve the problem of rough operation by strengthening the guidance to students' experimental details. The technical nature of experimental teaching can reflect the engineering nature of conventional experiments through the early intervention of students and the division and collaboration of experimental content, such as small divisions of labor such as team leaders, experimental inspectors, and experimental recorders. Specifically, start from two aspects: one is that each experimental group sends people to participate in the pre-experiment preparation work, so that students have a perceptual understanding of the complexity and standardized operation of the experiment; In order to find problems in time, reduce irregular operations, record and summarize in class. In the subsequent results reporting session, the instructor will list the typical non-standard operations again, so that students can deeply understand the motto "details determine success or failure".

In order to enhance students' understanding of the main laboratories of the School of Life Sciences and the typical technologies and equipment of each laboratory, we specially compiled a collection of technical systems of some research groups engaged in biotechnology, bioengineering, and biological science research in the School of Life Sciences for senior students. , its content includes information such as the principles, main uses, main equipment used, storage locations, technical directors and other information of 46 technologies. It is handy for students to find and use.

3.2.3 In the extracurricular practice, build a comprehensive quality training carrier with the "ecological scientific research" as the traction

Responding to the call of the country, using what they have learned to understand ecology, research ecology, and protect ecology is an obligatory duty for students majoring in life sciences, and it is also an important contribution of what they have learned. To this end, in response to the disconnection between students' social practice and professional knowledge points and the cultivation of scientific and technological innovation capabilities, we have constructed and implemented a scientific research quality training model that is oriented to scientific and technological innovation and themed on the hot issue of life science "ecological scientific research". Regular summer social practice activities generally focus on social science topics. The "Ecological Science Examination" of the School of Life Sciences has opened up a practice model that combines social practice with professional guidance and extracurricular innovation, and has achieved good results.

4 MAIN RESULTS

(1) Cultivate family and country feelings. Through the "ecological scientific research" activity, not only through the complete scientific training process of experimental plan design, process implementation, result analysis, and report writing, students can systematically master the whole process of carrying out a scientific research activity. , Social practice and national strategy are combined to improve students' understanding that what they have learned should serve

the needs of the country. Through the understanding of China's beautiful mountains and rivers, he cultivated his sentiment and aesthetic taste. Through international exchanges and competitions, recognize the gap between China and the world and its own advantages, and cultivate its ability to analyze problems objectively.

(2) The concept of integrating the STEAM training model into the training system and daily teaching work has been established among the teachers. as in undergraduate. Research experiments are carried out during the teaching process of the three most important professional experimental courses "Biotechnology Comprehensive Experiment", "Bioseparation Engineering Experiment" and "Bioengineering Comprehensive Experiment". In addition, more than 10 school-level teaching research and teaching reform projects have been approved, and more than 10 teaching research and teaching reform papers have been published.

(3) Encourage and guide undergraduates to apply for and have been approved for more than 50 national and Beijing university student innovation and entrepreneurship projects, and many others have been funded by the school. From 2016 to 2019, about 10 such projects were approved each year, with more than 65% of students participate and get exercise. He has won dozens of scientific and technological innovation achievement awards, typically including 4 gold medals in the International Genetic Engineering Competition (iGEM) and 1 first prize in the National College Student Life Science Competition.

(4) Establish a set of guarantee system for scientific and technological innovation with the help of summer social practice, and the students and teams have achieved outstanding results. Typical ones include "Exploring the Influencing Factors of China's Typical Wetland Development—Based on the Thinking of the Ten Years of Ecological Research in Shandong, Ningxia and Yunnan Provinces" won the 2015 National University Student Challenge Cup "Special Prize" "2018 Capital College Students Summer Social Practice Top 100 Team", wrote dozens of papers and published 2 monographs.

(5) The employment rate increases year by year. From 2015 to 2018, the employment rate increased steadily and remained above 90%, showing that students have high core competitiveness.

5 CONCLUSION

As mentioned earlier, the concept of STEAM is necessary to cultivate high-quality reserve forces for society and enterprises in the new era [1]. However, considering that there is a big difference between its problem-based or goal-based education model and the existing general education that focuses on imparting knowledge, it is fully

It is also a big challenge for colleges and teachers to fully understand and digest this model. On the premise of emphasizing the concept of STEAM education, it is also necessary to avoid paying too much attention to STEAM for career preparation, avoid the marginalization of scientific content, avoid the devaluation of basic science, and keep the origin of education, which is to give students experience and knowledge beyond the limitations of their personal experience and interests , reduce the narrow content of STEAM courses, and ensure that students gain indirect experience [3, 5-6].

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] Cai Haiyun. Design and practice research on STEM teaching model. Shanghai: East China Normal University, 2017.
[2]Ministry of Education. The 13th Five-Year Plan for Education Informatization, 2016, 2.
[3] Shao Lixuan. Research on project-based STEM teaching evaluation path under the concept of "student-oriented" education. Jiangsu Education Research, 2018, 378(18): 366-369.
[4] Zhao Dongxu, Sun Liquan, Yang Jianmei, etc. A New Model of Experimental Teaching Design for Comprehensive Engineering Majors. Laboratory Research and Exploration, 2016, 35(7): 214-217.
[5] Huang Xuejiao, Zhou Dongdai, Huang Jin, et al. Research on the Construction of STEM Teaching Model Based on Knowledge Construction. Modern Educational Technology, 2019, 29(6): 115-121.
[6] Song Yi, Ma Hongjia. The Value Implications of STEM Teaching: Based on Habermas's Theory of Knowledge Pursuit. Higher Science Education, 2019, 2: 1-8.