

Teaching Reform Integration of Scientific Research, Teaching and Psychology

Chunhua Feng*, Yilong Wu

*School of Mechanical Engineering, University of Shanghai for Science and Technology, Shanghai,
200093, China*

**Corresponding author: fengchunhua333@163.com*

Keywords: Integrated of Research and Teaching, New Engineering Course, Teaching Innovation

Abstract: The construction of new engineering requires the cultivation of innovative and practical engineering talents. Aiming at the common problems existing in the teaching of engineering courses, this paper proposes a teaching reform method based on the organic integration of scientific research, teaching and psychology. Specific measures: Integrate the scientific research projects of master and doctoral supervisors. According to the basic theoretical knowledge of professional courses, scientific research projects are classified. A basic theoretical knowledge system oriented to practical projects is constructed, which effectively improves the ability of new engineering students to master theoretical knowledge, innovate and solve practical engineering problems.

1. Introduction

Since the 21st century, in the new round of global technological revolution and industrial transformation, countries around the world have taken the development of intelligent manufacturing, industrial artificial intelligence, and industrial big data as important strategies to seize the commanding heights of future competition. Take innovative talents as an important support for the implementation of the manufacturing development strategy, and continuously reform the education and training system for new engineering talents. However, the current new engineering teaching model still has outstanding problems such as the disconnection between theoretical knowledge and engineering application, the single teaching mode of core courses, and difficulty in stimulating learning interest [1-2]. Therefore, this paper proposes that scientific research projects of the master and doctoral are studied, and a basic theoretical knowledge system by engineering projects is constructed, which can effectively promote the mastery of theoretical knowledge of new engineering students and improve students' ability to innovate and solve practical engineering projects.

2. The direction and focus of the training of new engineering talents

There are constantly increasing requirements for talents under the background of new engineering, enterprises, scientific research institutes, education systems, etc. It is necessary not only to master solid and rich theoretical knowledge, but also have the ability to solve engineering problems. At the

same time, the learning of professional courses is no longer the mastery of a single knowledge, but requires an interdisciplinary knowledge reserve, such as artificial intelligence methods, machine learning methods, etc., and the organic combination of mechanical disciplines. Taking the "Mechanical Testing Technology Fundamentals" course in the mechanical discipline as an example, the involved signal processing technologies, such as Fourier transform, correlation function, time domain signal, frequency domain signal and other knowledge. If it is not combined with the explanation of the engineering project, it is difficult for students to fully digest the knowledge they have learned, and they may even be in a state of confusion. Therefore, it is a very important means to make full use of the master's and doctoral supervisor's engineering projects and to construct an association system between engineering projects and theoretical knowledge based on the classification of projects based on basic theoretical knowledge.

3. The organic integration method of scientific research and teaching

Usually, college students have a strong scientific research interest in engineering projects, strong innovation ability, active thinking. And hence, research project can provide a certain degree of innovative thinking to the problems of engineering projects. Therefore, the advantages of students should be brought into full play, and the traditional single teaching model or simple multi-model can no longer adapt to the current talent market environment [3-4].

The vertical or horizontal scientific research projects of master's or doctoral supervisors generally study the frontier problems of science and technology or the technical problems that enterprises need to solve urgently. Taking full advantage of this advantage and correlating it with in-depth basic theoretical knowledge can improve students' enthusiasm for learning, and enhance engineering practice ability and innovation consciousness. It is a long-term process to continue to adhere to teaching reform and integrate scientific research elements, and we must continue to explore, practice and innovate.

Taking the University of Shanghai for Science and Technology as an example, it has carried out several courses on scientific research projects. The main purposes include reasonably increasing the difficulty of university courses, expanding the depth of courses, promoting the organic integration of scientific research and teaching, and cultivating students' innovative ability and scientific literacy. It has also formulated implementation measures, including applying for the qualifications of teachers, and cultivating scientific research projects for no less than one semester, and has achieved certain results. Teachers should have a rigorous scientific attitude, abide by scientific research ethics, a good scientific research reputation, high level, and sufficient funds, etc. and performer should limit the level of scientific research projects, which should rely on national, provincial and municipal government departments or enterprises at all levels.

The current method is to target some outstanding students. In the future, it should be popularized in the classroom and applied in reverse to all courses, not just the establishment of scientific research project courses. The content of scientific research projects is transformed into teaching resources for undergraduate courses, and students can promote the independent learning of relevant courses through project practice, thereby improving students' scientific research literacy and innovation ability, and having scientific research academic or industrial frontier.

4. Construction of an innovative curriculum system

Based on the organic integration method of scientific research and teaching, an innovative curriculum system with the following characteristics is constructed:

(1) Innovative model, multi-dimensional teaching. In the initial stage, with project courses as the carrier, students will be brought into the scientific palace of academic innovation, taught in

accordance with the talent training model created by scientific and technological inventions, explore new talent training models, and improve the quality of talent training. In the later stage, the basic theoretical knowledge of the course is used as the carrier to guide students in the reverse direction to associate the solutions of technical problems with the essential mechanism of things, transform technical problems into basic scientific problems. And teachers should explore the origin of scientific problems to achieve the organic integration of real scientific research and theoretical teaching knowledge.

(2) Industry integration, school-enterprise cooperation. Through scientific research practice training, students are encouraged to apply the knowledge learned and learn new knowledge to solve theoretical problems or technical problems in scientific research projects, so as to realize the combination of theory and practice. Considering the current technical problems of enterprises into the classroom, it could lead students to innovative thinking, and solve practical problems.

(3) Teachers and experts participate together. Teachers' scientific research innovation knowledge and achievements are transformed into classroom teaching content. Students master the most cutting-edge knowledge and latest technologies in this field. Through teacher-student interaction and expert guidance, students' innovative potential is stimulated and the mutual promotion of scientific research and teaching realized.

(4) Optimize the practice link and combine it with the discipline competition. Combined with the innovative requirements of new engineering-related competitions and the characteristics of scientific research projects, we will use our professional knowledge to jointly discuss the ability to solve practical problems. For example, the Internet + competition has been widely recognized. Students and instructors are highly involved, cooperate with each other, innovate constantly, improve the level of students' subject competition, and fully mobilize students' enthusiasm for learning.

There are still many problems that need to be solved urgently in the process of organic integration of scientific research and teaching, such as various engineering and technical problems, various types of technical problems, and how to effectively connect the most closely with the professional knowledge learned requires a step-by-step process. At the same time, the teachers' professional knowledge reserve and engineering practice experience are extremely demanding. In the future, it is not only necessary to establish a perfect system of organic integration of scientific research and teaching, but also to establish a reward mechanism to promote master and doctoral supervisors to continuously summarize the relationship between technical problems and scientific problems. Meanwhile, we should establish a perfect knowledge reserve database, and continuously expand excellent cases and classic cases.

5. Case study

Based on a section of mechanical control engineering course as an example, we stated how to integrate scientific research into the teaching process. The name of this section is “Steady-state error analysis and calculation”. Learning goals are described as follows:

- Understand the concept of the control system accuracy, the steady state error.
- The calculation method of master control system steady-state error.
- Understanding to eliminate and reduce the static error.

Teaching achievement expectations are “clear types of control system and the input signal to the influence of the steady-state error”; “Lay the foundation for the control system accuracy analysis and improvement”.

Education goals as:

- Based on the FAST project illustrate the importance of the accuracy of the control system of industrial products, to cultivate students the spirit of the best.

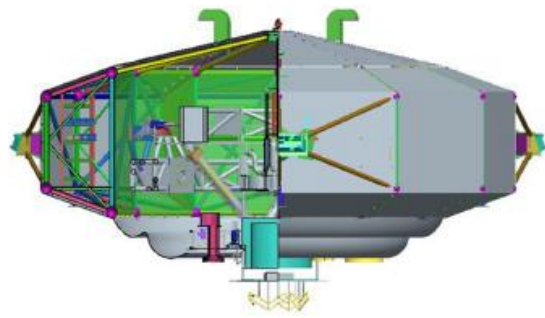
- The FAST project successfully stimulates science and technology of patriotic feelings and mission of students as home countries for science and technology major.

- By the father of the "third eye" - "role model" south Ren Dong struggle, guides the student to learn he grasped the nettle, indomitable before others, scientific spirit.

The integration of research project is the "Eye" of Heaven as shown in Fig.1 [5]. The world's largest 500-meter-aperture spherical radio telescope (FAST), "China Sky Eye" is the world's largest single-aperture and most sensitive radio telescope with my country's independent intellectual property rights. The large-scale and high-precision spatial positioning of the feed cabin is a very challenging technical problem. The team proposed a world-unique opto-mechatronics lightweight feed support system which embodies the craftsman spirit of excellence.



(a) "Eye" of Heaven



(b) Lightweight feed support system

Figure 1: The appearance drawing of "Eye" of Heaven.

The success of Tianyan is inseparable from Nan Rendong, Chief Scientist and Chief Engineer of FAST. He devoted all his efforts to FAST for 22 years and fought to the last moment of his life.

Integration point: Stability is the primary condition for the normal operation of the control system. Only when the stability of the system is determined can the accuracy and rapidity of the system be further required. To guide students to deeply understand the importance of national and social stability, each of us citizens must shoulder the responsibility of maintaining social stability,

6. Conclusion

This paper mainly discusses the problems existing in the process of organic integration of scientific research and teaching, the characteristics of constructing an innovative curriculum system, and summarizes the existing problems. It provides an effective way to explore the nature of scientific problems.

Acknowledgements

Funding: This research is funded by the National Natural Science Foundation of China Grant No. 51605294.

References

- [1] Wehrmeyer W., Chenoweth J. *The role and effectiveness of continuing education training courses offered by higher education institutions in furthering the implementation of sustainable development. International Journal of Sustainability in Higher Education*, 2006, 7(2): 129-141.
- [2] Álvarez-Huerta P., Muela A., Larrea I. *Disposition toward critical thinking and creative confidence beliefs in higher education students: The mediating role of openness to diversity and challenge. Thinking Skills and Creativity*, 2022, 43:101003.
- [3] Zhang Y., An R., Cui J., Shang X. *Undergraduate Grade Prediction in Chinese Higher Education Using Convolutional Neural Networks. 2021, LAK21: 11th International Learning Analytics and Knowledge Conference.*

- [4] Othayman M.B., Meshari A., Mulyata J., Debrah Y. *Challenges experienced by public higher education institutions of learning in the implementation of training and development: a case study of saudi arabian higher education. Journal of Business Administration Research*, 2021, 10.
- [5] Li D., Nan R., Pan Z. *The Five-Hundred-Meter Aperture Spherical Radio Telescope (FAST) Project. Proceedings of the International Astronomical Union*, 2012, 20 (S291): 989-1024.