

Cultivation of Energy-saving Innovation Ability in Energy and Power Engineering Major under the Background of Teaching Reform

Hao Xiaowen*, Wang Fangzhou, Wang Fuqiang

School of New Energy, Harbin Institute of Technology, Weihai, Weihai 264209, Shandong, China,

*corresponding author, haoxiaowen@sohu.com

Keywords: Energy-saving, Innovation, Energy and Power Engineering Major, Innovative, Science and Technology Competition

Abstract: One goal of the energy and power engineering major is to learn the principles and technologies of energy and then to save energy. Energy-saving and its innovation are also key development directions and frontier areas of the relevant enterprises and institutions. Professional courses of the energy and power engineering involve energy saving. But energy-saving involves a wide range. But the cultivation of the system's energy-saving innovation ability is lacking. This paper refers to three levels of innovation education. The cultivation of students' energy-saving innovation ability will be carried out in stages according to the characteristics of their grades. And how to strengthen the students' teamwork, to strengthen the guidance of teachers' scientific research, and finally to use competition as a means to improve students' energy-saving innovation are discussed. Thereby, the energy and power engineering major can cultivate energy-saving innovative talents needed by the society.

1. Introduction

Key factor for the sustainable development of society is technological progress and technological revolution brought by continuous innovation and development of human society. Various theories and abilities education in universities are bearing heavy responsibility of cultivating students as professional talents in the new era. Universities need to cultivate new types of talents with practical and innovative spirit to meet the needs of the times and society from the perspective of scientific and technological progress and talent cultivation [1-2].

Energy utilization is one of China's pillar industries and of foundations for China's new kinetic energy development. At present, China's economy is developing rapidly so that the energy consumption has risen sharply. The energy consumption causes many problems such as environmental pollution and resource shortage. The energy-saving can reduce environmental pollution and resource shortage in a certain extent. The energy-saving is also a cutting-edge direction that universities, research institutes and enterprises focus on. Therefore, the reform and innovation of the energy-conservation has attracted much attention.

"Energy and power engineering" major must continuously upgrade its education model and its education reform methods in accordance with the needs of enterprises and the institutions while meeting China's development. At the same time, the large-scale applications of the new technologies in the factories have raised higher standards and requirements for the training of professionals in the energy and power engineering major [3]. Therefore, the mode of the personnel training combined the energy-saving and the innovation together is a key component in the training of active professional systems.

2. Research of Energy-saving Innovation in Energy and Power Engineering Major

2.1 Innovation Education Being the Key to the Students' Cultivation

Innovative education is the foundation for the promotion of the innovative ability. The innovation education consists of three layers. The first layer is to learn innovation through learning.

The second one is based on the learning to become an owner with the innovative quality, innovative spirit, and innovative ability. The third one is to get new product through learning and innovation [4].

University students are busy with teaching contents and their examinations. Many university students fail to develop their creative thinking, which leads them lacking the consciousness to think and to innovate. The content of their innovations always lacks breadth and depth. However, international competition in various industries has become increasingly fierce in recent years. The grim situation requires contemporary Chinese students to be brave and initiative in innovation. Then the students can improve the innovation level [5-6].

2.2 Energy-saving Education in the Energy and Power Engineering Major

At present, there is not a relatively unified and widely recognized concept of energy education. But on the whole, the primary purpose of energy education is to make students recognizing the necessity of energy conservation, and to establish the energy-saving thinking. It is difficult to achieve the ultimate goal of energy education if energy education has only the intention to save energy but lacks the science and technology to promote energy-saving. It is difficult to meet the talent cultivating goal if energy education has only energy-saving technologies and no energy-saving awareness [7].

Energy saving can represent a future state of economic development [8], that is, while further increasing the efficiency of energy use, it can reduce energy consumption, establish a new energy structure and a new economic development model. Their core lies in energy-saving technological and institutional innovations [9].

Energy-saving is a broad concept and a part in the curriculum structure of the energy and power engineering. Major basic courses, major core courses, and major elective courses include part knowledge of energy-saving. Students do not systematically study energy conservation in the courses, and rarely extend to energy conservation innovation. It was found through papers that few specific and comprehensive active education reforms centered on energy-saving innovation.

Students in energy and power engineering study thermal science from freshman year. But the simple knowledge cannot make them meet the requirements of the energy innovation. Students' enthusiasm for innovation is not enough although the teaching of the specialized course will improve the lack of energy innovation. Students fail to meet the teachers' requirements or give up halfway when assisting teachers in scientific research without innovation initiative. Moreover, students' passion for innovation sharply plummets as grades increasing.

3. Cultivation of Energy-saving Innovation Ability for Energy and Power Engineering Students

According to the main problems in the previous section, this paper refers to the three levels of innovation education combining the training characteristics of majors and the situation of each grade together. This manuscript focuses on energy-saving innovation and carries out a step-by-step energy education reform. This manuscript enhance the cultivation of students' energy-saving innovation ability in the following three levels.

3.1 Basic Practice Level: Cultivation of Energy-saving Innovation Idea and Basic Innovation

Teachers communicate with students since the beginning of the freshman year to explain and promote energy-saving. Incorporating energy-saving into students' social responsibility education enables students to develop stronger energy-saving ideas. Students carry out energy-saving innovations about daily life, and participate into basic projects and competitions at school level.

3.2 Major Practice Level: Promotion and Systematization of Energy-saving Innovation in Training Program

Teachers innovate and reform the teaching mode and the content in professional basic courses. Then teachers establish a system of basic theory-simulation analysis-application examples in

transfer of energy-saving knowledge. Heuristic + contrastive teaching is used to bring the basic knowledge of energy discipline to life. A special teacher is responsible to systematize the fragmentary energy-saving knowledge during the each course, and teach with examples. This teacher should grasp the professional skills and comprehensive qualities of each student.

3.3 Innovation Practice Level: the Combination of Energy-saving Innovation and Practice Session

Energy-saving modules are integrated into curriculum designs and production practices. Alumni and experts at home and abroad can be invited to give cutting-edge lectures. The combination of energy and power engineering major and the company's needs follows the path of combined production, education, and research. In this way, teachers can strengthen the cultivation of students' innovative ability based on the curriculums and professional skills. Students are divided into multiple energy-saving innovation groups such as life product innovation, research product innovation, and competition product innovation according to students' hobbies and curriculum system. Students carry out corresponding scientific problem exploration or engineering innovative practice project and solution research for different types of energy-saving innovation groups. Teachers encourage students to publish scientific and technological papers and patents related to energy-saving, and encourage them to participate in science and technology competitions at all levels.

Major can establish a course teaching system that is more suitable for the cultivation of contemporary innovative talents, and provide a better environment for the cultivation of innovative talents under the system of the active education reform. At the same time, the major can establish an energy-saving innovative training model.

4. Implementation Path of Energy-saving Innovation Ability for Energy and Power Engineering Students

Energy-saving innovation has high requirements on students' training and teachers' ability. Students trained by energy-saving innovation are not only research-type talents with preliminary scientific research and innovation ability, but also elites and engineering talents with strong practical innovation ability. Not only the talents that the companies need, but also high-quality talents that can adapt to national development and even international needs. The following implementation paths can be selected to achieve this goal.

4.1 Cultivating Energy-saving Innovation in Different Grades

Teachers' requirements and research questions for students in energy-saving innovation training are different because the courses are set up in layers.

Freshmen mainly focus on setting up research questions for basic courses and changes in learning styles. Specifically, the introduction of energy-saving knowledge is proceeded in professional introduction courses, related scientific research, and class meetings. Freshmen follow the senior juniors or postgraduates who conduct them basic scientific exercises.

Sophomores are exposed to the basic principles of professional basic courses. At this time, problem-oriented training for energy-saving innovation is promoted.

Junior year is an important stage for students to cultivate energy-saving innovation. Teachers set up closely related research topics to fully exercise students' ability to find and solve problems according to the courses requirements and the direction of teachers research.

Senior students mainly focus on some engineering cases. The students should combine the cases with numerical analysis, engineering design, and analysis through production practice, curriculum design and graduation design. Thus they can further creatively solve some engineering problems.

4.2 Strengthening Team Collaboration in Energy-saving Innovation Training

There are many areas where energy-saving innovation can be generated. Teachers from energy and power engineering major should understand each other's research directions and research

frontiers through group discussions. Teachers combine theory with practice, and innovate the content related to energy-saving in the courses. Teachers carry out more comprehensive energy-saving teaching. Teachers can use energy-saving innovation as a link between the new and old teachers. Teachers tries to couple the professional courses into a system.

The teacher as instructor should pay attention to the coordination in the team, should arrange the work reasonably, should enable the students to take the corresponding direction, and should make the students achieving success in energy-saving innovation.

4.3 Enhancing the Energy-saving Innovation Ability Assisted by Competitions

Team of Students participating in the competitions should be driven by interest. Their goal is to get awards and is to solve the innovative problem-oriented. Scientific research and innovation ability of students can be improved by the competitions. Students' psychological quality, knowledge level, teamwork and innovation ability are tested through competitions. Students' energy-saving innovation ideas and energy-saving ideas can be inherited and carried forward by students from different grades.

Through the construction of energy-saving innovation in the new-generation professional course system, teachers train students' teamwork and writing skills in grades. Competitions are used to further enhance students' level of innovation. Thus, students' practical skills, innovation ability, comprehensive quality, knowledge application ability, and social adaptation ability can be enhanced.

Through the above studies, a training system more suitable for talents of contemporary energy-saving innovative has been established, thereby providing a good education environment for the cultivation of energy-saving innovative talents, and establishing a training model for energy-saving innovative talents.

5. Conclusion

This paper combines professional course learning, research-based learning, and students' innovative practice in energy-saving innovation for power engineering major. The innovation cultivation is driven by students' interest, by solving innovation problems, and by targets science and technology competition. Students' ability in energy-saving innovation research can be improved through the cooperation of the teacher team. Based on the methods of consciousness cultivation, teaching improvement, course database update, competition enhancement, and practice diversification, it has been progressively formed energy-saving innovation research in the active professional system for teaching reform. The reform really runs through the teaching for four years of university.

Acknowledgements

This work was supported in part by grants from Research Project on Teaching Reform of Undergraduate Universities in Shandong Province in 2018 (M2018B332) and Educational Teaching Research of Harbin Institute of Technology, Weihai (BKJY201919).

References

- [1] Ruhul S., Yao Y., and George S.C. (2017) Does Human Capital Matter for Energy Consumption in China?. *Energy Economics*, 67, 49-59.
- [2] Li J.K., Yang D.W., Li H.B., Wang H, and Wang F.Q. (2019) Numerical Analysis of Temperature Field of Photocatalytic Hydrolysis Hydrogen Production Reactor. *Journal of Liaoning Shihua University*, 39, 1-9.
- [3] Lina B.C., Julia K.S. (2017) A Framework for Decoupling Human Need Satisfaction from Energy Use. *Ecological Economics*, 141, 43-52.
- [4] Tiancheng O.U., Huang H.Z. (2017) Research on Innovation and Entrepreneurship Education

Reform of Energy and Power Engineering. *Journal of Higher Education*, 5, 3-4.

[5] Wang Z.R. (2016) Research on the Disciplinary Features and Development Orientation of Innovative Entrepreneurship Education in Chinese Universities. *Education Research*, 3, 56-63.

[6] Chen D.Y. (2016) Research on the Innovation Ability of Students in New Energy Science and Engineering Major. *Disciplines Exploration*, 27, 39-40.

[7] Yang M., Zhang G.J. (2017) Approaches to Energy Education in China's Colleges. *Journal of Southwest Petroleum University (Social Sciences Edition)*, 19, 23-28.

[8] Hao H.M. (2016) College Students' Consciousness and Behavior of Energy Saving in Guangdong. *Journal of Guangdong University of Petrochemical Technology*, 6: 81-84.

[9] Zhang Z.Q. (2016) A Survey and Study on Research on Energy Saving and Emission Reduction of College Students. *Journal of Hubei University of Education*, 8, 79-82.