Adult and Higher Education (2025)
Clausius Scientific Press, Canada

DOI: 10.23977/aduhe.2025.070202
ISSN 2523-5826 Vol. 7 Num. 2

Teaching reform and innovative talent training via industry-education integration for electrical and electronic engineering

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Keywords: Teaching Reform, Innovative talent training, Industry-education integration, Electrical and electronic engineering

Abstract: Emerging technologies such as big data, robots and artificial intelligence have become the focus of international competition, promoting the improvement and development of industries. The 2024 national education work conference in January pointed out that it is necessary to strengthen the link between science and education integration, industry-education integration, and talent training. Electrical and electronic engineering is the theoretical basis of various industries (e.g., electric power, mechanical electronics, chips et al.) and is related to a wide range of fields, so it is necessary to carry out the industry-education integration of electrical and electronic engineering. This paper focuses on the problems faced by industry-education integration, pays attention to the frontiers of industries, innovates the teaching modes, improves evaluation system of students, excites the learning enthusiasm of students, improves the innovation ability of students, and trains excellent engineering talents.

1. Introduction

In 2024, the national education work conference pointed out to deepen the integration of industry and education [1,2], and to promote the integration of "four chains" through technology transfer. In 2011, University of Shanghai for Science and Technology (USST) was approved as the second batch of colleges and universities under the plan of excellence. In 2023, the action plan for high quality development of USST in three years (2024-2026) issued by the committee of the communist party of China (CPC) of USST and USST pointed out that, it is necessary to build the strong relationship between the industry-education integration and the science-education integration [3]. In 2023, the implementation plan of labour education for students of USST issued by the Committee

of CPC of USST and USST pointed out that, it constantly deepens the industry-education integration and optimizes the talent training programs, curriculum contents and teaching modes.

Electrical and electronic engineering [4,5] is the theoretical foundation of electric power, mechanical electronics, chips and other industries, involving a wide range of fields and a large number of enterprises with professional counterparts. In addition, electrical and electronic engineering is a compulsory course for majors of engineering such as mechanical design and manufacturing and automation, energy and power engineering, food science and engineering, etc., benefiting more students. In summarize, this study relies on electrical and electronic engineering, to carry out the teaching reform [6] of industry-teaching integration and collaborative education.

2. Problems currently faced by industry-education integration for electrical and electronic engineering

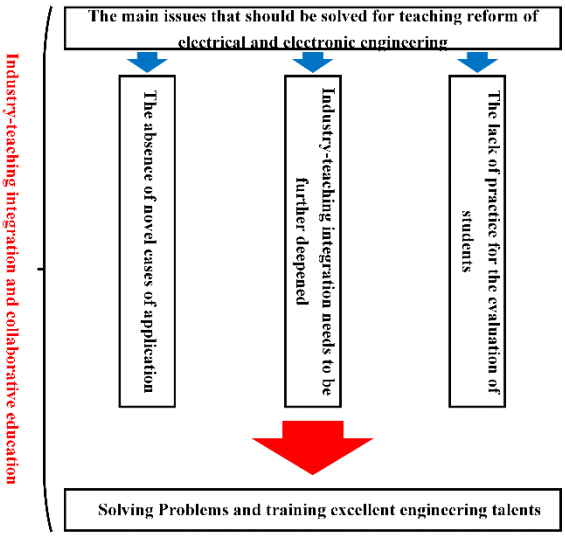

Figure 1: Problems currently faced by industry-education integration for electrical and electronic engineering

(1) The absence of novel cases of application

As shown in Figure 1,with the iteration of chips, computers and new energy (such as wind power, photovoltaic power, etc.), as well as the emergence of smart phones, smart homes and electric vehicles, these devices that utilize the theoretical foundation of electrical and electronic engineering, and combine with the Internet, artificial intelligence and advanced manufacturing technologies, play an increasingly important role in production and life, and create new demands for higher education. Based on above backgrounds, the content of electrical and electronic engineering gradually reveals the problems of lack of timeliness and practice, as well as the problems of emphasizing on theory and despising practice. However, the integration of industry and education can absorb the novel knowledge of the relevant industry in time, and constantly give the curriculum new content (including emerging technologies and social hotspots) to meet the students' thirst.

(2) Industry-teaching integration needs to be further deepened

At present, due to limited time in classroom, large content of curriculum and shortage of teaching aids, teachers mainly focus on the theoretical knowledge during the teaching process of electrical and electronic engineering, such as display of models, analyses of circuit and derivation of formula. There is a large gap between the teaching and engineering, meanwhile it is difficult to cultivate students' innovative thinking and practical ability. In addition, the visit of factory usually

makes no sense since the cooperation between school and enterprise is not close enough. Students cannot independently explore learning.

(3) The lack of practice for the students' evaluation

Performance in classroom, assignments and grades in final exams are regarded as the main evaluation in electrical and electronic engineering, emphasizing on theory and despising practice. Performance in classroom, assignments and grades in final exams mainly assess the students' theoretical knowledge, while the proportion of practical ability is low, cutting-edge knowledge is not involved, and engineering is not connected with the teaching. Therefore, students are not enough motivated to learn.

3. Corresponding explorations based on the electrical and electronic engineering

(1) Focusing on the frontier of industries and enriching the cases of applications

The traditional teaching content of Electricity and Electronics mainly focuses on theoretical knowledge, and less on production and life practice. Students are familiar with various types of problems, but are unable to solve practical problems. This study addresses the above problems, relying on DeepSeek, Unitree Go2-W robot dog, high-speed railroad, Huawei cell phone, DJI drone, BYD car and Xiaomi smart home and other "Chinese business cards", to explore the knowledge related to the course, stimulate students' enthusiasm for learning, and help students to broaden their horizons and cultivate patriotism. At the same time, it is aimed at the fields of Internet, artificial intelligence and advanced manufacturing, which are closely related to electricity and electronic engineering, and this study takes this as the starting point to expand students' knowledge in an all-round and multi-level way.

(2) Establishing novel teaching modes as well as conducting industry-teaching integration and collaborative education

The "five-step teaching method" is proposed to integrate teacher-student interaction and industry-education integration. This method takes social demand, industry-teaching integration, professional skills learning, and cultivation of engineering excellence talents as four entry points, and forms the four-step teaching mode of "collecting information before class - constructing theoretical knowledge system and applying it during class - industry-teaching integration and post-course innovation - feedback on teaching - and collaborative cultivation". Post-course innovation - teaching feedback - focusing on industry frontiers" teaching mode, the abstract Kirchhoff's law, Davening's theorem and the three-factor analysis method visualization, the complex three-stage tube amplifier circuit, integrated operational amplifier and combinational logic circuits physicalizing, the complex three-stage tube amplifier circuit, integrated operational amplifier and combinational logic circuits physicalizing. Physicalizing of complex three-stage tube amplifier circuits, integrated operational amplifiers and combinational logic circuits, deepening students' understanding and knowledge of professional knowledge, realizing on-campus resource integration, promoting in-depth school-enterprise integration, continuously broadening learning channels, enhancing students' ability to solve practical problems and innovation, and cultivating engineering talents of excellence.

(3) Building the novel students' evaluation systems as well as rectifying the misunderstanding of emphasizing on theory and despising practice

The traditional evaluation of electrical and electronic engineering emphasizes theory but not practice. This study takes into account the above situation, takes into account the existing evaluation (such as attendance, classroom performance, assignments and final exams, etc.), introduces the evaluation of practical ability (such as enterprise internship, innovation and entrepreneurship competition for college students, and research reports on the application of electrical engineering

and electronics in the industry frontiers, etc.), and builds a diversified student evaluation system to investigate the students' research ability and knowledge application ability. We have constructed a diversified student evaluation system to examine students' research ability, knowledge application ability, practical ability and teamwork ability, and to improve students' comprehensive quality.

4. Cases of applications

For Chapter 8 (triodes and their amplified circuits) in electricity and electronic engineering, a simple fire alarm, as a teaching aid (shown in Figure 2), is designed and made by a triode, a photodiode, a resistor and a buzzer. When the lighter is lit, there is a beeping sound, which serves as a warning.

The appearance of fire and beeping sound in the teaching aid makes students know the working principle of the triodes. Meanwhile, it greatly stimulates students' interest, exhibiting a good teaching effect in the past three semesters.

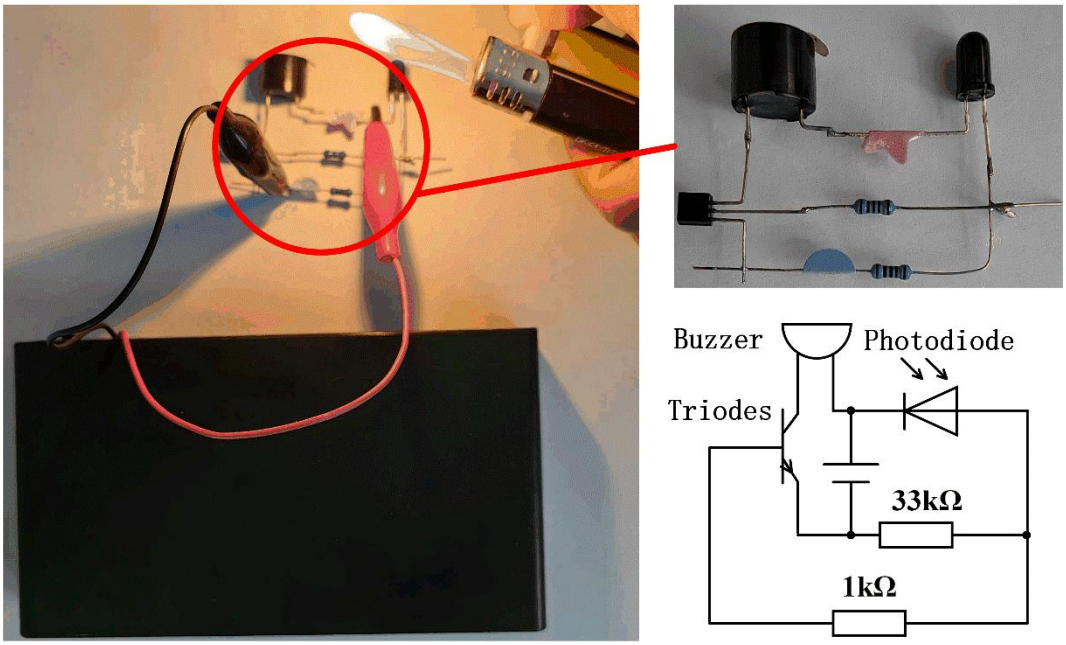

Figure 2: DIY teaching aids based on triodes

5. Cases of applications

(1) Proposing a new teaching mode and building a new students' evaluation system

The implementation of the "five-step" teaching methods and the new students' evaluation systems is benefit to teacher-student communication and industry-education integration. They can improve students' innovation ability, researching ability, knowledge application ability, practical ability, teamwork ability, problem-solving ability, and build a theoretical foundation for teaching reform of electrical and electronic engineering.

(2) Stimulating students' learning enthusiasm and developing students' innovative ability

Based on the theoretical knowledge of electrical and electronic engineering, students can gain satisfaction and sense of achievement by applying what they have learned to practice, as well as understanding the frontiers of the industries. This greatly excites students' motivation and develops their innovative ability.

(3) Forming a training program for excellent engineering talents in electrical and electronic engineering

For electrical and electronic engineering, we have cooperated with relevant enterprises to form a “three-in-one” cultivation model combining school education, enterprise cooperation and social practice. This will be applied to actual teaching and student cultivation, to promote industry-education integration and collaborative education.

Acknowledgements

This research was funded by the University-Industry Collaborative Education Program by Ministry of Education (Grant No. 220904469195013) and Shanghai University Youth Teacher Training Assistance Scheme (Grant No. ZZ202203047).

References

[1] He, Z., Chen, L., Zhu, L. (2023). A study of Inter-Technology Information Management (ITIM) system for industry-education integration, 9, e19928.

[2] Li, Y., Hsu, W.-L., Zhang, Y. (2022). Evaluation study on the ecosystem governance of industry–Education integration platform in China. Sustainability, 14(20), 13208.

[3] Kartashova, K., Shirko, T., Khomenko, I., Naumova, L. (2015). Educational Activity of National Research Universities as a Basis for Integration of Science, Education and Industry in Regional Research and Educational Complexes. Procedia - Social and Behavioral Sciences 214, 619- 627.

[4] Ab-Rahman, M. S., Hwang, I-S., Yusoff, A. R. M., Mohamad, A. W., Ihsan, A. K. A. M., Rahman, J. A., Nor, M. J.M., Kaharudin, I. H. (2022). A Global Program-Educational-Objectives Comparative Study for Malaysian Electrical and Electronic Engineering Graduates. Sustainability, 14, 1280.

[5] Salas-Rueda, R.-A., RamÃrez-Ortega, J. (2021). Students' perceptions about the use of flipped classroom in the field of electronic electrical engineering. Cadernos de Educa ção Tecnologia e Sociedade, 14, 158-166.

[6] Dimmock, C., Tan, C. Y., Nguyen, D., Tran, T. A., Dinh, T. T. (2021). Implementing education system reform: Local adaptation in school reform of teaching and learning. International Journal of Educational Development, 80, 102302.