Education Reform Discussion of Sensor Principles and Applications Curriculum Based on Innovation and Entrepreneurship Ideas

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**Keywords:** Education reform; CDIO method; sensor technology; two-combined mode.

**Abstract.** In order to enhance students' comprehensive qualities and deepen the innovative and entrepreneurial education reform (IEER), this paper discusses teaching content, teaching modes and methods of sensor principles and applications. A new system of the teaching content is arranged, and the teaching ideas take the students as the main body, and case teaching method may be first brought in classes. In the teaching process based in CDIO method, the sensor technologies may be considered into different-type practical subjects of different majors, the four two-combined measures are summed up in order to cultivate the innovative and entrepreneurial talents.

1 Introduction

Facing on the 21st-century sustainable development relying on the innovations of high technologies and the entrepreneurship that makes a huge contribution towards the quality and hopes of a country [1], the innovation and entrepreneurship education reform (IEER) needs to be deepened in every college and university proposed by the national education ministry. In the base of conventional education including the wide scope of quality-oriented education, thick foundation of a research-oriented education and personalization of an application-oriented education, IEER will challenge rigorously all kinds of correspondingly traditional course teachings, and must achieve the new breakthrough in general courses, professional basic courses, professional platform courses, specialized core courses and professional elective courses, which has to increase the ratio of practice hours to total hours. Sensor technology is just about one of three main technologies which are information acquisition, transmission and processing in the information age [2], so that the development and application status of sensors has become the symbol measuring the development level of the national science and technology. It has become one of the most important technology in many fields involved all aspects of human life, such as aerospace, industry, agriculture, environmental protection and medical, which should be learnt by the students who come from many majors including information, electronics, physics, chemistry, biology, measurement, automatic control, the Internet of things and so on. Therefore, the educational reform of sensor principle and application curriculum must be implemented, and IEER ideas in the course has great effect to all kinds of professional talents cultivation.

This course covering a wide range of knowledge belongs to the category of the interdisciplinary and high technology, and can reflect the open scientific view, and then has the characteristics of the comprehensive application and training. In order to make corresponding students master sensors in a high level, we must adopt advanced and interesting teaching mode starting from the basic principle and characteristics, and introduce the actual application circuit to deepen students' impression and improve their comprehensive ability [3]. Using interactive teaching mode, we take the student as the main body by adjusting teaching thoughts, guiding the students' learning methods to think and develop immediately. By designing some circuits realizing the specific function, the students can learn to analyze the principles of sensors and the related circuits, and can perform a certain product development, or can be inspired to run a startup pilot of the new sensor application products, which can strengthen the students' cooperative consciousness and improve the overall
quality including observation, thinking, analysis, judgment, and the innovation. Making use of IEER ideas in the course which is CDIO concepts and methods that is on the behalf of Conceive, Design, Implement and Operate [4], we can establish a set of the complete teaching system of sensor principle, application and practice, so that we let in-class instructing and outside-class practicing in different ways together penetrate into the whole teaching process of information subject and move towards an ideal education system of many majors in the information age.

2 Teaching content reform of sensor principles and applications as excellent curriculum

In the college of information science and technology in many universities, the students in several majors must learn sensor principle and application course, such as electronic science and technology, electronic information engineering, internet of things engineering, microelectronics science and engineering, automation, etc., and many students want to study independently to participate in various contests (for example, electronic design, or Internet of Things + design, must use sensors first to collect the signals of external environment information) in other majors that include electronic information science and technology, communication engineering, computer science and technology, and software engineering, etc. According mainly to the application ideas of different sensors, we compile teaching materials. Because the temperature is the most important in external information including light, temperature, pressure, magnetic, gas, sound and so on, especially it can affect the test accuracy of other sensors as one of the testing environment factors, the temperature sensor must be first introduced in sensor teaching materials [5]. As a sort of light sensor can be used to test gas pressure[6], some force sensors can measure sound wave[7], the light sensors and force sensors are put second and third chapters respectively. The magnetic sensors and gas/humidity sensors are arranged the fourth, fifth and sixth chapters, and the acoustic sensors are listed the seventh chapter since this kind includes the application of force and magnetic sensors [8,9]. The integrated sensor that is a development direction of many kinds of sensors is listed the eighth chapter, and a network sensor that is the most advanced application is placed finally. Thus, the contents of before and after chapters can be linked together with hook-ups and form a system. In each chapter, there are several principles of sensors that are relatively independent, which are arranged from simple to complex, their application and the new sensors are put in the last of a chapter. In each back chapter, some content of temperature compensation sensor or the application of a front sensor can be planned in the later. Finally, the textbook can be achieved to be mutual cohesive, and its hierarchical structure is gone deep into some new-type application.

Its curriculum can be divided into theory teaching and practice teaching, which is mainly composed of the lectures in the traditional teaching mode, and the amount of the theoretical teaching hours is much greater than that of practical teaching hours. With new development of an information technology, what is too focused on theory teaching mode is getting bad to cultivate the students' ability of innovation and entrepreneurship, and new teaching behaviors in the classroom and the practical teaching must intensify. Therefore, a case teaching method may be brought in sensor lecture classroom, which can raise students' interest of active participation and master easily their basic knowledge and basic skills, and the teachers can practice some effective case teaching measures to carry on the various reform and innovation by aiming at the teaching system of different majors.

3 Reform ideas of teaching principle taking the students as the main body

In order to deal well with the relation between teaching principles of sensor and the corresponding circuit and training students' manipulative ability, the teachers must pay first attention to students' independence and initiative, and make students' learning become active process with rich individual character under teacher's guidance, which the teachers take students as main body in the entire teaching process and consider or design diverse teaching content and measures for different students, because learning or mastering information to achieve future goals is
what refer to as endogenous instrumentality which leads to positive behaviors being perceived as instrumental and deep learning strategies[10]. In order to let the students like and understand the basic concept of a sensor under autonomous learning environment of a university, we must elect some actual phenomenon cases to attract students. For example, we guide the students analyze and trace the information springhead, including reading books, reading the newspaper, mobile phone chatting and so on, and dig up that the initial source of all information is a sensor, and let the students can become active participant in teaching activities at every moment. Taking a few of human labors as examples, we let students understand "features" of a sensor by the feeling of five sense organs, timely encourage and praise them in order to increase their confidence and improve their abilities and quality. In the day that the multi-disciplines develop together with rich information source, some students whose accept ability is very strong maybe have different interest within a short time, we must teach them at first the principle of each sensor, and supervise to grasp the principle through various means such as inspection, examination, urge, encouraging. To know students and teach them in accordance of their aptitude and majors, not necessarily all are taught according to the teaching materials in order, we may let the students find the set of thought of sensor application and design in order to train and shape their innovation and enterprising awareness. According to the context of subject development combining students' majors, modern science and technology, production practice with the textbook knowledge, the teaching contents of different majors are arranged, the outlines are formulated, and the teaching plans are determined. In a word, the reform ideas takes the students as the main body in a class are embodied in teaching content, and each step of teaching process, which possess certain innovation in the traditional base.

4 Reform teaching modes to improve teaching quality

The traditional teaching modes that the students hear or transcribe while a teacher speaks or writes, which hold students' thinking on a single pathway, and hamper students' creative ability, should be changed into a kind of interactive teaching mode[10] that is face-to-face learning environment and can be evidenced through deep learning. The modern teaching process should include teacher' teaching, students' learning and dynamically intercommunicating between teachers with students through their "five sense organs" which includes knowledge, experience, norms, requirements, especially mutual influence and complementation, and so on. In order to promote the interaction between teachers and students, the teaching rhythm should reach a state that alternates the tension with relaxation livingly and orderly, a teacher guides the students to participate in the lively discussion and make them accept the knowledge added emotions and values. Because many principles of sensors in the textbook are some effects (for example, Seebeck Effect, Photoelectric Effect, etc.) that belong to some experimental phenomena, a teacher may lead the students to imagine the phenomenon and analyze the principle of sensor combining with the application so that the students can understand the principle and application simultaneously. Before having class, the teachers produce actively multiple computer-assisted instruction (CAI) to reflect the phenomena, and study the teaching method and means to be suitable to different students to comprehend well. In class, we ask first a scene reappearace by multimedia and animations in CAI to deepen students’ perceptual knowledge, and lead to explore themselves so as to sublimate some ideas [3]. In order to meet the needs of modern education, four two-combined teaching modes are adopted. The first mode is the combination of the principle and the related application case of a sensor, which can make the students digest the sensor integrally. The second is that a teacher gives a lesson intuitively combining CAI with blackboard-writing. The third is that the theoretical teaching in class combines with practical teaching in the laboratory to deepen understanding theory and improve engineering practice ability. The last is that teaching content of textbook introduce some new professional literature in class or homework. Further, a teacher may put forward a target object, let students conceive the related application project, select a few of sensors that must be useful in the detecting different information of the project, design the respective application circuits of the sensors, implement them by building related electronic components and IC (Integration Circuit) modules on
the printed circuit board in the Innovation laboratory, measure and control each needful information of the object project, and plan to operate the products in a market, in which the CDIO idea [4] coming from the front main activities what the life cycle of product development and product operation is the carrier that students can study the project actively and practically by contacting different courses organically, which may improve students' abilities and teaching quality deeply.

5 Guide students to join activities for raising the developing ability

The theories in sensor course can not only reflect the reality, but also may be put into practice under the application conditions, which have a certain practicality. In teaching process including the class teaching, assigning homework and experiment teaching, we establish the relationship between the knowledge teaching and intelligence development, and prompt the students to grasp gradually knowledge skills into the systematization, generalization and individuation, which can be converted into a certain ability of innovation and entrepreneurship. While assigning homework, we should let the students know well the principle of a sensor, but also broaden the sensor application field. We should arrange many questions including concepts, principles and designs, and guide the students to join some discussions timely in order to train and develop each student' ability, intelligence, talent and potential. At the same time, we must inspire students' creative design thinking by calling for them asking questions and being encouraged to dare to do the something unconventional or unorthodox in their homework or designing experiments, even if a student's original is wrong, we should help students to improve and perfect it in order to deepen the extent of their participation [11] and cultivate their innovation ability, which can encourage them to develop new sensor application products for building a good foundation of their future entrepreneurship.

Various practices of the principle and the related application of sensors may be closely combined with "Internet +" fields[12], which include a number of the fields in intelligent transportation, environmental monitoring, public and home security, intelligent fire protection, industrial monitoring, elderly care, flower cultivation, water monitoring, food tracing, etc., so they may be run in different ways (such as signal acquisition, signal processing, signal transmission, signal control, intelligence system, and so on) throughout the practical teaching systems of all majors in information college. By launching all kinds of competition projects for the students in different majors, we can stimulate the students' thirst for knowledge, and let them design all kinds of application circuits, which can train their innovation consciousness and habits starting delightedly work and practicing diligently. We can carry out the plan of extracurricular scientific research internship for senior students and make them combine the learning in professional stage with the practice of scientific research, which can foster the students’ scientific spirit and scientific work style and raise their developing ability. Thus, what that students join many activities can eliminate their phenomena of high mark with weak physique, or low morality, or low capacity, which will lay a solid foundation for training high-quality comprehensive talents.

6 Conclusion

In order to improve the teaching effect of sensor principles and applications and develop students' intelligence, we strive to study teaching contents for different majors, and reform teaching ideas by taking the learners as the main body, and proposing four two-combined teaching modes, adjusting various application cases of sensors, and then guiding students to engage in practice activities. By adopting the CDIO idea, we can train the students roundly from theory to practice in different steps of different teaching system of all majors by basing on in-class or out-class teaching process, and promote their innovation & enterprise capability, which can enhance the teaching quality. In the future, we will execute even more activities for innovation education, such as practicing more extracurricular scientific research internship, developing more products and expanding more fields of application sensors than today in order to cultivate innovative and entrepreneurial talents according to the development of the times enriched with advanced technologies.
Acknowledgement

In this paper, the research was sponsored by Provincial High-quality Curriculum Construction fund in 2012(Project No. 331030007), and Curriculum construction fund of innovation and entrepreneurship education in shaanxi province in 2018 (Project No. XM05190503).

References

[1] Soares, F. O., Sepúlveda, M. J., Monteiro, S., Lima, R. M., & Dinis-Carvalho, J. An integrated project of entrepreneurship and innovation in engineering education. Mechatronics, 2013, 23(8), 987-996.

[2] Brown, T. E. Sensor-based entrepreneurship: A framework for developing new products and services. Business Horizons, 2017, 60: 819-830

[3] Edgar, T. F., Ogunnaike, B. A., Downs, J. J., Muske, K. R., & Bequette, B. W.. Renovating the undergraduate process control course. Computers & Chemical Engineering, 2006, 30(10–12), 1749-1762.

[4] Liang, Z., Deng, H., & Tao, J. Teaching Examples and Pedagogy of Mechanical Manufacture based on the CDIO-Based Teaching Method. Procedia Engineering, 2011, 15(1), 4084-4088.

[5] Jia, P., Fang, G., Liang, T., Hong, Y., Tan, Q., Chen, X., Liu W., Xue C., Liu J., Zhang W., Xiong J.. Temperature-compensated fiber-optic Fabry–Perot interferometric gas refractive-index sensor based on hollow silica tube for high-temperature application. Sensors & Actuators B Chemical, 2017, 244, 226-232.

[6] Bremer, K., Reinsch, T., Leen, G., Roth, B., Lochmann, S., & Lewis, E. Pressure, temperature and refractive index determination of fluids using a single fibre optic point sensor. Sensors & Actuators A Physical, 2017, 256, 84-88.

[7] Zhang, M., Thompson, W., Frendi, A., & Casiano, M. J. Acoustic wave propagation in a sensor port: Experimental measurements and analytical model predictions. Applied Acoustics, 2017,127, 1-14.

[8] Matatagui, D., Kolokoltsev, O., Qureshi, N., Mejía-Uriarte, E., Ordoñez-Romero, C., Vázquez-Olmos, A., & Saniger, J. Magnonic sensor array based on magnetic nanoparticles to detect, discriminate and classify toxic gases. Sensors and Actuators B: Chemical, 2017, 240, 497-502.

[9] Zhang, J., Wan, X., Li, Y., Zhao, Z., & Li, C. An integrated electro-optic magnetic field sensor based on reflected Mach-Zehnder interferometer. Optik-International Journal for Light and Electron Optics, 2018, 157, 315-318.

[10] Burga, R., Leblanc, J., & Rezania, D.. Analysing the effects of teaching approach on engagement, satisfaction and future time perspective among students in a course on CSR. International Journal of Management Education, 2017, 15(2), 306-317.

[11] Korthagen, F. A. J., & Evelein, F. G. Relations between student teachers' basic needs fulfillment and their teaching behavior. Teaching & Teacher Education, 2016, 60, 234-244.

[12] Lopez, J., Rios, R., Bao, F., & Wang, G. Evolving privacy: From sensors to the Internet of Things. Future Generation Computer Systems, 2017, 75, 46-57.