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The Teaching Reform of ”Sensor Principle and Application” Course Based on OBE Education Concept

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Abstract. Outcome based Education (OBE) emphasizes ”student-centered, output-oriented” continuous improvement to meet the needs of students to acquire knowledge and develop abilities. The result orientation of the existing ”Sensor principle and application” course teaching reform emphasizes the understanding and application of sensor principle, mastering the principle of language rules, object-oriented programming method and thinking mode. The teaching reform of this course is based on the concept of OBE, focusing on the combination of sensor principles and students' majors, and guiding students to apply object-oriented development tools reasonably and efficiently in related professional engineering. Comprehensive projects should be introduced into practical teaching to appropriately increase the workload and difficulty of practical teaching and cultivate students' awareness and ability of teamwork. Solve the ”pain points” and ”blocking points” existing in the curriculum, so as to combine the curriculum with talent training. The results of practical application show that the students' engineering application ability is improved and they can complete the comprehensive practical project well.

Keywords: OBE, Sensor principle and application, Practical teaching, Talent training.

1. Introduction

Outcome Based Education (OBE) is the basis of quality evaluation of engineering education certification and the development direction of new engineering education reform in the new era. It is a structural education model centered on the expected learning output to organize, implement and evaluate [1,2]. This model is different from the traditional education model, emphasizing not the traditional sense of ”how teachers teach and teach what”, but ”how students learn and learn what”, and it is clear that the school wants students to achieve the learning outcomes, how teachers effectively help students to achieve the learning outcomes, how to know that students have achieved these learning outcomes. This requires different schools to combine their own characteristics and set up major and related courses according to social needs [3]. According to the different situations of students, students are equipped with academic mentors to guide students to achieve learning goals. The investigation and realization of social needs is both the logical starting point of OBE education concept and the only criterion for testing and evaluating educational outcomes.” From teacher-centered to student-centered, the combination of core quality and personality development is the starting point of OBE and the implementation point of evaluating students' learning results.

Sensor Principle and Application is an important professional technical course for electronic information and automatic control majors. Sensor is an important way and means to obtain information, and it is an important unit for the development and application of intelligent technology. ”Sensor Principle and Application” is a multidisciplinary, engineering practice of a strong professional course, in the professional curriculum system in the position of the link between the preceding and the following. According to the characteristics of the curriculum system, this paper discusses how to guide the teaching reform of the curriculum with the educational concept of OBE [4-6].

2. The Problems Existing in The Course Teaching Process

After reviewing the teaching process of ”Sensor Principle and Application”, we believe that there are mainly the following problems:

1. The knowledge is complicated and the content is scattered, there is no organization and coherence, and it is difficult for students to master it.

2. Students lack perceptual understanding of similar but different types of sensors, and feel boring in learning, without initiative and enthusiasm.
3. There is a disconnect between experiment and theory. Experiments are taught separately, and most of them focus on performance tests, so students lack a sense of harvest.
4. The homework is almost all concept and principle narrative questions and performance parameter calculation questions, lack of vivid extracurricular exercises that can inspire students' creativity.
5. There are large differences in the individual sources of students in ethnic colleges and universities, and the learning outcomes of different students with the same knowledge are more discrete.

In short, there are many problems in the teaching process of "Sensor Principle and Application" course, which have both commonalities and personalities. They affect students' learning enthusiasm from different aspects and in different ways, which is not conducive to improving students' ability to analyze and solve practical engineering problems and practical innovation. Therefore, it is urgent to introduce new teaching concepts and teaching models [7,8].

3. Results-oriented Curriculum System Reform

School of Electrical and Electronic Engineering of Zhengzhou University of Science and Technology adheres to the education and teaching concept of "students as the main body, teaching according to their aptitude, classification training, and emphasizing practice", aiming at cultivating innovation and entrepreneurial ability of engineering students, and cultivating senior applied engineering talents with good organization and management ability, unity and cooperation spirit, and innovative thinking consciousness for the economic development of Central Plains region [9,10]. According to the training plan and graduation requirements of relevant majors in our college, the course "Sensor Principle and Application" has been comprehensively reformed.

1. Clarify the relationship between the course objectives and the achievement of relevant graduation requirements. According to the training plan and teaching syllabus, establish the correlation between graduation requirement indicators and the support of each course, and determine the weight value of the course content and main assessment links on the indicators according to the support strength of the teaching link to the graduation ability requirements. The purpose of the course "Sensor Principle and Application" is to enable students to master the basic principles, main characteristics and use methods of various sensors, to choose and use sensors reasonably, and to flexibly apply these sensors and technical methods to solve practical problems in the future graduation design and practical work. The course evaluation mainly focuses on the learning process, including the regular assessment, the final examination and the experiment assessment. Normal assessment weight 0.4, including class attendance 0.2, class discussion and homework 0.2; Final exam weight 0.4; Experimental operation and report weight 0.2.
2. Classroom theory teaching reform. A sensor is a device or device that can sense the specified measured signal and convert it into a usable output signal according to a certain law. Therefore, the traditional course theory teaching mode is mainly to introduce the principle of the sensor, then introduce the structural characteristics, then introduce various conversion circuits, and finally introduce the practical application of the sensor. The teaching method is simple, lack of vividness, boring theory, abstract technology is difficult to mobilize the enthusiasm of students to learn, and students will lose their interest in learning over time. Combined with the OBE concept and according to the actual curriculum reform requirements, this course has carried out reform attempts from the following aspects. First, in terms of teaching content, we focus on starting from the electronic devices familiar to students, inspiring and guiding students' impression of sensor applications, and enhancing their learning interest [11-13]. In addition, in the classroom teaching, attention should be paid to the connection between sensors and other related courses, so that students can understand the interdependence between various courses, and strengthen the ability to comprehensively apply all aspects of knowledge to analyze and solve problems. For example, when talking about the basic characteristics of sensors, pay attention to the connection with the "Signal and system" course; When talking about the principle of sensors, it emphasizes the connection with University Physics; When teaching conversion circuit, pay attention to "Circuit analysis", "analog Electronic technology", "digital electronic Technology" and "electronic measurement technology" and other courses; When talking about the application of sensors, it focuses on the connection with single-chip computer and college students' extracurricular innovation. This can not only mobilize the students' learning initiative, but also exercise the students' ability to comprehensively use all aspects of knowledge. Secondly, in terms of teaching methods, we should strengthen the use of multimedia. Abstract principles and invisible internal structures are presented to students through animation and simulation, and then combined with animations, pictures and videos of practical application, which can not only make the

classroom content more vivid, but also let students see the real application situation outside the book and text knowledge, effectively solving the hollow sense of theoretical learning. In addition, the use of network resources to assign some extracurricular homework to students, so that students can combine their own hobbies, consult information about sensors, and write reading reports. Third, in the course of teaching, it is clear that students are the main body of learning. How to let this subject exert its subjective initiative is the key to learn a course well. Teachers should arrange classroom discussions with different contents at different times and stages according to the teaching content. In this way, students' independent learning ability can be enhanced through thinking, and students' ability to organize and explain sensor knowledge can be trained, so that knowledge and ability can accompany students' growth just like sensors in mobile phones. The essence of OBE is everything for the students, everything for the students, everything for the students. Therefore, in teaching, we should always pay attention to helping students with learning difficulties, especially those students from remote ethnic areas. Let them build up their confidence in learning, and create a learning atmosphere for them to unite and help each other and make progress together.

3. Experimental teaching reform. First, in terms of basic experiments, there are many kinds of sensors and different conversion circuits, but they also have rules to follow in experiments, most of which convert non-electricity in reality into voltage output. Therefore, the basic experiments are not many, but fine. According to the characteristics of different majors, about three representative experimental projects can be selected, and students with good basic ability and a relatively poor student can be formed into a pair to complete the experiment together, or students can choose to do different experiments according to the experimental equipment. Based on the principle of "consolidating the foundation, focusing on ability, emphasizing quality, and cooperating to help", we try not to let a student transfer the team. The experimental assessment is also based on group assessment. The better students are required to help guide the worse students to write experimental reports and make data analysis, and the experimental results of this group are taken as the experimental results. Second, in the comprehensive experiment, students can re-form a group of three, but still follow the principle of strong with weak, emphasizing common progress. Lab projects can be either given by the teacher or designed by the students themselves [14,15]. Students are required to negotiate and discuss the design scheme of the experiment. After the teacher's guidance and approval, students design the circuit, select the sensor and circuit components by themselves, and finally complete the production, and give the experimental results and report. This aspect emphasizes the design and application of experiments and the ability of students to comprehensively use relevant knowledge to analyze and solve problems, which not only enhances students' teamwork spirit, but also trains students' flexible use of sensors, and more importantly, strengthens the application ability of classroom theory to solve specific practical problems. Third, in order to enable students to fully understand the application of sensors in actual production and life, students are organized to participate in contests or extracurricular activities related to sensor courses. At the same time, students are allowed to engage in intelligent car competition, robot competition, drone competition and electronic design competition and other sensor-related competition projects as the current sensor experiment, and the results of the competition can also be used as experimental results. It is very important to establish a reasonable test method to evaluate the effect of experiment teaching and the comprehensive ability of students, and to stimulate the enthusiasm of students. In the aspect of comprehensive innovation, we should pay attention to the assessment of process and problem-solving ability [16-18].

4. Using Network Resources to Establish Online Mobile Information Platform to Improve Students' Autonomous Learning Ability

Make full use of network resources to establish a mobile information platform after class, which can find the weak links and common problems of students in the first time, so as to facilitate teaching reflection and improvement, and constantly optimize the teaching process; In addition, students with outstanding ability and strong thirst for knowledge will be timely guided and gradually guided to extend their online learning and self-development.

1. Online preview review: the knowledge points will be decomposed, sorted out and made relevant teaching resources, and pushed to the mobile information platform for students to preview before class and review after class.
2. Online homework: Push daily knowledge assignments on the information platform to help students further deepen their understanding and mastery of knowledge points in a way that students are willing to accept, and strengthen the application of knowledge points.
3. Project extension training: Students are required to update and optimize the function of the project after understanding and digesting the classroom engineering cases, and upload it to the information platform to improve students' engineering practice ability and innovation ability.

5. The Application of OBE Concept in The Teaching of Formulae

The teaching research team has integrated the OBE concept into the teaching of formulae, emphasizing student learning rather than teacher teaching, especially emphasizing research-based rather than indoctrination teaching model, personalized rather than ”horse-drawn” teaching. Through the overall understanding of students' learning basis, learning progress, learning goals, etc., teachers comprehensively control students' learning process, timely formulate and improve teaching plans and personalized teaching guidance. In terms of teaching evaluation system, OBE adopts multiple grading evaluation criteria, emphasizing the combination of vertical progress and horizontal comparison, and provides different evaluation criteria ranging from proficient, good to excellent for corresponding evaluation, so as to grasp the learning progress and status of students and provide feasible reference for improving the teaching plan of schools and teachers [19].

5.1. Centered on Student Development

Teachers should reform teaching methods, guide students to learn independently, and set different results according to the differences of students. First of all, the learning results of prescription courses are clearly defined, and students' learning aspirations, learning ability improvement needs, professional qualification improvement needs, employment needs are systematically grasped, so as to set different outcome guidance for students at different levels, so as to guide teachers to carry out teaching design and effectively improve the teaching process. Secondly, to create a hierarchical teaching system, using different textbooks and teaching methods for students according to different results; In the process of teaching, real-time assessment is carried out to reasonably formulate curriculum design, curriculum arrangement, classroom teaching and teaching reflection, and determine teaching strategies; At the same time, teachers improve the teaching work in real time during the teaching process, and emphasize research-based teaching and personalized teaching. Finally, teachers accurately control the learning track of students and timely grasp the goals, foundations and progress of each person, formulate different teaching plans and provide different learning opportunities according to different needs, so as to effectively enhance the experience of students, and provide reasonable classified guidance for different entry-level students, guide different levels of sense, strengthen the interest of learning, improve learning enthusiasm and learning effect [20-24].

5.2. Continuous Improvement of the Teaching Evaluation System

The OBE concept focuses on the output of learning outcomes, rather than the innovation of learning content, time and style. It adopts multiple and grade evaluation standards, focusing on the connotation of learning outcomes and personal progress, and does not recommend inter-student comparison. According to the educational requirements that each student can achieve, the evaluation is targeted, giving different grades from unskilled, good to excellent, and reaching the peak step by step; The learning process of students is divided into primary, intermediate and advanced stages, and the learning objectives of each stage are determined. By mastering the learning status and results of students, we can grasp the learning progress and realize reasonable teaching, which provides a powerful reference for teachers to improve their teaching work, and provides driving force for continuous improvement of the definition and realization of professional learning outcomes. Under the guidance of the OBE concept, teachers actively study new educational methods, master the use of new teaching tools, continue to improve teaching work according to real-time feedback from students, face the change of identity, recognize the new value of self, assume new roles, and become a good teacher and friend to guide, inspire and encourage students. This helps to cultivate students' independent learning ability, develop the habit of lifelong learning, effectively improve their learning interest and efficiency, stimulate and mobilize students' subjective initiative to the maximum extent, and make them become the master of learning [25-29].

5.3. Student Achievement Presentation

The teacher guided the students to master the content according to the course. 10 students worked together for a group to complete the formulation courseware, and let the students independently explain the micro-lesson and complete the corresponding academic paper writing according to the 11 topics given by the teacher. Each group has its own characteristics, and each group has completed the task assigned by the teacher beyond the expectation, which well reflects the participation and enthusiasm of the students.

Courseware making.

In the process of formulation teaching, make full use of multimedia network resources, let students take the initiative to participate in the production of teaching courseware, put forward higher requirements for students to understand the chapters. Students attend lectures with tasks, carefully summarize and sort out the key points of

chapters, and deepen their understanding of chapter content in the process of participating in the production of PPT courseware, which is conducive to the formation of knowledge framework system and exercise the ability of summary. In class, the teacher comments on the courseware made by each group of students, praises the highlights and improves the shortcomings, stimulates students' enthusiasm for learning and creation, makes them deeply grasp the teaching focus, and enriches the teaching form [30-32].

Making micro-lessons.

Liaoning University of Traditional Chinese Medicine's online course of Formulation has been named the most popular MOOC course in China in 2017. The current teaching team breaks the traditional teaching mode of teachers recording micro-lessons, makes full use of online education resources [33], and allows students to make online micro-lessons in small groups. Students prepare and record lessons after class, actively use case based teaching method (CBL) and question based teaching method (PBL) [34], and express their opinions in the process of "speaking out", which not only helps to flexibly grasp the key and difficult points of formulations, but also exercises the thinking of traditional Chinese medicine, and strengthens the ability of communication, cooperation and expression.

Writing of academic papers.

According to the feedback of learning results such as courseware making and micro-class recording, higher requirements are further put forward for students. Due to the lack of interaction between formulology and domestic and foreign medical research and the narrow scientific research ideas in formulology [35], teachers assign 11 topics according to students' individual learning ability and require students to complete academic paper writing tasks on corresponding topics, so as to train medical students' scientific research ability and academic thinking, and lay a good foundation for their future medical career or further study The basis of scientific research [36-40].

6. Conclusion

Guided by the OBE concept, it is proposed that the teaching of "Sensor Principle and application" for non-computer engineering majors should be closely related to the professional courses and reflect the application value of development tools in the major. The concept of building minimum software system is introduced in teaching to cultivate students' practical engineering application ability. The concept of project is introduced into practical teaching, and the form of teamwork required by enterprises is simulated to improve students' hardware design ability, coordination and cooperation ability and professional report writing ability. And by breaking through the barriers between "online-offline" and "in-class-out-of-class", the students' object-oriented programming ability and object-oriented application ability have been improved as a whole.

7. Conflict of Interest

The authors declare that there are no conflict of interests, we do not have any possible conflicts of interest.

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References

1. Bergmark U. Teachers' professional learning when building a research-based education: context-specific, collaborative and teacher-driven professional development[J]. Professional Development in Education, 2023, 49(2): 210-224.
2. Goss H. Student learning outcomes assessment in higher education and in academic libraries: A review of the literature[J]. The Journal of Academic Librarianship, 2022, 48(2): 102485.
3. Salendab F A, Akmad S P. A Personal Narrative Experience of Teachers Teaching Purposive Commu-nication During the New Normal Education[J]. International Journal of Multidisciplinary: Applied Business and Education Research, 2023, 4(5): 1590-1601.
4. Teng L. Brief Review of Medical Image Segmentation Based on Deep Learning[J]. IJLAI Transactions on Science and Engineering, 2023, 1(02): 01-08.
5. Jisi A and Shoulin Yin. A New Feature Fusion Network for Student Behavior Recognition in Education [J]. Journal of Applied Science and Engineering. vol. 24, no. 2, pp.133-140, 2021.
6. Meng X, Wang X, Yin S, et al. Few-shot image classification algorithm based on attention mechanism and weight fusion[J]. Journal of Engineering and Applied Science, 2023, 70(1): 14.
7. Morawska-Jancelewicz J. The role of universities in social innovation within quadruple/quintuple helix model: Practical implications from polish experience[J]. Journal of the Knowledge Economy, 2022, 13(3): 2230-2271.

8. Feng Y, Lai K, Zhu Q. Green supply chain innovation: Emergence, adoption, and challenges[J]. International Journal of Production Economics, 2022, 248: 108497.
9. Ying Z, Jiao Z, Wang H. Carbon footprint and embodied carbon transfer at city level: A nested MRIO analysis of Central Plain urban agglomeration in China[J]. Sustainable Cities and Society, 2022, 83: 103977.
10. Yu Q, Li M, Li Q, et al. Economic agglomeration and emissions reduction: Does high agglomeration in China's urban clusters lead to higher carbon intensity?[J]. Urban Climate, 2022, 43: 101174.
11. Yin S, Wang L, Wang Q, et al. M2F2-RCNN: Multi-functional faster RCNN based on multi-scale feature fusion for region search in remote sensing images[J]. Computer Science and Information Systems, 2023 (00): 54-54.
12. Jiang Y, Yin S. Heterogenous-view occluded expression data recognition based on cycle-consistent adversarial network and K-SVD dictionary learning under intelligent cooperative robot environment[J]. Computer Science and Information Systems, 2023, 20(4): 1869-1883.
13. Wu Y, Feng J, Hu G, et al. Colorimetric sensors for chemical and biological sensing applications[J]. Sensors, 2023, 23(5): 2749.
14. Li T, Zhu X, Hai X, et al. Recent progress in sensor arrays: from construction principles of sensing elements to applications[J]. ACS sensors, 2023, 8(3): 994-1016.
15. Alanazi N, Almutairi M, Alodhayb A N. A review of quartz crystal microbalance for chemical and biological sensing applications[J]. Sensing and Imaging, 2023, 24(1): 10.
16. Osco L P, Wu Q, de Lemos E L, et al. The segment anything model (sam) for remote sensing applications: From zero to one shot[J]. International Journal of Applied Earth Observation and Geoinformation, 2023, 124: 103540.
17. Yin S, Li H, Teng L, et al. Attribute-based multiparty searchable encryption model for privacy protection of text data[J]. Multimedia Tools and Applications, 2023: 1-22.
18. Kumar A, Gupta G, Bapna K, et al. Semiconductor-metal-oxide-based nano-composites for humidity sensing applications[J]. Materials Research Bulletin, 2023, 158: 112053.
19. Carlucci D, Renna P, Izzo C, et al. Assessing teaching performance in higher education: a framework for continuous improvement[J]. Management Decision, 2018, 57(2): 461-479.
20. Stronge J H. Teacher evaluation and school improvement: Improving the educational landscape[J]. Evaluating teaching: A guide to current thinking and best practice, 2006, 2: 1-23.
21. Temponi C. Continuous improvement framework: implications for academia[J]. Quality assurance in education, 2005, 13(1): 17-36.
22. Lindahl F W, Fanelli R. Applying continuous improvement to teaching in another culture[J]. Journal of Accounting Education, 2002, 20(4): 285-295.
23. Szököl I. Continuous improvement of the teaching process in primary education[J]. Journal of Language and Cultural Education, 2018, 6(1): 53-64.
24. Wittmann M, Boehm O, Thiessen N, et al. Student evaluation of anesthesiological teaching: steering instrument of a continuous improvement process[J]. Der Anaesthesist, 2012, 61: 588-596.
25. Kregel I. Kaizen in university teaching: continuous course improvement[J]. International Journal of Lean Six Sigma, 2019, 10(4): 975-991.
26. Walsh J M. Co-teaching as a school system strategy for continuous improvement[J]. Preventing School Failure: Alternative Education for Children and Youth, 2012, 56(1): 29-36.
27. Santally M I, Rajabalee Y B, Sungkur R K, et al. Enabling continuous improvement in online teaching and learning through e-learning capability and maturity assessment[J]. Business Process Management Journal, 2020, 26(6): 1687-1707.
28. Zmuda A, Kuklis R. Transforming schools: Creating a culture of continuous improvement[M]. ASCD, 2004.
29. Taylor E S, Tyler J H. Can teacher evaluation improve teaching[J]. Education Next, 2012, 12(4): 78-84.
30. Hilliger I, Celis S, Perez-Sanagustin M. Engaged versus disengaged teaching staff: A case study of continuous curriculum improvement in higher education[J]. Higher Education Policy, 2022, 35(1): 81-101.
31. Verna I, Perozzi D. Continuous improvement in the university teaching: the TEM model[J]. 2010.
32. Sutherland S. Creating a culture of data use for continuous improvement: A case study of an Edison Project school[J]. American Journal of Evaluation, 2004, 25(3): 277-293.
33. McGourty J, Sebastian C, Swart W. Performance measurement and continuous improvement of undergraduate engineering education systems[C]//Proceedings Frontiers in Education 1997 27th Annual Conference. Teaching and Learning in an Era of Change. IEEE, 1997, 3: 1294-1301.
34. Rowland C, Feygin A, Lee F, et al. Improving the Use of Information to Support Teaching and Learning through Continuous Improvement Cycles[J]. American Institutes for Research, 2018.
35. Rowland C, Feygin A, Lee F, et al. Improving the Use of Information to Support Teaching and Learning through Continuous Improvement Cycles[J]. American Institutes for Research, 2018.
36. Chang O H, Chow C W. The balanced scorecard: A potential tool for supporting change and continuous improvement in accounting education[J]. Issues in Accounting Education, 1999, 14(3): 395-412.
37. Heinrich E. Supporting continuous improvement in teaching development through electronic teaching portfolios[C]//31st HERDSA Annual Conference, Rotorua, New Zealand. 2008.
38. Nikolic D, Castronovo F, Leicht R. Teaching BIM as a collaborative information management process through a continuous improvement assessment lens: a case study[J]. Engineering, Construction and Architectural Management, 2021, 28(8): 2248-2269.
39. Bush-Mecenas S. The business of teaching and learning: Institutionalizing equity in educational organizations through continuous improvement[J]. American Educational Research Journal, 2022, 59(3): 461-499.
40. Tripathi R, Kumar A. Importance and improvements in teaching-learning process through effective evaluation methodologies[J]. International Journal for Environmental Rehabilitation and Conservation, IX, 2018, 2: 07-16.

Biography

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