

Research on the design and practice of comprehensive practical training of digital circuit based on OBE concept

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Abstract

The introduction of "Made in China 2025", a national strategy document for the implementation of manufacturing power, has put forward higher requirements on the training quality of information technology and intelligent manufacturing talents in China. On the one hand, industries and enterprises are in urgent need of a large number of high quality electronic technical skill talents in order to successfully realize the development goal of "Made in China 2025", on the other hand, higher education, as an important base for the training of such talents, at this stage, it is difficult for its graduates to find satisfactory professional jobs in the market, and the supply of talents in schools is The current situation is that the supply of talents lags behind the demand of enterprises. under the guidance of OBE concept, the expected learning outcomes of the survey are refined into three teaching objectives in terms of knowledge, ability and quality, and around the teaching objectives, we construct the content of digital circuit practical training with practical significance by linking knowledge points, select the hybrid teaching mode of "flipped classroom + guided text", carry out the process and final The OBE concept is designed based on the concept of "OBE". Thus, the new teaching mode of digital circuit comprehensive practical training in colleges and universities based on OBE concept is highly effective and feasible.

Keywords

OBE concept, university education, practical training, digital circuit course

1. Research Background

The demand of China's economic development In March 2015, "Made in China 2025" was considered and adopted by the State Council, and this document has put forward higher requirements on the training quality of information technology and intelligent manufacturing talents in China. On the one hand, the industry and enterprises are in urgent need of a large number of high-quality technical and skilled talents in electronics for the successful realization of the development goal of "Made in China 2025", on the other hand, as an important base for the cultivation of such talents, it is difficult for the graduates to find satisfactory professional jobs in the market at this stage, and the supply of talents in schools lags behind the demand of enterprises. The current situation is that the supply of talents lags behind the demand of enterprises. so as to support the development of China's social economy. In order to support the development of China's social economy.

2. Inspiration and guidance of OBE concept

(1) The principle of "reverse design" of OBE concept can play a great role in improving the quality of talent cultivation in colleges and universities. Based on this, colleges and universities

determine the training objectives of students according to the actual needs of employers, and infer the education and teaching process of students from the education results to ensure the employment competitiveness of college students upon graduation.

(2) The OBE concept focuses on the mastery of students' higher-order abilities, which can provide a certain guarantee for the acquisition of "key abilities" of college students, so as to help students actively cope with the phenomenon of job changes or career changes caused by social and technological changes in the future career process.

(3) The OBE concept believes that every student can be successful, which brings "gospel" to college students with different knowledge bases and accepting abilities, and helps to solve the current situation of "not enough" in college education and teaching. In conclusion, the OBE concept of "reverse design" of teaching process based on learning outcomes, focusing on students' mastery of "key competencies" and believing that every student can succeed is an important inspiration and guidance to the education and teaching in China. The OBE concept is a very important inspiration and guidance for teaching and learning in universities in China.

3. Purpose and significance of the study

3.1. Purpose of the Study

It is composed of two parts: digital circuit and analog circuit, and digital circuit is the basis of many subsequent courses, such as microcontroller technology and application, electronic product manufacturing process practice, etc. The knowledge of digital circuit is used in teaching these courses. At the same time, digital circuits are both theoretical and practical in nature, so the role of practical training courses in promoting students' understanding of digital circuit theory, mastering digital circuit skills, and developing the ability to link theory with practice cannot be underestimated. At present, the teaching of digital circuits in colleges and universities does not match the needs of enterprises, the teaching content is fragmented and unsystematic, and the teaching methods do not meet the real demands of students with different knowledge levels and acceptance abilities, etc. Although colleges and universities have been improving the training in recent years, they have not been able to change their inherent problems.

3.2. Significance of the study

(1) Theoretical significance

The study has enriched the theoretical research on curriculum and teaching reform based on the OBE concept, which was born from the American basic education reform movement and has become a mainstream educational concept used in education and teaching reform worldwide after continuous development. Through collecting related research literature at home and abroad, we can see that the application research of OBE concept is mostly reflected in the general education field such as higher engineering education and higher medical education, but the application research in the vocational education field is less, and the application research in the teaching reform of higher education practical training courses is few and far between. Therefore, this study integrates OBE concept into the teaching reform of digital circuit practical training courses in colleges and universities, which can broaden the field and scope of OBE concept application research, enrich the theoretical research of course teaching reform under OBE concept, and have a certain promotion effect on the development of OBE concept in China. It enriches the theoretical research of teaching reform of practical training courses in colleges and universities.

The OBE concept emphasizes the formulation and implementation of expected learning outcomes in the education process, which makes the curriculum teaching reform from the previous focus on "education input" to the current focus on "education input". The OBE concept emphasizes the formulation and implementation of expected learning outcomes in the

education process, which makes the curriculum and teaching reform change from focusing on "education input" in the past to focusing on "education output" now, that is, the design, implementation and evaluation of the curriculum and teaching reversal from the actual requirements of the market, industry, enterprises and other employers for students' graduation, which opens up a new perspective and new ideas for the teaching reform of practical training courses for college educators. It provides a guarantee for the formation of employment competitiveness of college students at graduation. Therefore, this study integrates the OBE concept into the digital circuit practical training teaching in colleges and universities, and designs the practical training teaching into a closed-loop system with the function of continuous improvement in five specific aspects: determining teaching objectives, constructing teaching contents, selecting teaching mode, carrying out teaching evaluation and improving teaching reflection, which also enriches the teaching reform of the practical training courses in colleges and universities while improving the quality of personnel training in electronics technology. It also enriches the theoretical research on the reform of practical training courses in colleges and universities.

(2) Practical significance

To provide practical guidance and basis for college teachers to carry out teaching reform of practical training courses. At present, the teaching design and implementation of practical training courses in colleges and universities are still in the state of "what to teach and how to teach are mainly decided by schools and teachers' ideas", and the settings of practical training courses and teachers' teaching status are more arbitrary. Therefore, what and how students in colleges and universities learn should be more determined by the actual needs of the market and enterprises. The advanced ideas of learning results-oriented, student-centered and continuous improvement of teaching in the OBE concept provide help for college teachers to solve the inherent problems in the teaching of current practical training courses.

Therefore, this study defines the expected learning outcomes of this practical training course based on the actual needs of educational stakeholders such as counterpart enterprises and teachers and students, using the OBE concept as a guide to address the problems in the teaching of digital circuit practical training course, and then reverses the teaching objectives, designs the teaching model, and explores the teaching effects of the model in practice. As a result, it provides practical guidance and basis for teachers to reform other practical training courses while improving the teaching quality of digital circuit practical training courses in colleges and universities.

4. The status of domestic and foreign research

4.1. Status of Overseas Research

The OBE concept was born and matured in foreign countries. In the 1970s and 1980s, the American public launched the basic education reform movement because the current education model of the country did not provide enough feedback to the cause of science and technology, and in this situation, the OBE concept came into being. The concept was first proposed by the American scholar Spady W.G., who explained the OBE concept in depth in his book "Output-Based Education Model: Controversies and Answers", which also explained the structure of education based on the OBE concept, that is, this structure is composed of 1 implementation paradigm, 2 key objectives, 3 key prerequisites, 4 implementation principles, and 5 implementation points. The structure is composed of 1 implementation paradigm, 2 key objectives, 3 key prerequisites, 4 implementation principles and 5 implementation points. After Spedding's creation, the basic prototype of the OBE concept emerged in the educational reform in the United States at that time and had a profound impact on the whole world. Later, based on Spedding's research, AcharyaC divided the implementation process of OBE concept into four

steps: defining, realizing, assessing, and using, which greatly enhanced the feasibility and operability of OBE concept in education and teaching. This greatly enhances the feasibility and operability of applying the OBE concept to education and teaching. The practical application of OBE concept in higher engineering education and higher medical education in the United States, European Union, Japan, Canada, South Korea, and South Africa for many years has shown that OBE concept is scientific and advanced while improving the education level in these countries and regions.

4.2. Research on the application of OBE concept to electronic circuit curriculum in foreign countries

The electronic circuit curriculum belongs to the scope of engineering education research, and there are abundant overseas researches on the application of OBE concept in this field, which are mainly divided into the application researches in teaching assessment, teaching reform and curriculum design. First of all, in the aspect of teaching assessment. OuahadaK (2016), a South African scholar, analyzed the advantages and disadvantages of the continuous assessment framework based on the OBE concept constructed by the Department of Electrical and Electronic Engineering Sciences of the University of Johannesburg, South Africa, and proposed corresponding solutions to the disadvantages. FarookO (2006), an American scholar, and others have described the Department of Electrical and Computer Engineering Technology, Purdue University, USA, the results-based continuous improvement program implemented in the past three years and its effectiveness. Then a TAC-ABET model based on outcome assessment was proposed, defining all its components and detailing the protocols to be used and followed during the implementation of the model [20], which provides for the achievement and monitoring of learning outcomes. Secondly, in terms of pedagogical reform. The Indian scholar Gowra (GowraPS) (2014), in order to promote the interconnection and coherence between theory and practice, as well as to develop their teamwork, used the OBE concept to reform the teaching of an undergraduate course on analog electronic circuits offered by the Department of Telecommunications, BMS College of Engineering, Bangalore, India, by introducing a new course outcome (Cos) in a student-centered manner, giving students The new pedagogical model has largely achieved the desired goals as demonstrated by the introduction of a new curriculum outcome (Cos), a student-centered approach that gives students the opportunity to do their own demonstrations using innovative methods and experiments using creativity. LlorenteC (2017), a Filipino scholar, applied the OBE concept in the design of a laboratory manual for the undergraduate computer and electrical engineering program at De La Salle University in line with the curriculum reform of the country's universities, which was designed with the intended goal of enhancing students' ability to design and solve machine problems on their own. However, the actual results revealed that although the manual is in line with the implementation framework of the OBE concept and highlights the student-centered principle, the expected objectives of the manual are too ideal and too demanding for both students and teachers, and should be given some improvements in the context of reality.

4.3. Overview of Current Situation and Development Analysis

In summary, first of all, foreign countries are the birthplace of OBE concept, and there are rich and diverse studies on the theoretical connotation, practical structure and application of OBE concept, which fully reflect the great value and significance of OBE concept in meeting the actual demand for talents in the market. The research on OBE concept in China, from the initial introduction of learning to the current localized application, also reflects the great role of OBE concept in improving the quality of talent training in China. Although the results of the domestic research on the application of OBE concept have had some influence in the world, the domestic research is still not as comprehensive and in-depth as the foreign research, therefore, at this

stage, domestic scholars should combine the characteristics of their own research objects, reasonably absorb and learn from the foreign advanced research, so as to continuously promote the development of OBE concept toward the localization in China.

Secondly, compared with domestic research on the application of OBE concept in vocational education, foreign countries have applied OBE concept in vocational education earlier and have richer practical research. Through the domestic research on the application of OBE concept in college education, it is clear that many scholars have started to apply OBE concept in some aspects of college education in the past two years, and many results have been achieved. Finally, there is a need for more scholars to integrate the OBE concept with all aspects of higher education, so that the OBE concept can continue to develop its advantages in higher education. Finally, in terms of the application of the OBE concept to electronic circuit courses, the OBE concept is mostly applied to electronic circuit courses in higher engineering education in foreign countries due to the implementation of international engineering certification, but rarely applied to electronic circuit courses in vocational education. In China, due to the accession to the Washington Agreement in recent years, the OBE concept is mostly applied to undergraduate engineering education in order to accelerate the realization of international engineering certification in domestic universities, and later some scholars have also introduced the OBE concept from the undergraduate field to the higher vocational field, but there is almost no research on the OBE concept in the digital circuit practical training courses in colleges and universities, and the digital circuit practical training is an important part of the practical training teaching in colleges and universities. As an important part of practical training, digital circuit training plays a crucial role in the development of key skills for students in higher education, and because the development of new generation of information technology in "Made in China 2025" requires a large number of high-quality college electronic technical skills talents, and most of the students in higher education are unable to meet the vocational requirements of enterprises in terms of their knowledge and skills when they graduate. The OBE concept, as an educational idea of setting teaching goals in reverse from the graduation requirements, has brought a "dawn" to change the employment situation of college students in electronics technology. The "dawn".

Therefore, this study starts from the knowledge, ability and quality that the students of electronics technology majors in colleges and universities need to achieve when they graduate to formulate the expected learning outcomes, teaching objectives and teaching activities of digital circuit practical training, so as to help students in colleges and universities can learn more useful and more beneficial to their own employment and future career development within the limited study time in school, and then help colleges and universities improve the quality of talent training. In order to respond to the national call for reform of vocational education and to guarantee the realization of "Made in China 2025", the value and significance of this study can also be reflected.

5. Research Methods

(1) Literature analysis method

Through the resources of China Knowledge Network (CNKI), Google Scholar, Baidu Scholar and the library of Hebei Normal University, we collected a wide range of domestic and foreign research literature about OBE concept and its application in education and teaching, grasped the historical lineage of existing researches, sorted out and summarized their research results, from which we derived the research perspective and ideas of this study, and laid the relevant theoretical and methodological foundation for the development of this study. (2).

(2). Questionnaire survey method

A self-administered electronic questionnaire was designed and produced through the Questionnaire Star platform, and the questionnaires were distributed and collected from the students and graduates of electrical technology application majors in the form of two-dimensional codes. In this study, the questionnaire survey is divided into two stages, the first stage is to understand the actual needs of the students in the university of electrical technology for the reform of the teaching of digital circuits and the actual contents of the vocational skills required by the graduates in the job, so as to carry out the diagnosis and reform of the teaching of practical training. The latter stage is to understand the effect of the new model of practical training based on the OBE concept and the students' attitude and opinion towards the model, so as to obtain the practical results of the new model.

(3) Interview survey method

Structured interviews were conducted by using a pre-designed interview outline and investigating the interviewees through field, weibo, telephone and email. The interview survey in this study is mainly divided into two categories. One type of interview survey was conducted with the teachers of digital circuit practical training courses in two colleges and universities in Shijiazhuang and Zhuozhou to understand the current situation of digital circuit practical training teaching in colleges and universities, and to compare and repair the results of student questionnaire survey accordingly. Another type of interview survey was conducted with human resource managers of electronic and electrical enterprises to understand the jobs and the actual contents of the jobs that the graduates of university electronics technology courses can do in their corresponding positions.

(4) Educational experiment method

The education control experiment was adopted, and the electronics and information technology majors were selected. In the first stage, the theoretical foundation of digital circuits of students in two classes was understood through mapping tests, and 30 students were selected in each class according to the test results, after which one of the classes was randomly set up as the experimental class and the other class was set up as the control class. The experimental class was taught using the new model of practical training designed by the OBE concept, while the control class still used the traditional model of practical training teaching existing in the school for this major, but the knowledge points contained in the practical training content of both classes were the same. After a period of educational practice, the learning outcomes of students in the two classes were compared to explore the teaching effects of the new model of practical training teaching designed based on the OBE concept.

6. Core Concept Definition

6.1. OBE Concept

The OBE concept is called "Outcome-based Education", which is translated as "Outcome-Based Education". The definition of the OBE concept is more precisely explained by Spedding in "The Output-Based Education Model: Controversies and Answers", that is, it is a concept that clearly focuses on and structures the educational system to ensure that students can learn and gain the substantive experiences necessary for their future lives and thus achieve success [40]. The curriculum and teaching under its guidance should first formulate the learning outcomes that students should eventually achieve through the education process according to the actual requirements of society for talents, i.e., set the expected learning outcomes, then design the teaching objectives and teaching activities in reverse from the expected learning outcomes, and finally judge the completion of the expected learning outcomes according to the achievement of the teaching objectives and continuously improve the teaching. Therefore, the OBE concept is different from the traditional discipline-oriented education concept, which focuses on "educational input" and favors "what to teach and how to teach", while the OBE concept focuses

on "educational output" and favors "learning". "All educational activities and processes, curriculum and instructional design are focused on achieving the desired learning outcomes.

6.2. Digital Circuits

Digital circuits, also known as digital electronics, are often combined with analog circuits to form a comprehensive course in "Fundamentals of Electronics" at the college level. Digital circuits are both theoretical and practical in nature, and require a high level of theoretical knowledge and practical hands-on skills, making them one of the most important basic courses in electronics technology in higher education. Digital circuits are mainly divided into two modules: combinational logic circuits and timing logic circuits. Through the learning of these contents, students should master the basic knowledge of digital circuits and the analysis and design methods of circuits, form a good scientific experimental attitude, innovative thinking and develop correct professional operating habits, and lay a solid foundation for the learning of subsequent related courses, and also broaden the career development for students when they graduate. direction.

6.3. Practical Training

Practical training, or vocational skills training, refers to the teaching process of training students with appropriate professional skills within the control of the school and in accordance with the rules and objectives of personnel training. There are experiments, practice, and internship that are different from them. Experiment refers to the experimental learning with certain theme and verification goal; practice refers to the conscious and organized activity of transforming society; internship refers to the process of applying theoretical knowledge to practice. The practical training has the characteristics of authenticity, teaching, science and practice, which makes up for the shortcomings of the above-mentioned methods. The school creates specialized training space and training room for students according to the specific curriculum, so that students can be familiar with the professional work process and achieve good professionalism, so that they can be better integrated into the society after graduation.

7. Explanation of theoretical basis

7.1. Educational Objective Theory

OBE concept is closely related to two theories of educational objectives, one is the educational objectives in Taylor's principle and the other is Bloom's educational objectives classification theory, the former is the theoretical basis for the formation of OBE concept and the latter is the theoretical basis for the implementation of OBE concept. Among them, the educational goal theory in Taylor's Principle was proposed by the famous American educationalist Taylor in his 1949 book *The Fundamentals of Curriculum and Instruction*, in which Taylor emphasized that there are four basic steps to follow in developing any curriculum and designing any instruction: (1) What educational goals does the school want to achieve? (2) What educational experiences are to be provided to achieve these educational goals? (3) How can these educational experiences be effectively organized? (4) How can we determine if these educational goals are being achieved? From these four basic steps, we can see that both curriculum development and instructional design are centered on "educational goals. Therefore, educational objectives are the core of education and teaching, which provides the theoretical basis for the formation of the OBE concept oriented to the expected learning outcomes, and also provides ideas for the development of the practical training instructional design in this study. In addition, Bloom's classification theory of educational objectives was proposed by the famous American psychologists led by Bloom in 1956, and the theory has been widely respected by the international education community since its birth. Rather than a theory, it is more like a method of classifying educational objectives according to three major domains: cognitive, motor skills,

and affective. In the specific implementation of the OBE concept, the migration uses this classification method to specifically divide the expected learning outcomes obtained from society into three levels of teaching objectives: knowledge, competence, and quality, which are thus more conducive to the achievement and observation of the expected learning outcomes. Therefore, Bloom's classification theory of educational objectives provides a theoretical basis for the concrete implementation of the OBE concept, and also provides a method for defining and classifying the expected learning outcomes of practical training teaching in this study.

7.2. Competency-Based Education Theory

Competency Based Education (CBE) originated in the United States in the 1960s and has been widely used in universities, vocational education and corporate training in Europe and the United States. In the 1980s, CBE was introduced to China, and after many studies and practical researches by domestic scholars, it has proved the advanced and effective application of the theory in China. The core of competency-based education theory is to develop students' abilities as the key goal of education and teaching, and the abilities that students need to master are determined according to the needs of vocational jobs and refined by gradually decomposing teaching objectives [46], and the theory also emphasizes that all teaching processes and management methods should serve the development of students' vocational abilities. The theory also emphasizes that all teaching processes and management methods should serve the development of students' professional competencies. The above-mentioned theoretical foundation is laid for the OBE concept to define the content of expected learning outcomes based on the actual requirements of the market and enterprises for students. Education using the competency-based education theory has five main advantages over traditional education: (1) the education and teaching objectives are more focused on the actual needs of the industry; (2) it is highly operational; (3) it focuses on the integration of theory and practice; (4) it pays attention to the cultivation of students' interdisciplinary and comprehensive abilities; and (5) it focuses on students' independent and personalized learning. Therefore, the practical training teaching design of this study is based on the competency-based education theory, with a view to highlighting the student center and facilitating the cultivation of students' comprehensive quality, so that students can more easily form employment competitiveness when they graduate.

7.3. Bloom's Mastery Learning Theory

Bloom's mastery learning theory was also proposed by the famous American psychologist Bloom in the 1970s, the core content of the theory is: students' poor learning performance is not because they have intellectual problems, but because they are not given the best teaching help and sufficient learning time. If teachers could provide this, most students would master the content and achieve good academic performance. This theory is the basis for the "flipped classroom" model in this study, in which students are given sufficient time to study in class and teachers give them the help they need in class, so that students can personalize their learning and each student can master the content. In addition, the theory also provides hypothesis support for the design of practical training based on OBE concept in this study. As long as students can be guaranteed to get suitable teaching help and sufficient learning time, most of them can master the practical work of the market and enterprises, so as to achieve the expected learning outcomes of practical training.

7.4. Blended Learning Theory

The blended teaching theory was born in the United States at the beginning of the 21st century, and was later introduced to China by Professor He Antique of Beijing Normal University. Although blended teaching is a mixed mode of online and offline teaching, it does not mean that it is a simple physical superposition of the two, but a way of teaching in which online and offline

teaching are mixed at multiple levels so that they can achieve organic integration and complementary advantages. The multi-level mixture includes the mixture of theories, the mixture of learning resources and environment, the mixture of learning media and the mixture of learning methods. The specific contents of each level of blending are as follows.

(1) Blending of learning theories.

The formation of blended teaching is related to many learning theories, for example, cognitivism, behaviorism, constructivism, humanism and so on. Among them, cognitivism believes that learning should be a process in which students form their own "cognitive structures" from sensory and perceptual information in the form of subjective epiphanies. Behaviorism, on the other hand, emphasizes that learning is the connection between stimulus and response, which is manifested in blended teaching by the importance of timely evaluation of learning effects, feedback and adjustment of teaching. Constructivism is derived from cognitivism, but constructivism is based on the active, social and situational nature of student learning. In addition, constructivism emphasizes that the mastery of knowledge should be achieved by students' active construction and focuses on the connection between old and new knowledge experiences. The "guided text teaching method" used in this study is a reflection of students' active construction of new knowledge on the basis of their existing knowledge. Humanism, on the other hand, focuses on the real feelings and needs of students in the learning process, emphasizes that teaching should be student-centered, and highlights the value of students as biological human beings. Therefore, blended teaching organically integrates the above theories, reflecting the advanced and scientific nature of the teaching mode.

(2) Blending of learning resources and environment.

Since blended teaching is an in-depth combination of online and offline teaching, it naturally includes all the learning resources and environment used in online and offline teaching. For example, online teaching digital resources such as video, audio, electronic courseware, online question bank, online learning software, virtual simulation platform, online communication platform and other digital teaching environment, offline teaching traditional resources such as paper textbooks, teaching aids and exercise books, offline teaching traditional teaching environment such as physical classroom, training room and training base. The blended teaching makes full use of these two types of learning resources and environment to achieve the teaching effect of "1+1>2".

(3) Mixing of learning media.

Blended teaching can use various electronic devices such as computers and cell phones for online teaching as the media for students' learning, and can also use traditional media such as blackboards, chalk and practical training simulation displays for offline teaching, thus surpassing the respective teaching effects of pure online teaching and pure offline teaching.

(4) Blending of learning styles.

Blended teaching can help students realize personalized learning online, and students can make use of digital resources and environment to arrange their own learning plans anytime and anywhere in their free time outside of class without the restriction of venue and time, which is more suitable for the current situation of college students with different knowledge bases and acceptance abilities. In addition, in order to prevent the problems of students' lack of self-control, lack of supervision and inability to ensure the quality of learning, offline teaching can control the effect of students' online learning and improve their learning effect through the most familiar learning method. Thus, the learning style in blended teaching can both personalize students' learning and guarantee their learning effectiveness.

8. Summary of existing problems

Through the analysis of the research results of college students, teachers and graduates, it is found that the existing problems of digital circuit practical training teaching in colleges and universities mainly include.

(1) Students' practical training learning objectives are not clear, their theoretical knowledge base is weak, they lack the ability and quality of practical training such as innovative design and teamwork consciousness, and their learning initiative is not strong.

(2) Teachers have problems in teaching objectives, teaching contents, teaching methods, teaching evaluation and reflection in practical training teaching design, and the quality of teachers' vocational education needs to be improved.

(3) Insufficient arrangement of practical training hours in schools, backward practical training equipment and neglect of teachers' enterprise skills training, etc.

In addition, through the research, we have also obtained the feedback from the teachers and students on the demand for practical training teaching and the corresponding positions that the graduates of college electronics technology can be engaged in and the vocational ability required by these positions in the electronic and electrical enterprises, which is a sufficient preparation for the reform of college digital circuit practical training based on the OBE concept.

9. Teaching design of digital circuits based on OBE concept

9.1. Analysis of Reference Materials

The reference textbook for this comprehensive practical training teaching design comes from the current textbook of the investigated university, which is "Fundamentals of Electronic Technology (Second Edition)", edited by Zhang Longxing and published by Higher Education Press. The book is one of the series of teaching materials of electronics in colleges and universities, which belongs to the planning scope of the Ministry of Education. The book is divided into two parts, the first is the foundation of analog circuits, the second is the foundation of digital circuits, where the second part contains the chapter content. The book can be used as a professional textbook of electronics and electrical engineering in colleges and universities, and can also be used by relevant enterprises for job training and students for self-study. This study combines the teaching syllabus with the needs of job vocational ability, and mainly focuses on the content of the first six chapters.

9.2. Analysis of students' learning situation

The design of this practical training is designed for the second-year students of the electronics technology majors in colleges and universities. The students at this stage are familiar with the theoretical knowledge of digital circuits through the systematic study of the "Fundamentals of Electronics Technology" course in the previous academic year, and have several experiences of practical training, which has laid a certain foundation for the design of this practical training of digital circuits. Through the preliminary research, it is known that these college students have good logical thinking ability, belong to the abstract perceiver, good at observation and analysis, and have strong practical operation ability, but the theoretical knowledge of digital circuit is not solid, lacking the ability of analysis and design of practical training tasks, the ability to find problems and solve them, the consciousness of teamwork, and the ability of innovative thinking, and some students have weak learning motivation, low self-efficacy, and have a fear of Some students have low motivation, low self-efficacy, and are afraid of the practical training of digital circuits.

9.3. Practical Training Teaching Design

In view of the current problems in the teaching of digital circuits in colleges and universities, according to the actual needs of enterprises, teachers and students and other educational stakeholders, the OBE concept is used to define the expected learning outcomes, achieve the expected learning outcomes, assess the expected learning outcomes and continuously improve them, and the main line of thought is "The study uses the OBE concept to design a closed-loop system for the teaching of digital circuits in colleges and universities in five specific aspects: defining teaching objectives, constructing teaching contents, selecting teaching methods, conducting teaching evaluation, and improving teaching reflection, so as to change the status quo and improve the quality of the teaching.

9.4. The design ideas of this study based on OBE concept

(1) The objective of practical training is determined in order to solve the problem of unreasonable objective setting in the current practical training teaching, which is not conducive to the formation of students' employment competitiveness. Based on the OBE concept, the teaching objectives are determined according to its implementation principles of clear focus and reverse design. The educational stakeholders such as enterprises, teachers and students about the most important learning outcomes that students should have in practical training teaching obtained from the research are summarized, i.e., the vocational abilities that college graduates in electronics technology need to have when working in their counterpart positions in electronic and electrical enterprises, and the key abilities that students lack before and after practical training teaching as reflected by the research results of teachers and students, so as to define the expected digital circuit practical training teaching in colleges and universities. Then, using the definitions of cognitive, skill and affective domains in Bloom's education goal classification theory and their given behavioral verbs, the defined expected learning outcomes are divided into three levels of knowledge, ability and quality, and refined into specific measurable teaching objectives.

(2) Practical training teaching content is constructed to solve the current problems of boring practical training teaching content, which cannot mobilize students' learning enthusiasm; fragmented knowledge points contained between each practical training project, which is not conducive to the establishment of students' knowledge framework; and insufficient class time for practical training courses in schools. Based on the OBE concept, the teaching content is constructed according to its implementation principles of clear focus, heightened expectations and reverse design. Since digital circuits are mainly composed of two parts: combinational logic circuits and timing logic circuits, the digital circuit training course is structured as "basic - improvement - design" according to the teaching objectives.

10. Analysis of the teaching effect of practical training

The teaching process and teaching results of the experimental class and the control class were compared and analyzed by the combination of classroom observation, process evaluation and summative assessment. First of all, through classroom observation, it was found that students in the experimental class were usually active in learning and active in class, while students in the control class were more silent in class, students were busy with their own work, and some students would appear to be lazy and fish in the water due to the lack of peer supervision. In addition, the students in the experimental class had understood the learning objectives and contents of the practical training clearly through pre-class study, and understood the importance and difficulties of the practical training tasks, and the time arrangement was more reasonable, so the completion rate of the practical training projects in the experimental class was higher than that in the control class. Secondly, through the process evaluation, because the

experimental class used the guide text in the teaching, the students were more clear about their shortcomings in the process of practical training and would improve their performance in the next practical training. In contrast, students in the control class are not very clear about the problems of their own practical training operations and do not know how to improve them, and because the good or bad process of practical training operations does not affect the evaluation of their final grades, students with poor self-awareness make a lot of mistakes in the process of practical training and do not know how to improve them.

11. Summary

In this study, in order to improve the quality of digital circuit practical training teaching in colleges and universities, the OBE concept is used as a guide to design and practice the teaching for the problems existing in the current digital circuit practical training teaching in colleges and universities.

Using the educational experiment method to investigate the teaching effect of the new mode of practical training teaching, the content of "Comprehensive Practical Training of Combinational Logic Circuits" constructed in the previous teaching design was selected, and the students of telecommunications majors in colleges and universities were used as the practice objects. The results of the practice are known that the new mode of teaching digital circuits comprehensive practical training in colleges and universities designed based on OBE concept is beneficial to the solution of current practical training teaching problems and has high feasibility and operability.

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