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Reform and Exploration of Multi-course Integration of Electronic Practice based on Outcomes-based Education

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Abstract: The concept of outcomes-based education makes use of the internal connection between electronic practical courses to further define the educational objectives. It enriches teaching methods and teaching resources, and carries out the "goal-oriented", "capacity-oriented" and "demand-oriented" combination, to integrate with "student-centered" curriculum reform. Based on the result-oriented multi-course integration teaching reform of electronic practice, aiming at the internal connection of electronic practice courses, closely following the orientation of electronic information specialty, this paper constructs the integration reform program, designs multi-course fusion experiment with teaching case, demonstrating the whole course. We take "experiment peripheral board" as carrier, regard experiment teaching as grasping hand, link up four specialized courses in series, break the course barrier to cultivate students' practical ability and to provide theoretical guidance for the construction of talents' ability with new engineering achievement-oriented concept.

Keywords: Outcomes-based Education; Electronic Practice; Multi-course Integration.

1. The Relationship between Achievement oriented Education Concept and Electronic Practice Courses in Universities

The relevant national policies have promoted the cultivation of applied talents, and as the main body of applied talent cultivation, the curriculum design in applied undergraduate universities involves knowledge structure, ability structure, and quality structure, which are crucial factors affecting the quality of talent cultivation. Electronic practical courses in universities are an important teaching link for cultivating talents with solid theoretical knowledge, and also an important way to cultivate applied innovative talents. Practical courses can not only consolidate theoretical knowledge, but also improve students' hands-on ability and problem-solving ability. At the same time, they also cultivate their innovative ability and scientific and rigorous attitude, which will play a very important role in the completion of their graduation thesis and employment.

Outcome based education (OBE) refers to a clear focus on organizing the education system around ensuring that students gain substantial success in their future lives. It was first proposed by the United States and is also known as ability oriented education, goal oriented education, or demand oriented education. The results oriented education and teaching reform is currently widely explored and studied [4-7], and many domestic universities have also carried out teaching reforms for professional core practical courses [8-10]. The guiding ideology of the multi course integration teaching reform in the practical core of electronic majors based on the results oriented concept is student-centered, with engineering practice projects as carriers, and guided by the cultivation of student knowledge, abilities, and qualities, to construct a multi-level and progressive practical teaching system. Therefore, when formulating the training objectives and teaching directions for electronic information majors, they should be in line with the direction of social and economic development, and promote the comprehensive development of students in morality, intelligence, physical fitness, and aesthetics.

There is no fixed model for outcome oriented teaching, and it must be adjusted through teaching practices in various disciplines to achieve the best results [12]. So the results oriented education concept is suitable for electronic practical courses in universities, especially for electronic courses with strong practicality. On the one hand, the results oriented education concept guides the education of electronic practical courses in universities. Under its influence, the teaching of electronic practical courses will determine teaching objectives based on the social demand for talents, and design corresponding teaching links and activities according to the teaching objectives. As an important foundational course in universities, electronic practical courses are mainly oriented towards the employment of students and their professional, hands-on, and innovative abilities. Teachers will carry out curriculum construction based on results orientation to cultivate practical talents and ensure the sustainable promotion of talent quality. On the other hand, electronic practical courses in universities are the practice of results oriented educational concepts. The problems encountered and the results achieved in the course practice can not only verify the effectiveness of the results oriented education concept, but also have a reverse impact on the updating of the results oriented education concept in the teaching practice of electronic information disciplines. Applying the results oriented education concept to electronic practical courses, guided by student learning outcomes, and innovating teaching models, is of great significance for improving the teaching effectiveness of electronic practical courses, cultivating students' innovative awareness, and solving practical engineering problems.

2. The Current Teaching Status of Electronic Practical Courses

In response to the current situation of cultivating undergraduate students in engineering majors in China, there are several prominent problems in the teaching of undergraduate students in engineering majors, including: (1) the current construction of engineering majors in China focuses on the construction of single professional courses in curriculum design, the orderly connection and planning of courses are not precise enough, the updating of cutting-edge technology courses in majors is slow, and timely adjustments cannot be made to meet the needs of professional development; (2) At present, in the construction of engineering majors in China, there is still a common emphasis on basic theoretical learning in teaching plans, weak teaching in practical courses, weak professional practical skills of students, and insufficient practical problem-solving abilities. At present, in the process of cultivating applied talents, there are still problems such as "the cultivation of students' abilities and qualities cannot keep up with the rapid development of the industry; educational concepts cannot keep up with the new changes in educational objects" [13]. The author has previously discussed that embedded talents cultivated according to the current model are difficult to meet social needs and require secondary training by enterprises, which increases the employment costs of society and enterprises, and restricts their innovation capabilities [14].

The main problem currently faced by electronic information majors in domestic universities is that undergraduate students generally have weak practical skills, with a focus on theoretical advancement. There is a disconnect between theory and practice, which presents a trend of laying too much foundation for graduate studies. Undergraduate students are limited to professional practical abilities, and their theoretical research level is not deep enough compared to graduate students, resulting in difficulties in smoothly engaging in research and development and design work related to their major. This creates a dilemma where enterprises find it difficult to recruit suitable talents and students find suitable positions. Therefore, it is necessary to increase the cultivation and exercise of practical abilities for students in the undergraduate stage of electronic information majors. However, due to the complexity and difficulty of professional experimental courses, the lack of systematic knowledge among students, the fear of difficulties in learning, weak interest in learning, and low enthusiasm, it is necessary to design and offer interesting experiments to update outdated content; Furthermore, the equipment for professional experiments is relatively expensive, and the updating of teaching content and experimental equipment cannot keep up with the pace of new technological development. Therefore, it is necessary to increase experimental funding and replace professional experimental equipment. Overcoming the above difficulties, effectively connecting electronic practical courses and enhancing practical abilities will greatly help students apply the theoretical content learned in courses such as C language programming, ARM architecture, digital electronic technology basics, analog electronic technology basics, high-frequency electronic circuits, microcontrollers, and interface technology to practice, enabling students to apply what they have learned and ultimately solve practical problems.

3. Reform Plan for the Integration of Multiple Courses in Electronic Practice Based on Achievement Orientation

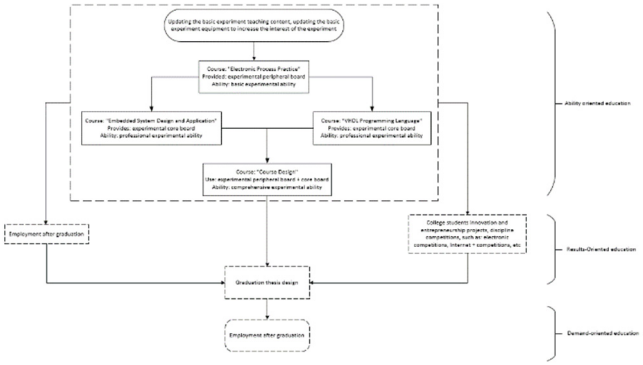

Fig 1. Reform plan of multi-course integration of electronic practice based on outcomes-based education

The electronic practical courses in universities are aimed at cultivating innovative and practical talents who can meet the needs of social development, and innovative research on electronic practical courses in universities is essential. The reform of multi course integration teaching in electronic practice based on results orientation aims to integrate current professional courses, coordinate and arrange, carefully plan, and reasonably connect. It is necessary to ensure good teaching quality in all aspects in order to fully leverage the advantages of integration. Based on the current development of enterprise technology application needs, reform the teaching content of professional experimental courses, delete relatively outdated content, and increase the content of basic experimental ability training to enable students to have good practical abilities, laying a solid foundation for subsequent experimental learning of professional courses, and laying a solid professional practical foundation for undergraduate students' professional employment. At the same time, the content involving new technology practice should be increased and expanded, and the original teaching content structure should be changed to better meet the current social needs.

Multi course integration refers to the overall design and planning of the content of four courses, namely "Electronic Process Internship", "Embedded System Design and Application", "VHDL and Application", and "Course Design", so that the course content is organically connected and avoids cross repetition, with a gradient increase in difficulty, making practical teaching coherent and holistic, improving the efficiency of practical teaching, and gradually improving students' practical abilities, thereby enhancing their relevant market competitiveness. While considering the compatibility with society, the teaching content should be as interesting as possible, mobilizing students' interest in professional practice, stimulating their learning enthusiasm, and enabling them to apply what they have learned in the interdisciplinary and complex environment of curriculum design and graduation thesis design, solving practical problems. The reform plan for the integration of electronic practical courses based on results orientation mainly includes the following aspects: (1) updating the basic experimental teaching content, updating the basic experimental instruments, and increasing the interest of experiments; (2) Increase the serial connection between experimental platforms, and use "peripheral boards" and

"core boards" to link four professional core experimental courses; (3) Utilize the college's technology expo season activities and various subject competitions to enhance students' practical abilities; (4) Strictly control the graduation thesis design process, improve student employment rates, and serve the local economy. The specific scheme diagram is shown in Figure 1.

4. Implementation and Effectiveness of Multi Course Integration Teaching in Electronic Practice Based on Results Orientation

With the strong support of the school's colleges, the electronic laboratory has completed the elimination and scrapping of basic instruments and equipment, and has purchased 50 sets of mainstream basic instruments currently used by off campus enterprises, which are equipped with hardware conditions for the implementation of teaching reform. The members of the course team have long-term horizontal cooperation with off campus enterprises, familiar with the social development needs and mainstream technology status of electronic information majors, able to grasp the general direction of the demand for electronic information talents in society, and have a certain technical reserve through long-term frontline technology research and development work. Therefore, they can design a series of interesting experimental content according to the specific profession, effectively connect multiple electronic practice courses using the "experimental peripheral board" and "experimental core board", achieve the teaching reform effect of multi course integration, and further cultivate outstanding graduates with professional practical abilities, new engineering achievement oriented concepts, and industry market competitiveness.

By offering electronic practical teaching courses in stages, if the results oriented concept can be applied to practical teaching, and the four courses can be effectively integrated, the limited classroom teaching time can be combined with a large number of open experiments to stimulate innovation awareness in the course learning process. This can enable students to acquire core knowledge that should be learned in their professional field and cultivate the ability to solve practical problems. During the practical teaching process of the four core professional courses, different development boards are created separately, which can be used together to optimize resource allocation. The main content and relationship are shown in Figure 2.

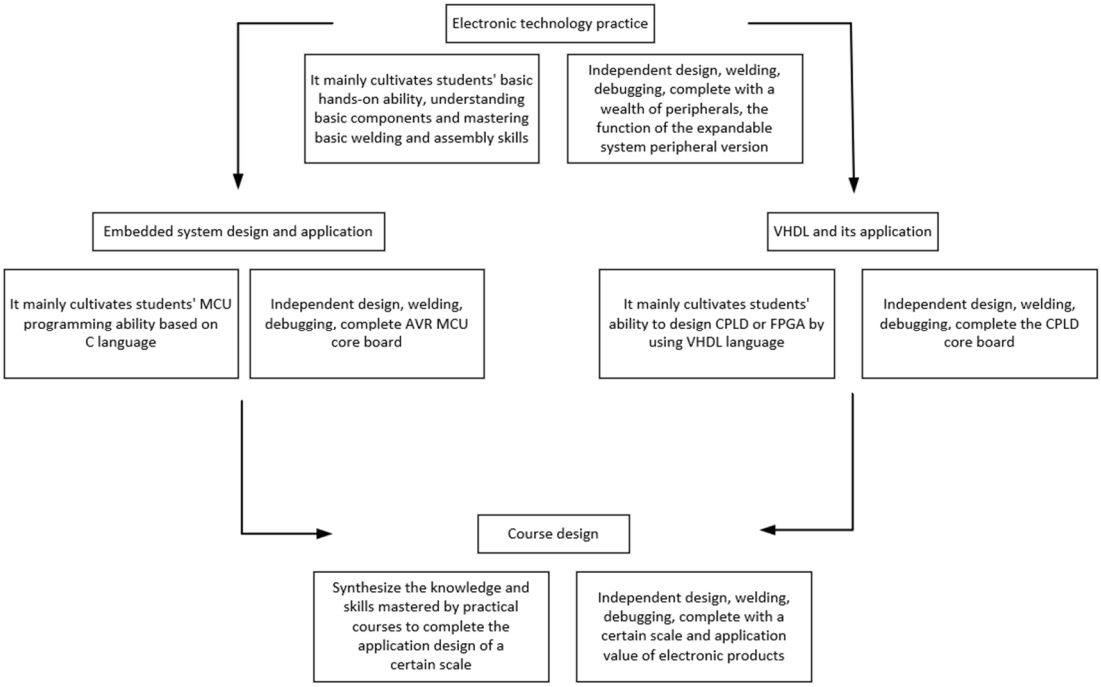

Fig 2. Main contents and correlation diagram of 4 professional core courses

Using the college level technology exhibition season as a starting point to stimulate students' interest in learning. Each academic year, a three-month science and technology activity is held based on different themes, mainly to allow students to truly engage with professional knowledge in various forms (teachers and students entering enterprises, science museums, primary and secondary schools, communities, podiums, and open laboratories for preparation), and to subtly stimulate students' interest in learning within a relatively regular time. Using city level subject competitions as practice to enhance students' practical abilities. For example, in the Tianjin "TI" Cup Electronic Design Competition, the college has a training program, and each open laboratory guides teachers to use their spare time and winter and summer vacations to train students according to the training program. Intended to use city level competitions as practice, comprehensively exercise students' practical skills, and lay a solid foundation for participating in the National Electronic Design Competition. With the goal of national subject competitions, we aim to enhance the comprehensive quality of students. Such as National Electronic Design Competition, Internet plus Competition, Challenge Cup, China International Aircraft Design Challenge, etc.

Based on the integration of multiple courses in electronic practice, improve the quality of graduation design. According to statistics, as many as 78.5% of students have utilized the knowledge of electronic practical courses in their graduation projects in the past five years. Among them, the proportion of practical courses in excellent undergraduate graduation theses (designs) is as high as 75%. It can be seen that students have

indeed applied the professional knowledge of electronic practical courses to their undergraduate graduation projects and have also completed their undergraduate graduation projects to a high level. The graduation thesis topic of the student is signal amplification and filtering circuit design for pressure sensors. The main focus is on designing the signal amplification circuit for pressure sensors and filtering the amplification circuit to remove noise at specific frequencies, ensuring the stability, reliability, and authenticity of the signal. The amplification part is designed using a differential circuit, using a low noise and low-temperature instrument operational amplifier, and filtering is using a low-pass filter with a variable upper limit cutoff frequency. During the completion of the project, students were primarily trained in their ability to design analog electronic circuits, use operational amplifiers, and design filter circuits. At the same time, their comprehensive abilities in PCB design were examined and honed. The physical design diagram is shown in Figure 3.

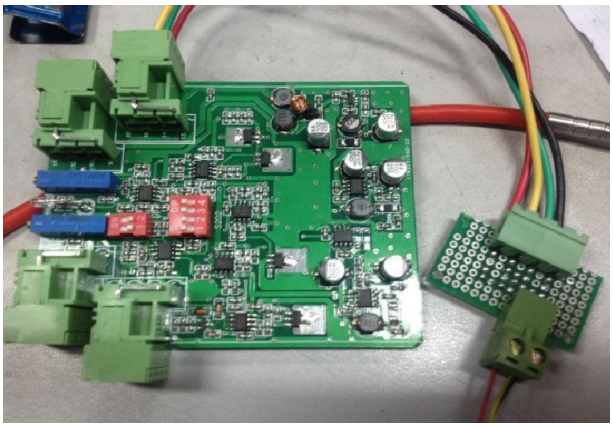

Fig 3. Physical drawing of graduation project

The employment difficulties of college graduates and the difficulty for employers to find suitable talents are two prominent social problems in today's society. The fundamental reason for this lies in the disconnect between the training system of universities and the knowledge structure of talents needed by society. The fundamental solution to this problem lies in transforming the knowledge structure of talents needed by enterprises into the professional curriculum system of universities. This requires close integration between universities and enterprises, insight into the direction of technological development, timely adjustment of teaching content, and cultivation of practical talents. The reform and exploration of the integration of electronic practical courses based on results orientation is precisely to solve this problem. The reform has achieved good results by adjusting teaching content and connecting electronic practical courses. Through long-term tracking of graduates, students who enter open laboratories, actively participate in science and technology exhibition season activities, and subject competitions can all achieve good development in their professional positions. Some students enter well-known companies to work and receive unanimous feedback and praise from the companies.

5. Conclusion

Applying the concepts of achievement orientation, ability orientation, and demand orientation to the exploration of the reform of multi course integrated teaching mode in electronic practice is beneficial for improving students' practical skills, enhancing their market competitiveness, and providing certain contributions to the development of the electronic communication industry. The reform of integrating multi course teaching in electronic practice based on results orientation has been applied in the Electronic Information Science and Technology major of our school, and promoted in the teaching of Communication Engineering and Artificial Intelligence majors. Practice has proven that through the integration of multiple courses in teaching reform, the practical abilities of students in three majors have been enhanced, laying a solid foundation for their participation in subject competitions and graduation thesis design. It also lays a good foundation for their graduation and employment, enhances their social fit, and plays a guarantee role in comprehensively improving their comprehensive literacy.

Acknowledgments

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