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Basic teaching design of digital electronic technology based on the UbD model—Taking the basic law of logic algebra as an example

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Abstract: There are many disadvantages to traditional teaching methods in the theory of digital electronic technology. This paper takes the basic law of logic algebra in the basic course of digital electronic technology as an example by using the teaching Design mode of "Understanding by Design", a new teaching design strategy is discussed. Aiming at the problems of one-way knowledge transmission, low participation of students, and poor teaching effect in traditional theory teaching, this paper proposes a reverse teaching design process, it includes three stages: defining expected learning results, determining reasonable evaluation evidence, and designing relevant teaching activities to improve teaching quality, aiming at improving teaching quality through the application of the UbD mode, it provides practical reference for the teaching reform of basic courses of digital electronic technology.

1. Introduction

In teaching the basic course of digital electronic technology, the content of the course can be divided into theoretical teaching and practical operation of two major links. In the process of learning, the teacher first explained the theory systematically, then through a series of confirmatory experiments to deepen students' understanding of key knowledge points. However, there are obvious disadvantages in this mode: for the teaching of theoretical knowledge, the traditional teaching mode, which is dominated by teachers, is the core of the one-way transfer of knowledge, rather than inspiring students to take the initiative to learn and explore. Students in this process of low participation, it difficult to form an intuitive sense of knowledge and deep understanding, only staying in the level of mechanical memory. In addition, the course content itself is complex and abstract, which makes the teaching process heavy for teachers and monotonous for students, thus affecting the overall teaching effect.

From the perspective of higher educational psychology, in the process of experimental teaching, students are required to hear, see, feel, and hand, the sensory stimulation and impression obtained are more profound and lasting than classroom theory teaching[1]. But theoretical teaching, such as digital logic fundamentals, logic gates, combinational logic, triggers, sequential logic, circuits, digital/analog/digital converters, large-scale digital IC, etc., are abstract and difficult to master. Therefore, the quality of teaching can be improved through the improvement of teaching mode.

Understanding by Design (UbD), a teaching Design model chosen in this paper, takes the Basic Law of logical algebra as an example, and aims at developing and deepening students' Understanding, developing a new instructional design model that includes “Defining expected learning outcomes-identifying evaluative evidence-designing relevant instructional activities” for in-depth learning, to promote students to truly understand the knowledge.

2. The teaching of basic logic algebra is realized by using the UbD model

The UbD model advocates a planned teaching design process, which includes three core stages: establishing desired learning outcomes, setting appropriate assessment mechanisms, and meticulously designing and organizing teaching activities. This unit design follows the principle of "backward design," starting with the clear definition of learning goals and tasks to be completed, then breaking down these goals into core concepts, integrating key knowledge points and core subject competencies, and implementing reverse design strategies. Ultimately, this approach is detailed down to each specific task directive. During the learning process, it emphasizes the importance of helping students understand their learning direction—what they are about to learn, the significance of these content areas, and the standards to be achieved. At the same time, it focuses on monitoring students' learning experiences by designing engaging and motivating projects or activities, ensuring that the learning process is filled with interest and enthusiasm, prompting students to participate and desire to complete learning tasks actively[2].

2.1. UbD model overview and significance

The UbD model is also known as the "teaching design that prioritizes understanding." This teaching design framework was developed and innovated by Grant Wiggins and Jay McTighe after the American educational evaluation expert Ralph Tyler proposed the "goal-oriented" educational teaching model.

This reverse teaching design model emphasizes clarifying learning objectives and expected outcomes first in the teaching design process, then planning teaching activities, assessment methods, and teaching resources based on these objectives and outcomes.

The UbD model primarily consists of three stages: the first stage is to determine the expected outcomes; the second stage is to determine appropriate assessment evidence; and the third stage is to design learning experiences and teaching activities. Under this framework, teachers are required to have a forward-looking perspective, with the primary task of clearly defining the success criteria for students to achieve learning objectives, and then reverse-planning teaching strategies based on this[2].

Therefore, assessment is the core link in this process, which should no longer be limited to traditional single tests (such as unit quizzes). Instead, as the course content deepens and teaching activities unfold, a diversified assessment system should be gradually constructed. This assessment system runs through every critical link of teaching, aiming to comprehensively evaluate students' learning outcomes through various means. In addition to traditional written exams, it also includes various assessment methods such as thinking feedback, peer evaluation, self-reflection, and achievement display. These methods not only enrich the dimensions of assessment but also promote students' deep involvement and active thinking in the learning process.

2.2. Three Stages of reverse instructional design based on the UbD model

Phase 1: identify the expected results

These aims aim at promoting students' knowledge mastery, ability improvement, and positive development of emotional attitude in an all-round way.

2.2.1. Identifying Desired Results

These aims aim at promoting students' knowledge mastery, ability improvement, and positive development of emotional attitude in an all-round way.

According to the three-dimensional goal theory, three-goal dimensions should be achieved in the process of education and teaching, namely, knowledge and skills, process and method, emotional attitude, and values, as shown in Table 1.

Table 1: Teaching objectives.

Knowledge & Skills	1. Students can clearly and accurately explain logic AND (AND), logic OR (OR), AND logical NOT. 2. Students can skillfully use the basic formulas of logical algebra, and effectively solve all kinds of logical operation problems. 3. Students can connect with the reality of life, illustrate the application of logic algebra in daily life or professional fields, and enhance the ability of knowledge transfer and application.
Process & Steps	1. Through the teacher's careful explanation and the positive interaction between students, guide students to develop the ability of independent thinking, promote the theory and practice of close integration, and improve the efficiency of knowledge internalization. 2. In the class practice link, encourages the student to explore actively, the positive attempt, deepens through the practice operation to the logical algebra knowledge the understanding and the grasping, simultaneously guides the student to reflect, identify, and remedy deficiencies in the knowledge system.
Emotional Attitude & Values	1. To help students establish a preliminary but solid cognitive framework for the logic algebra in digital circuits, to lay a solid foundation for further study, and to stimulate the interest and motivation of continuous exploration. 2. Through the completion of learning tasks and problem-solving processes, students experience the joy of success, enhance the sense of achievement, and then enhance the curriculum and the entire field of love and investment, develop a good learning attitude and values.

In alignment with the course objectives, the anticipated outcomes can be broken down into key concepts, principles, and skills that students need to grasp profoundly. Subsequently, corresponding fundamental questions can be formulated, such as: "What are AND, OR, and NOT logic operations?"; "How do we perform calculations involving NAND, NOR, AND-NOR, XOR, and XNOR?"; "How can logical algebra be utilized to comprehend electrical circuits?"; and so forth.

2.2.2. Determining Acceptable Evidence

To assess whether students have achieved the established learning objectives and to what extent they have met them, teachers can employ a variety of methods. These include, but are not limited to, real-time questioning in the classroom, regular quizzes, and detailed classroom observations. Additionally, encouraging students to engage in self-assessment or using peer evaluations within groups are also effective ways to obtain feedback on students' learning outcomes. Together, these methods form a comprehensive and multidimensional assessment system.

Performance tasks are an important means of evaluating students' abilities. By designing specific scenarios, these tasks require students to apply their knowledge to solve practical problems, thereby demonstrating their understanding and application skills. During the teaching process, teachers should incorporate relevant performance tasks. For example, they might ask students to use logical symbols to accurately represent the functions of switches under different connection methods for a given circuit. This can help assess students' grasp of logical algebra and their application abilities. To obtain more scientific and rigorous assessment evidence, teachers should employ a range of assessment methods. These may include interactive questioning in the classroom, meticulous classroom observations, targeted classroom exercises, regular unit tests, and evaluating students' understanding and insights on specific issues during discussions. These approaches collectively provide rich materials and perspectives for evaluating students' learning progress and outcomes.

2.2.3. Designing Learning Experiences and Instruction

To stimulate students' enthusiasm and motivation, teachers can meticulously plan diverse teaching practice activities aimed at promoting students' comprehensive development and gradually shaping their correct values and essential core competencies. According to the core principles of the "Understanding by Design" (UbD) theory, textbooks are considered fundamental resources in the teaching process. Teachers should flexibly utilize these resources based on student's specific learning conditions and needs, integrating them with lesson and work requirements. This involves designing activities before, during, and after class to ensure that teaching activities are closely aligned with core teaching goals, showcasing teachers' autonomy and creativity.

Before class, release a task list related to the lesson. Through preliminary online platform resources, students can gain a preliminary understanding of difficult content, enabling them to grasp new knowledge more quickly. The task list helps students identify key points and address gaps. Additionally, pre-class online learning platform check-ins can be used to gauge students' preparatory work. Comparing these summaries helps identify any gaps and reinforces the learned material, achieving the desired teaching outcomes.

3. Practical Reflection

The main content of this section is the basic laws and rules of logic algebra. Before the lesson, a carefully designed task list was prepared for students, which not only covered the necessary foundational knowledge but also aimed to guide students through practical exploration to achieve knowledge internalization and deepening. From the practical results, this approach helps students clarify their learning direction, understand the value of the content, and stimulate their intrinsic motivation, setting a good foundation for subsequent in-depth learning.

During the teaching process, the teacher employed a variety of interactive strategies. Through group discussions, collective wisdom was stimulated, enhancing students' interest in learning and deepening their understanding of key knowledge points, while also developing their teamwork skills, communication techniques, and critical thinking abilities. Guiding students to create mind maps not only helps them systematically summarize key knowledge points and form knowledge networks but also provides effective review tools, promoting long-term memory and flexible application of knowledge. Additionally, classroom sharing encouraged students to articulate what they learned, further consolidating their understanding through discussion and promoting the deepening and expansion of their thinking.

After the lesson, the teacher assigned corresponding homework to help students reinforce what they learned, transfer knowledge, and deepen their memory, transforming students from passive knowledge recipients into active knowledge creators. Overall, the students' learning outcomes met the teaching expectations[3-4].

4. Conclusions

In this paper, the UbD (Understanding by Design) teaching design model is utilized to reform and implement the instruction of basic laws of Boolean algebra in foundational digital electronics courses. Through the three core stages of defining clear learning outcomes, determining appropriate assessment evidence, and designing relevant instructional activities, the aim is to enhance teaching quality as well as student interest and engagement.

Defining expected learning outcomes provides a clear direction for instruction, assists students in mapping their learning paths, and ensures the achievement of educational objectives. The use of diverse assessments allows for a comprehensive evaluation of student learning outcomes, surpassing the limitations of singular testing methods. This multidimensional feedback facilitates adjustments in teaching strategies and enables personalized guidance. Moreover, thoughtfully designed instructional activities stimulate student initiative and foster deep learning. Students, through interaction, practice, and reflection, construct knowledge independently and develop problem-solving skills.

Overall, the application of the UbD teaching model in the digital electronics foundational course has demonstrated significant results. It has not only increased students' interest and engagement but has also advanced their deep understanding and application of knowledge. It is anticipated that this model will continue to play a crucial role in future theoretical instruction, providing robust support for the enhancement of overall teaching quality.

References

[1] Zhaoxia Deng. (2006). Research on the reverse teaching method of the course objective of electrical circuits for electronic technology major. Vocational education studies (02), 86-87.

[2] Grant Wiggins, Jay McTay. Instructional design in pursuit of understanding[M]. Shanghai: East China Normal University Press, 2017.

[3] Yanping Wang. (2007). The reverse teaching method of digital electronic technology foundation. China Science and Technology Information (17), 211 + 213.

[4] Yinping Liu & Huishan Chen (2006). Discussion on the experimental teaching reform of "Digital electronic technology". Laboratory research and exploration (08), 981-983.