A NEW INQUIRING T&L STRATEGY OF THE "BASIC CIRCUIT THEORY"

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ABSTRACT

Initiative-cooperation inquiry teaching method is an important part in the educational reform. It is discussed and practiced in the article. First, some basic concepts of this teaching method are described, and then author illustrates the application of this teaching method in Basic Circuit Theory through two teaching cases. The practical results show that this teaching method can stimulate students' interest and enthusiasm of Basic Circuit Theory well, and develops their ability of active thinking and mutual cooperation.

KEYWORDS

Node voltage analysis,Operational amplifier,Inquiry learning,Active learning, CDIO Standards:8

INTRODUCTION

The Basic Circuit Theory is the colleges' electrical and electronic engineering subject compulsory basic course, and it has close contact with the follow-up courses. It is crucial to learn the circuit course well for the follow-up courses.

The author has been thinking about some problems in these years, such as, some of the points in the circuit course have been explained many times, why do students still have lots of questions? Some students have never asked a problem, why do they learn well? And some students like communicating with teacher, why are their records unsatisfactory? These issues are also one of the reasons that prompt the author to put the teaching reform of Basic Circuit Theory into practice. And the CDIO(Conceive Design Implement Operate) engineering education model that is implemented by the institute, through proceed of the project's conceive-design-implement-operate to enhance cultivation of students' life-long learning skills, communication skills, management ability, leadership ability, practical ability and teamwork ability. This kind of education model even more highlights the necessity of teaching reform.

INTRODUCTION OF INQUIRY TEACHING

The Background And Significance Of Research On Inquiry Teaching

Currently, the traditional teaching mode is widely used in domestic colleges. The famous educator Paulo Freire called it "banking education". In this teaching mode, teachers teach

knowledge while students passively accept. So teachers become the main body of the learning process, and the students just are the object of it [1].

So in the reform teaching method that Freire proposed, it emphasized student-centred. He promoted a multicultural, democratic, dynamic teaching method. In addition, he required students to build their own knowledge hierarchy during the process of participate in team projects, communicate and work with others to solve problems. This reform teaching method is initiative-cooperation inquiry teaching method in essentially. Therefore, it is the purposes of teaching reform in this article that how to apply the inquiry learning to basic circuit course, let students' learning from passive to active, enhance student's active thinking, and the ability to explore issues and mutual cooperation.

Inquiry teaching that was proposed by educator John Dewey, who advocates students to participate actively. It is a positive learning process. Students acquire knowledge and build capacity through the exploration activities, such as discover problems, investigate, experiment, operate, collect and process information, express and exchange independently. It can develop their explorative spirit and innovation capacity. Therefore, the inquiry teaching reform partly makes up for the deficiencies of a traditional education [2].

The Nature And Advantages Of Inquiry Teaching

Initiative-cooperation inquiry learning has been advocated by many well-known educators all the time. Freire believed that the initiative and cooperative learning could change the traditional teaching model, and it could establish the cooperation and equal relationship between teachers and students [1].

Initiative-cooperation inquiry teaching is different from the traditional teaching methods. It requires teachers to come down from the rostrum, stand among students, and have equal dialogues and communications with students. Teachers should create a specific learning environment for students to ask questions from a problem situation, establish assumptions, and prove or disprove the assumption on the basis of the collection of evidence, and finally draw their own conclusions [3]. Through this way, teachers guide students to think and explore the problem actively. So the initiative-cooperation inquiry teaching method is not only a test to students, but also a challenge to teachers.

TEACHING CASE

In the usual knowledge learning interactive seminars, author pays attention to cultivate students' creative thinking. The students on a team answer problems assigned by teachers commonly, two specific cases are shown in the following.

Teaching Case 1

Diagram of the circuit, as shown in figure 1:

Ask Question (5 minutes).

(1) Take ① as a reference, calculate u_{2n}. (2) Use node voltage method, write the equation of u_{3n}, u_{4n}, and calculate them. (3) Calculate the current source voltage u. (4) Try to use critical

thinking to prove: it doesn't contain 2Ω resistor above the current source in the equation to calculate u_{3n} and u_{4n}.

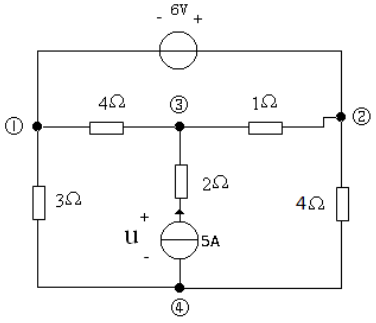

Figure 1. Teaching case 1

Discussion And Calculation (15 minutes).

The answer of question (1) is 6v that can be pointed out directly from the schematic. In question (2), take ① as a reference, write the node voltage equation as follows

$$\begin{cases} -u_{2n} + (\frac{1}{4} + 1)u_{3n} = 5 \\ -\frac{1}{4}u_{2n} + (\frac{1}{3} + \frac{1}{4})u_{4n} = -5 \end{cases} \quad (1)$$

the answers are $u_{3n} = 8.8v$, $u_{4n} = -6v$. In question (3), it can be written directly

$$u_{4n} - u_{3n} = 2 \times 5 - u \quad (2)$$

the answer is $u = 24.8v$.

Find Problem (10 minutes).

Most of students are able to answer question (1) correctly. In question (2), students' answers are inconsistent, the main reason is that there are part of students take the 2Ω resistor above the current source into consideration, so produce incorrect results. And question (3) is similar to question (2), some students don't consider the 2Ω resistor. When should the 2Ω resistor be considered, and when not? This is an issue worthy of exploring.

Solving Problem (20 minutes).

In question (4), we can take the node voltage method to derivate directly. Thus take the node voltage as unknown quantities to write KCL equations. For ③, ④ nodes, write the KCL equations

$$\begin{cases} \dfrac{u_{3n}-u_{1n}}{4}+(u_{3n}-u_{2n})=5 \\ \dfrac{u_{4n}-u_{1n}}{3}+\dfrac{u_{4n}-u_{2n}}{4}=-5 \end{cases} \tag{3}$$

Collate them, we have

$$\begin{cases} -u_{2n}+(\dfrac{1}{4}+1)u_{3n}=5 \\ -\dfrac{1}{4}u_{2n}+(\dfrac{1}{3}+\dfrac{1}{4})u_{4n}=-5 \end{cases} \tag{4}$$

This result is the same as the equation (1) of question (2). Thus, the equation does not contain the 2Ω resistor.

Teaching Case 2

This question extends from students' three projects. Circuit diagrams are shown as figure 2 and figure 3:

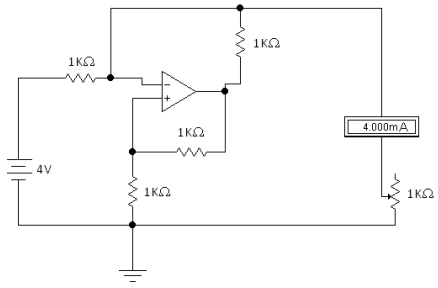

Figure 2. Teaching case 2(1)

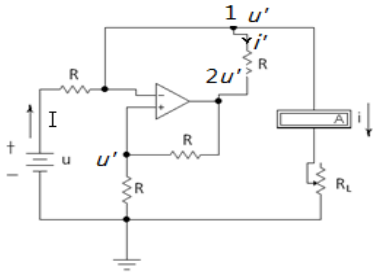

Figure 3.Teaching case 2(2)

Ask Question (5 minutes).

(1) In the EWB simulation, it can be found that the ammeter reading is always 4mA when the slide resistor is changed, therefore it can be said that the circuit output have the nature of ( ) source; (2) When the input voltage is increased by 2 times, the ammeter reading also increased 2 times, the circuit can be called ( ) control ( ) source; (3) The theoretical derivation: let each resistor as R, load resistor as R_L. When the input voltage is u, the output circuit is i, try to write out the expression of $i=f(u)$.

Prediction And Conjecture (5 minutes).

In this part, students discuss their results and reasons by taking form of group discussion.

Experiments And Observations (15 minutes).

In this part, students use the EWB circuit software to design and simulate the experimental circuit and to record the ammeter reading.

Processing Data, List, Description And Verification (25 minutes).

In this case, the (1) and (2) questions are the basic concept questions. It's easy to answer them. In question (3), we can find some of students who have creative thinking. Take the derivation of a student for an example. Assume that the potential between the two resistors of the amplifier's below is u', the current of voltage source is I, thus you can write the KCL equations of node 1

$$\begin{cases} I = \dfrac{u - u'}{R} \\ i' = \dfrac{u' - 2u'}{R} \\ i = I - i' \end{cases} \tag{5}$$

Collate them, we have

$$\begin{cases} I = \dfrac{u}{R} + (-\dfrac{u'}{R}) \\ i' = -\dfrac{u'}{R} \\ i = I - i' \end{cases} \tag{6}$$

The solution of equations is $i = \dfrac{u}{R}$, this result can be explained by figure 4:

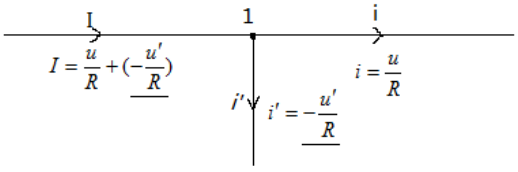

Figure 4. Visualize equations

From figure 4, we can see the current of voltage source is divided into two parts: i' and i. And figure 3 shows that if change the load resistor R_L, u' will change, thus I and i' will also change. But they change the same, i doesn't change with R_L. Therefore the size of i has nothing to do with R_L, i plays the role of the current source. It explains the question (1) and question (2) on the theory.

This question can be solved by the node voltage method. The method is complicated and unintuitive.

ACHIEVEMENTS AND UNRESOLVED ISSUES OF INQUIRY TEACHING

The author did two anonymous questionnaire surveys among the students at the beginning of the teaching reform and the end of the term. Through the results of two surveys, it can be found that: the proportion that students like group discussions roses from 27.53% to 40.68%, and the proportion that students like inquiry teaching roses from 30.43% to 44.07%. Through inquiry learning interactive seminars, students' innovative thinking and practice ability have a great improvement. These indicate that the teaching reform method achieves significant results.

SUMMARY

The teaching reform can cultivate students' active thinking and innovative ability well, and enhance the awareness of the student teamwork, so it had the desired effect. But because this is the initial attempt teaching reform, so there are many shortcomings. Taking into account the students' engineering practice ability also need to further strengthen, it's proposed to add an electronic production team competition. Inquiry teaching needs to improve, it will further add the teaching of integrated thinking, and apply the modern educational thought to further stimulate students' interest.

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