International Journal of Social Science and Education Research Volume 5 Issue 6, 2022
ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202206_5(6).0001

Teaching Reform and Practice in the Experiment of Analog Electronic Technology Based on the Rain Class

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Abstract

The experiment course of analog electronic technology plays a very important role in cultivating the practice and innovation ability of electronic majors. In order to improve the teaching quality of the course and the students' learning state, the teaching reform of analog electronic technology experiment based on the Rain class has been carried out. Under this teaching model, it is reformed to the teaching content, the teaching process and the assessment method. In the reform of teaching content, the main consideration is to cultivate students' interest, design and innovation abilities. The teaching process mainly includes preview, test, promotion, analysis and summary, online discussion. The assessment method is mainly focused on process assessment, rather than impression score and report. Under this teaching mode, students' enthusiasm and the abilities of communication and innovation are greatly improved.

Keywords

The Rain Class; The Experiment of Analog Electronic Technology; Reaching Reform; Assessment Method.

1. Introduction

Experimental teaching is not only an important part of the higher engineering education, but also an effective means to cultivate innovative talents. Students can consolidate their theoretical knowledge and improve the ability to connect theory with practice by the study of experimental courses. In this way, students can better establish scientific experimental methods and master the necessary practical skills [1]. Laboratory courses of the analog electronic technology is the core curriculum of the electrical and electronic information in Colleges and universities. The course has the characteristics of nonlinearity, complexity and engineering. It is a difficult experimental course, which makes the experimental teaching method and teaching process especially important [2].

The Rain class researched and developed by Xuetang online and Qinghua University is a smart teaching tool based on Wechat and Powerpoint [3]. In Rain Class, teachers can not only interact with students conveniently and quickly before class, during class and after class by the modern information technology and the Internet technology, but also understand the learning situation in time and carry on targeted teaching improvement. Finally, the effective integration of teaching based on Mobile Internet is realized [4].

At present, the rain class has been successfully applied in the teaching of many colleges and universities throughout the country [5], but its application in the experimental teaching is still relatively small, this is mainly due to the good teaching interaction between teachers and students in the traditional experimental teaching process [6].

Presently, the teaching of analog electronic technology experiment course still adopts the traditional teaching and examination method in most colleges and universities [7]. The

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202206_5(6).0001

examination of the experimental course is mainly based on the experimental operation, the experimental attendance, the experimental report after class and the experimental operation examination. The experimental teaching mode of rain class solving the practical problems in the experimental teaching is a way to cultivate students' creative ability, which emphasizes on process, individuation and hierarchy.

2. Problems in Experimental Teaching

The evaluation standard of analog electronic technology experiment course: 50% in ordinary time, 50% at the end of the term. The evaluation of ordinary achievement is based on students' attendance, actual operation and experimental report. Attendance is deducted according to the number of times students being late or leaving early. The actual Operation score is based on the teacher's evaluation of students' operation ability in the course of class. The experimental report is based on the analysis and summary of the contents and data of the report. The main problems in this teaching process and evaluation are as follows.

(1) The experimental report can not evaluate the students exactly, objectively and truly. The experimental report can not reflect the students' ability to deal with the problems and analyze the experimental data, and can not accurately and objectively reflect the effect of the students through the experimental study. Some students spend a lot of time previewing, simulating, analyzing and processing experimental data, while others can achieve the same experimental report data and results by copying, which makes it impossible to objectively distinguish students' learning situations, teachers can not give accurate, objective and true evaluation or assessment.

(2) The content of the experiment is based on the experiment box, the students' creativity and design ability can not be well trained, and the students' initiative and enthusiasm can not be well mobilized. Since most of the experimental contents are confirmatory, students only need to build the experimental circuit and measure the parameters according to the steps of the experimental handout. In the experiment students will not only be proactive in the design of the circuit and in the experimental process of parameter debugging but also not innovate. In this way, only the verification of the basic circuit and the training of operating skills are realized. Students with strong learning ability have nothing to do after doing experiments, which results in a waste of time. This experimental method is a wear and tear on the learning enthusiasm of the students with strong learning ability, and can not give full play to their advantages to make them further exploration.

(3) The fairness of the final examination results. The final examination randomly selects the experiment, the different experiment content has caused the experiment difficulty different. For every student, there is a question of fairness.

(4) Uncertainty in the assessment of ordinary grades. The assessment of peacetime results consists of attendance and the practical ability of teacher evaluation. The assessment of practical ability is based on the teacher's performance of students' daily operation process. In this way, there is no way to quantify the specific credentials or evidence. Therefore, the assessment of ordinary performance has uncertainty.

3. Design of Teaching Mode Based on Rain Class

According to the teaching problems of the experiment course of analog electronic technology, the reform of the teaching mode based on rain class mainly includes three aspects: The experiment content, the teaching process and the course examination.

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3.1. The Content of the Experiment

Table 1. Experimental Contents of Analog Electronic Technology

Number	Experimental Project	Experimental measurement parameter	Optional item
1	Transistor amplify circuit	Single Tube amplifier, Optional Circuit, amplification factor greater than 50, measured dynamic parameters (AV, Ri, Ro) , input and output waveform	AV>100(secondary amplification) , frequency characteristics tested
2	Differential amplifier	Given ciucuit, long tail constant current source, debug static, measure differential mode and common mode gains, input and output waveform of four kinds of circuit.	Using 10K resistance instead of long tail, measure and analyze the relationship among gain, input resistance and output resistance
3	Low Frequency Power Amplifier circuit	Using the OTL low frequency power Amplifier, the static circuit is adjusted so that there is no distortion, measure the maximum output power and efficiency	Test input sensitivity and frequency response
4	Negative feedback amplifier	Self-select amplifier circuit, add negative feedback, test gain, input resistance and output resistance with or without feedback circuit	Add 4 kinds of negative feedback circuit, test and analyze the difference of gain, input resistance, output resistance and pass-band with or without feedback
5	Analog operation	design three kinds of analog operation circuits (inverse, in-phase, addition, subtraction, integral and differential implemented using integrated operational amplifier), observe the changes of input and output waveform, measure the gain	In addition or subtraction operations, test and analyze the range of input DC voltage
6	Waveform generation and transformation	Given sine wave, square wave, triangle wave generator circuit, test the output voltage amplitude and frequency of these circuits	Analyze the relations between amplitude and frequency and the change of potentiometer, design the square wave and triangle wave circuits by sine wave signal.
7	Analog filter	Design second order low pass, high-pass filter, test frequency response characteristic, draw characteristic curve	Design band pass, band-stop filter, test amplitude frequency characteristics
8	DC regulated power supply	Design of DC power supply, output voltage 5V, maximum output current 1A, ripple voltage less than 5mV, voltage stability factor less than 5%	Add leakage protection
9	Temperature Control Circuit	Basic devices: positive and negative 12V power supply, UA741, potentiometer, temperature sensor LM35 requirements: Temperature Control Range 0-room temperature, control accuracy 1 °C	Extend the temperature range by 10 degrees

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In order to solve the problems of simple experiment content and cramming type, starting from mobilizing students' initiative, training students' design ability and innovative consciousness, on the basis of simple experiment items, the experimental content increases the deeper level experimental parameter test and the synthesis, the design experimental item. The experimental items are no longer the given circuit diagram and experimental test data table, but some specific requirements. There are basic measurement indexes and optional parts in the requirements. Students well prepare before class, such as design circuit, simulate and analysis parameters and so on, according to the previewing requirements issued by teachers before class. The details of the experiment are shown in Table 1.

3.2. Teaching Process

Teaching Process added content: With the help of the Rain class Pre-lecture preview requirement, experimental data in the form of Homework Upload, teachers according to the experimental data score, after each experiment test related to theoretical knowledge (rain class platform) . Students who do not finish the experiment data or do the optional part can do it in the open laboratory after class. In the discussion area on the platform of "Rain class"after class, students can discuss the problems in the experiment. The level of activity in the discussion was related to the average grade. The relevant facts are shown in Table 2. The final exam consists of two parts: theory and practice. The process is as follows:

(1) Pre-class review. Teachers Upload The experiment content and the pre-class request to the rain class before class. Students will be required to prepare and sign for a photo upload (such as theoretical knowledge, theoretical calculation formula, simulation results).

(2) The completion of the experiment. During class time, students complete the basic experimental data, upgrade experimental data, and the data and analysis summary, these data are uploaded to the rain class in the form of homework.

(3) The comprehensive quality of the class. Signing in rain class during class. The comprehensive quality of class includes tardiness, leaving early, sorting out experimental instruments and practicing operation.

(4) Pop quiz. At the end of the experiment, students take the test in the rain class (multiple choice or fill-in-the-blank questions).

(5) Discussion after class. Upload Experimental Data, Review Experimental data, answer questions.

(6) Final test. The final exam will consist of both theoretical and practical questions. Objective topic is mainly related to the experimental content of the knowledge or conclusions. The practical exercises test the students' learning, especially the ability of application, with comprehensive experimental contents.

3.3. Assessment of the Course

Rain classroom platform on the learning data, the platform will automatically generate class report card. The teacher may manage the class curriculum examination plan, may also establish the different examination module the score proportion. The system provides different statistical dimensions and scoring methods for different types of learning units. Teachers can modify some of the parameters to meet the needs of personalized teaching. Finally, the platform automatically generates the detailed report. The examination of experiment has the characteristics of comprehensiveness, justice, standardization and quantification. There is a basis for each of the students' scores. The specific details of the assessment are shown in Table 2.

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Table 2. General Assessment Form in the Term

	Content	Percentage	Requires
Ordinary Grades	Experiment Preview	10	Experiment content preview, theoretical calculation and simulation data or graph
	Experiment Content	10	The completion and correctness of the experiment content in class
	The experimental Part of the Upgrade	10	The completion and correctness of the upgrade content
	Pop Quiz	10	Pop quiz in rain class
	The Comprehensive Quality of the Class.	10	Arrive late, leave early, tidy up experiment instrument, experiment table clean
	After-class Discussion Participation in Rain Class	10	Upload Experimental Data, Review Experimental data, answer questions
Final Examination	Theoretical Test	20	Theoretical knowledge points and conclusions related to experiments
	Practical Operation	20	Comprehensive Experiment

4. Teaching Effect

4.1. Greatly Improve the Enthusiasm of Students in Learning

After the reform of experimental teaching, students will take the initiative to do exercises in the open laboratory to supplement the incomplete data, especially design the circuit diagram and the last two comprehensive experiments. Figure 1 shows a graph of the number of participants in the open lab during the second semester of 2020 and the second semester of the 2021. In the figures, we can see that the enthusiasm of students in experimental learning has been greatly improved. Under the pressure of the task, the students have to spend more time prepare before class, perfect after class, and upload the experimental data in the required time.

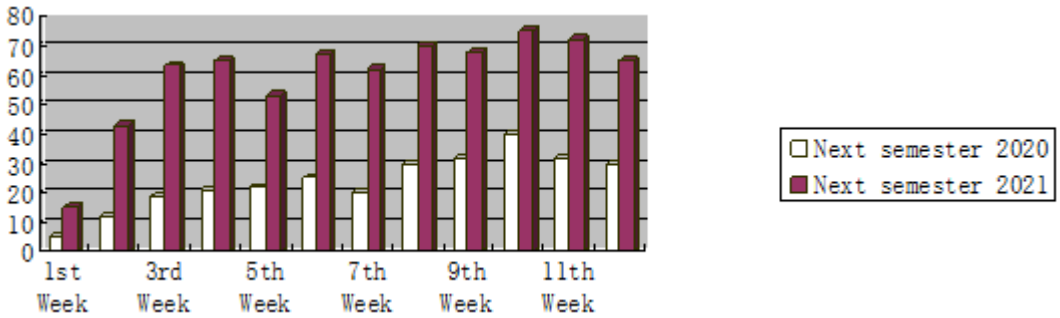

Figure 1. Statistical chart of the number of open laboratory experiments in the second semester of 2021 and 2020

4.2. The Process Assessment Method is Approved by the Students

Through the investigation of the learning situation of this course, students have a high recognition of the process assessment method, which is more fair and reasonable compared with the previous assessment method. The experiment class is no longer a mechanical drawing test, the data filled in the form, the tedious experimental reports copied after class, and the similar experimental reports. The experiment after the reform requires students to spend more time on thinking and preview before class. In the course, there are also small theoretical tests, and the need to analyze and summarize the data and phenomena after class. Finally, only the results of testing and analysis are uploaded without a mechanistic transcribe theory.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202206_5(6).0001

Student reaction: " In the past, doing experiments I did not need to prepare, just test according to the map. Now I need more time, but the theory and phenomenon are more clear, more thorough understanding of theory class. Theory class we do not need to spend a lot of energy review "," In the past, each experiment needed to write an experiment report, copying a large number of experimental principles and procedures. Now, instead of doing this trivial task, we only need to submit the experimental data and analysis summary in the form of homework, the time saved by writing a report can be used for understanding and analysis".

In the second semester of 2021 and 2020, the students of grade 19 and grade 20 electronic information science and technology and electronic information engineering were surveyed on the approval degree of the reform proposals. The data are shown in Table 3. From the form, we can see that the teaching reform of analog electronic technology experiment has been basically approved by the participating students and the degree of approval has reached 98.6%.

Table 3. Recognition Degree Questionnaire

Participating class	Degree of acceptance			Class acceptance (%)	General acceptance (%)
	very acceptable	more acceptable	Disapproved		
19 Grade Telecommunications Class 1	20	13	1	97	98.6
19 Grade Telecommunications Class 2	28	7	0	100	
19 Grade Electricians Class 1	21	23	1	98	
19 Grade Electricians Class 2	30	13	2	96	
20 Grade Telecommunications Class 1	24	12	0	100	
20 Grade Telecommunications Class 2	23	12	0	100	
20 Grade Electricians Class 1	29	15	1	98	
20 Grade Electricians Class 2	32	13	0	100	

5. Conclusion

Because of the characteristics of engineering, practicality and many knowledge points, the experiment course of analog electronic technology is difficult for students to learn, even do not want to learn. When students just contact with the professional course, the enthusiasm of students will be hit, making the experimental teaching effect worse. This paper aims at the teaching goal, on the basis of digging the knowledge content deeply, combines the modernized teaching method and the the Rain class platform, realizes the information teaching reform. Through the reform, it realizes the pre-class preview, design, simulation, interaction in class, test, after-class summary, analysis, discussion. Finally there is a very good teaching response.

The results of teaching practice show that: (1) Students' initiative is aroused by pre-class preparation; (2) Considering student personalize students' creative ability is cultivated and students' learning potential is developed by using the experimental contents of the hierarchy; (3)The after-class discussion strengthens the teacher-student interaction, stimulates the

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student's study interest and the communication ability, conveniently solves the student question ; (4) The whole process of teaching reform, with the help of the "Rain classroom" platform, makes the examination mechanism of the process be effectively realized. For Teachers, it solves the trouble of sorting out the assessment data, because the platform automatically exports all the data and the total score. For Students, the cumbersome experimental report to make the copying process, assessment results can be consulted from time to time. This kind of experiment examination is more fair and reasonable, obtains the student's unanimous approval.

Acknowledgments

Authors thanks for the financial support by teaching and research project of Hunan Provincial Department of Education (Grant: HNJG-2020-0686) and would like to express many thanks to the support of the College of Physics and Electronic Engineering, Hengyang normal University.

Fund Project: Teaching and Research Project of Hunan Provincial Department of Education "Research on the Teaching Reform of Electronic Technology Courses in Local Universities under the Background of New Engineering Course", Project Number: HNJG-2020-0686.

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