



Design of Circuit Course Micro-course Based on ADDIE Model

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Abstract. As a product of teaching reform in the information age, the research on the theory, design, development and application of micro-course had become one of the research focuses of experts and scholars. In order to provide resource for the teaching reform of Circuit course, the design framework of Circuit course micro-course, which is based on ADDIE instructional design model, is given, and the specific implementation stage is defined. The corresponding method and steps of micro-course design of circuit course based on ADDIE model, taking ‘the physical nature of wireless charging-mutual—mutual inductance phenomenon and volt-ampere characteristics of coupled inductors’ as an example, are expounded.

Keywords: ADDIE Model · Micro-course · Circuit

1 Introduction

Circuit course is a basic technical course to study the theory and application of electrical technology and electronic technology. It is also a professional background course for undergraduates majoring in electrical, electronic information and computer. The course plays an important role for students to systematically understand the basic knowledge of circuit theory, master the basic circuit analysis method, hammer-harden the electrician practical skills and develop rigorous and realistic scientific qualities.

Micro-course, as a teaching resource of flipped classroom, is a micro video as the main form, recording teachers around a knowledge point or teaching links to carry out a brief, complete teaching activities. In 2011, Hu Tiesheng first proposed the necessity and feasibility of building micro-course resources in the new development period in China [1]. Along with the upsurge of the construction of open educational resources, micro-course has become the focus and hotspot of the research on the construction of educational information resources. XIAO et al. [2] proposed that micro-course is the product of the field of education in the information age. Colleges and universities should seize this opportunity to combine micro-course with college teaching reform, so that micro-course can serve teaching reform and promote the development of college teaching reform. HUANG et al. [3] integrated micro-course and rain classroom into the practice of hybrid teaching reform, according to the linear algebra course teaching present

situation. Considering the problems existing in the current reform of college Chinese teaching, GUAN et al. [4] proposed that college Chinese teachers should strengthen the use of micro-class platform, so as to improve the teaching efficiency of the course. Similarly, circuit course educators also introduce micro-courses in classroom teaching. The combination of teaching reform and micro-course promotes the deepening of teaching reform of circuit courses [5, 6].

In the development and design of micro-courses, LIANG et al. [7] discussed the feasibility and method of using micro-blog platform to design and develop micro-course, and putted forward the method and steps of micro-course design based on microblog. HUANG et al. [8] putted forward the micro-course teaching design ideas and design template, and briefly introduced the production method of micro class. LIU et al. [9] proposed a conceptual design model of micro-course from the top-level design perspective. However, there are some phenomena in the design and development of micro-lecture, such as emphasizing technology but ignoring design, emphasizing construction but ignoring application and lacking operable instructional design model.

Aiming at these problems, JIAO Jianli and LI Jiahou [13] proposed to design micro-lectures according to ADDIE model in many micro-lecture training meetings. The ADDIE model embodies the core and common characteristics of the theoretical model of instructional design. It can provide a systematic and complete instructional design process for teachers to make micro-courses, which is beneficial for teachers to design and develop micro-courses [10]. CHENG et al. [11] analyzed the research status of micro-courses at domestic and abroad, and tried to construct the general process of micro-course design base on the ADDIE model. PU et al. [12] proposed a micro-course teaching design model based on ADDIE from the necessity of micro-course teaching design, but did not conduct empirical research. After that, WAN [13], CAI [14] et al. respectively explored the ADDIE model-based micro-lecture teaching design model of Secondary Vocational English, Secondary Vocational Pharmaceutics, providing reference for teachers to design and develop micro-lectures.

In view of this, in this paper, combined with the Circuit course teaching reform needs, under the guidance of ADDIE model framework, developed a Circuit course series micro-lesson, providing information resource support for the teaching reform of Circuit course.

2 Micro-course Teaching Design Model of Circuit Course Based on ADDIE

2.1 ADDIE Model Overview

ADDIE model is a systematic training model designed and developed by the Educational Technology Research Center of Florida State University for the U.S. Army in 1975. It is one of the most mainstream design methods in the field of course design.

The model includes five stages: analysis, design, development, implementation and evaluation. Among them, analysis and design are the premise, development and implementation are the core, and evaluation is the guarantee. They are interrelated and inseparable. In addition, the five stages of the ADDIE model contain specific sub-modules.

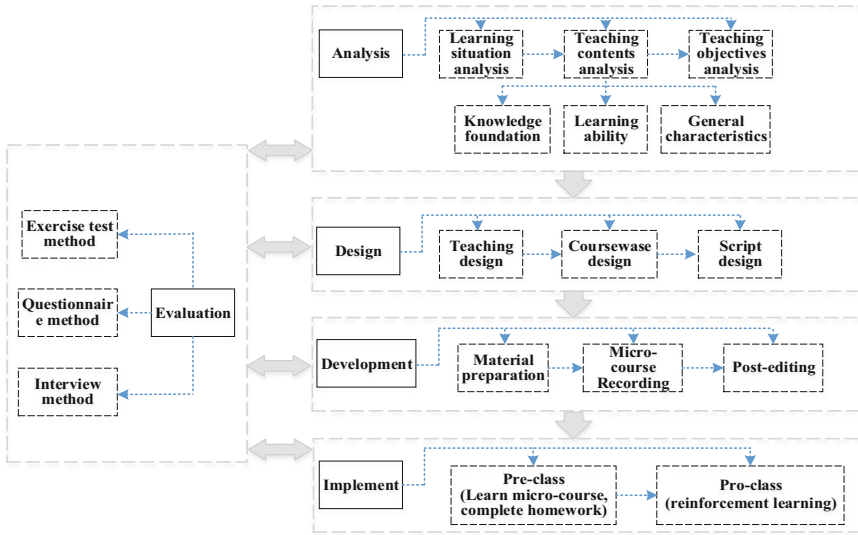


Fig. 1. Schematic diagram of micro-course design framework based on ADDIE model

2.2 Micro-course Design Framework of Circuit Course Based on ADDIE Model

According to the ADDIE model, the micro-course design of the Circuit course is divided into five stages: analysis-design-development-implementation-evaluation and each stage contains different sub-tasks. According to the characteristics of the Circuit course micro-course and previous teaching experience, a micro-course design framework for the Circuit course based on the ADDIE model is proposed, as shown in Fig. 1.

2.2.1 Analysis

(1) Learning situation analysis

The teaching object of Circuit course is the second grade undergraduate students. The students at this stage have mastered the theoretical knowledge of advanced Mathematics and College physics, and strong desire in applying the corresponding theory to practice. The Circuit course is the link between theory and practice. Therefore, the content of Circuit course micro-course should be constructed which are closely related to engineering practice. The introduction of rich and vivid application examples in the micro-course, reflecting and highlighting the engineering point of view in the course teaching, can adapt to the learning situation. For example, the knowledge point initial value of the first-order dynamic circuit and switching rule can be linked to the flash circuit, relay circuit and automotive ignition circuit. Similarly, the Circuit course is closely related to real life. Linking micro-courses to life examples as a useful supplement to in-class knowledge can provide students with broader ideas and improve their enthusiasm for learning. For example, mutual inductance can be linked to wireless charging devices.

(2) Teaching contents analysis

The Circuit course, as a basic course, which is different from the general network course, is that not all knowledge points are suitable for making micro-courses. The content selection of Circuit micro-course should be targeted. It is necessary to select some representative contents based on the problems existing in the actual teaching, which can solve the key, difficult and doubtful problems in the classroom teaching. In the meantime, micro-lecture content should meet the demand of students.

(3) Teaching objectives analysis

Teaching objective analysis is based on content analysis and learning situation analysis. The teaching objectives of the circuit course are as follows:

Knowledge objectives: through the study of the basic concepts, basic theories and basic methods of the Circuit, the knowledge architecture of the circuit system can be established. Circuit knowledge is accurately understood and used to analyze problems and solve practical problems. Mathematical tools and circuit knowledge can be used to identify and solve related engineering problems.

Ability objectives: through teaching, students have the ability of basic circuit analysis and circuit design, and the ability to solve circuit-related problems in practical complex engineering. At the same time, cultivate students' self-learning ability, teamwork ability and communication ability and enhance the scientific literacy of information acquisition, system analysis, summary and refinement.

Quality objectives: to cultivate students' scientific spirit of seeking truth and pragmatism, exploration and innovation and excellence, and to hone the collaborative spirit of intelligence and cooperation through teaching.

2.2.2 Design

(1) Teaching design

Teaching design is the basis of teaching. Based on the past teaching experience of Circuit course and combined with the Circuit course content, this paper divides the micro-course into five types: leading-in micro-course, problem-based micro-course, story-based micro-course, experimental micro-course, exercise micro-course. The specific teaching design methods of various types of micro-course are different, as follows.

The leading-in micro-course refers to the micro-course in which teachers use various methods to introduce new course content to stimulate students' learning consciousness according to the characteristics and objectives of the course teaching content, so as to lead students to have interest in learning new knowledge and new skills.

The problem-based micro-course focuses on the research and discussion of one core issue. Its general design process is: importing problems, analyzing problems, solving problems and summarizing. Therefore, in the design of problem-based micro-course, we should gradually start from the above four steps.

The story-based micro-course is a kind of micro-course produced by using the story narrative strategy and designing the main line of the story to connect the knowledge points. It is made by teachers according to their own teaching objectives, designing the main line of the story, processing the relevant materials and teaching knowledge in the form of story narrative.

Experimental micro-course is a kind of micro-course based on the needs of experimental teaching, which is controlled by teachers according to scientific principles to make

the experiment happen or reproduce. It can be used to help students understand experimental phenomena and laws. Its design process can be divided into five steps: importing experiments, clarifying experimental principles, proposing experimental requirements, displaying experimental process and extending knowledge.

The exercise micro-course is mainly used to explain the key and difficult points, clarify the problem-solving ideas, and summarize the problem-solving methods in exercises. The design process of exercise micro-course can be divided into: topic selection, problem solving, problem solving and summarizing ideas, and pay attention to the presentation of problem solving ideas and the summary of problem solving methods.

(2) Courseware and Script Design

After the teaching design is completed, scripts and courseware need to be designed. Script is the outline of the development of micro-course, from the overall planning of micro-course lens sequence, screen content. Micro-courseware is an important way to mediatize micro-course content and visualize knowledge. For the design of courseware, the screen should be simple, there are appropriate blank, illustrated, unified style.

2.2.3 Development

The development stage is based on the analysis and design of micro-course. There are many kinds of technical means for the development of micro-courses, mainly from the following: (1) shooting micro-courses; (2) slideshow demonstration micro-courses; (3) screen recording mixed micro-courses; (4) interactive animation micro-courses. What kind of technical means should be adopted in the development of micro-courses needs to be selected according to the specific types and technical requirements of micro-courses.

2.2.4 Implementation

The implementation process of micro-course, combined with the needs of hybrid teaching, can be divided into pre-class and after-class. Before class, micro-course is mainly used as a resource for students' self-learning. Through the network platform, the micro-course resources are uploaded to students for learning, and the self-learning task list is released. Under the guidance of the self-learning task list, students learn the new course content by themselves. Pre-class micro-course can improve students' self-learning ability, give full play to students' initiative in learning, and help students interact with teachers and students in class. After-class micro-course can help students consolidate what they have learned.

2.2.5 Evaluation

In order to check the learning effect, this paper used exercise test method, questionnaire method and interview method to feedback.

(1) Exercise test method

For each micro-course, corresponding test exercises are set up. After learning the micro-course, students need to complete the corresponding tests to test the learning effect.

(2) Questionnaire method

After the implementation of the course, the students were given a post-test questionnaire, and the results of the questionnaire were analyzed to reflect the implementation effect

and students’ acceptance, and to provide data support for the iterative modification and improvement of the teaching micro-course design.

(3) Interview method

In order to remedy for the shortcomings of the questionnaire method, after the end of the course, the interview method was used to conduct purposeful and planned interviews with the research objects, and the micro-course design and teaching mode were further improved by analyzing the interview results.

3 Case of Circuit Course Micro-course

In this paper, the design and development of micro-course based on ADDIE model is illustrated by taking the knowledge point ‘mutual inductance and volt-ampere characteristics of coupled inductor’ in the first section of Chapter 7 of Circuit course as an example.

With the help of online teaching platform, this micro-course selects two classes. Class A pushed the micro-lecture based on ADDIE instructional design model for teaching, and class B pushed the traditional classroom recording video for teaching. Both classes are taught by unified teachers, thus completing the control experiment teaching (Table 1).

Table 1. Micro-course ‘physical nature of wireless charging——mutual inductance phenomenon and volt-ampere characteristics of coupled inductors’ teaching design

micro-course	mutual inductance phenomenon and volt-ampere characteristics of coupled inductors	Type	knowledge teaching type
Analysis			
Source	Circuit Course Chapter 7 Section 1 ‘mutual inductance and volt-ampere characteristics of coupled inductors’		
Learning objects	the second year of undergraduate		
Learning situation analysis	Advantage: <ul style="list-style-type: none"> • Good knowledge basis; • Clearly logical thinking ability; • Certain problem solving skill. Disadvantage: <ul style="list-style-type: none"> • The content of complex electrical and magnetic related theorems is not well mastered, such as the method of determining the volt-ampere characteristics of coupled inductors. 		
Knowledge foundation	Electromagnetism of College Physics; Calculus of higher Mathematics;		
Learning objectives	Knowledge objectives: Understanding the phenomenon of mutual inductance; Ability objectives: Skilled using of mutual inductance phenomenon analysis of the principle of wireless charging technology; Quality objectives: Training students to explore the thinking method of inner physical essence from external phenomena;		

(continued)

Table 1. (continued)

micro-course	mutual inductance phenomenon and volt-ampere characteristics of coupled inductors	Type	knowledge teaching type	
Difficulties	keys: Mutual inductance phenomenon Difficulties: Volt-ampere characteristics of coupled inductors			
Design				
Design strategy	<p>This micro-course will stimulate students' learning interest based on the application of wireless charging technology in daily and military fields. Combined with practical equipment, from the analysis of ship wireless power supply system components of inductive wireless power transmission system, gradually the core components of wireless power transmission, which are transmitter coil and receiver coil, is decomposed. Then, the question 'Why can power transmission be achieved by virtue of this pair of coils' is raised. Afterwards, the corresponding teaching content is set according to the cognitive law. At the same time, in this process, through the gradual analysis of the way to guide students to develop scientific analysis of the problem.</p>			
Teaching process	Teaching content	Design intention	PPT	Time
Leader	This micro-course explores the physical nature of wireless charging—mutual inductance and volt-ampere characteristics of coupled inductors.	Guiding students to clarify the theme of micro-course.	P1	10 s
Introduction	Starting from letting students observe the demonstration of wireless charging small experiments, the application of wireless charging technology in daily and military fields is introduced, which led to key problems, 'Why can wireless power transmission be realized? And what are the volt-ampere characteristics of the two coils?'	Setting the suspense to inspire interest through experiment	P 2 ~ 3	1 m 30 s

(continued)

Table 1. (continued)

micro-course	mutual inductance phenomenon and volt-ampere characteristics of coupled inductors		Type	knowledge teaching type
Explaining	The first section: mutual inductor (The physical quantities analyzed are: magnetic flux, magnetic linkage, voltage)	Inspiring students to think about the phenomenon of two coils, so as to cultivate students' thinking mode of analogy analysis by analyzing single coil at the beginning.	P 4 ~ 7	4 m 30 s
	The second section: coupled inductors (The physical quantities analyzed are: magnetic flux, magnetic linkage, voltage)	Solving difficulty and enhancing knowledge by changing external condition.	P8 ~ 10	5 m 30 s
Conclusion	one phenomenon, one judgment method	Summarizing this micro-course	P11	20 s
Explication	Thinking questions	Guiding students to further thinking	P12	20 s
Ends	Ending words		P13	10 s

4 Conclusion

The design and development of Circuit course micro-course based on ADDIE model is clearer, the process is more standardized, and the quality is more guaranteed. However, the corresponding operation points and experience skills are worth further research.

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