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Research on Individualized Teaching Strategy under Creative Method Education

--Take the Example of Digital electronic circuits experiment Course

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Abstract

in view of the disadvantages of digital electronic experiment course in traditional teaching mode, this research aims to seek a teaching reform by applying individualized teaching strategy under the principle of creative method education. This reform is characterized by covertly-stratified asynchronous teaching and assisted by the corresponding multi-level experiment items and diversified examination mechanism. The practical results showed that the effect of the experimental teaching reform was quite remarkable in that it not only aroused the students' enthusiasm in experiment but also improved their comprehensive qualities including self-learning ability, practical ability, knowledge integration ability, creative practice ability, etc.

Keywords

Digital electronic circuits experiment; Creative method; Covertly-stratified; Asynchronous teaching; Reform.

1. Introduction

With the rapid development of science and technology, especially digital electronic technology playing an increasingly significant role in people's life and even an indispensable part of it, digital electronic circuits experiment, as a practice course of digital electronic technology, has become a basic practice course of specialties such as electronic information, industrial automation and computer application, etc. in colleges and is of great significance to learning and mastering follow-up courses and professional skills. In view of the existing problems with digital electronic circuits experiment course in some colleges, in this paper we carried out teaching reform exploration and practice with "creative method education" and studied on individualized teaching strategy characterized by covertly-stratified asynchronous teaching.

2. Individualized teaching strategy under creative method education

Creative method education is an education system that follows the equal education idea—the worst is the best, where educators use creative thinking of their own to unfold, repair and activate the creative thinking of educatees, in order to achieve balanced development of the left- and the right-brain thinking of the latter. For the students, it is a kind of "creative" education where all knowledge

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is obtained through "creative method"; as for the teachers, it is a kind of educational "creativity", an educational method the teachers use to teach students [1].

The study on ITS for digital electronic circuits experiment course under creative method teaching is mainly focused on the teaching programs carried out in consideration of the fact that the undergraduate students in this school having a background of different specialties and different foundations of knowledge.

The research of this topic is characterized by covertly-stratified asynchronous teaching. "Covertly" stratified is a teaching mode inspired by the "vertical" mode in creative method education. More specifically, teachers would group students "covertly" after setting different levels of questions in the face of the same knowledge in the same course and observing for a long period, which avoids the disadvantages of grouping by test scores which hurts students' self-esteem and inhibits their initiative, and instead improve their initiative in their "corresponding area", and thus help students achieve different degrees of "self-optimized" learning in different learning stages. In "asynchronous" teaching, teachers would set questions of different types and learning tasks of different difficulties according to the level of each group, so as to achieve better interaction between teaching and learning beyond the classroom [2].

In a word, the individualized teaching strategy for digital electronic circuits experiment course under creative method teaching is to discover students' merits (strong points) in time, help them achieve "self-optimized" learning in their "corresponding area" and balanced development of left and right brains and to complete our teaching goals and the purpose of education.

3. Problems with the teaching of the digital electronic circuits experiment course

3.1 Students' initiative and creativity are inhibited

First of all, traditional digital electronic circuits experiment course only involves basic experiments which are mostly verification. It still adopts former Soviet Union educator N. A. Kaiipob's education mode [3] which simply centers on teacher, classroom and teaching materials. The teaching process only contains three steps: first, the teacher explains the experiment according to the textbook; then the students get the measured data according to the experimental steps written on the textbook. The process of such traditional "imitative" experiment [5] makes students think that the experiment ends here and they need to neither think about the experiment principle, method, purpose and so on, nor care about the theory verified by it or its application in practical life and production, let alone thinking about verifying the theory with alternative methods and implementing the experimental design. As a result, the students would get into the habit of refusing to think by themselves and become increasingly less interested in such experiments which encourage their laziness, limit their thinking and inhibit their initiative and creativity.

Secondly, the contents of traditional experimental are mostly "changeless", i.e., the experimental contents are basically the same as long as it is of this experiment, regardless of the majors and levels of the students. They fail to provide optional experiments with emphasis for students at different levels from different majors. Those with a poor foundation may not catch up and "absorb it", while those with a good one may feels it too simple and "still hungry", therefore, such "big pot" experiment teaching makes students feel "the same" whether to learn or not, and "no difference" regardless of how much the experiment is done, which in turn inhibits the students' initiative and creativity in autonomic learning.

Finally, the opening time and subject of laboratory are relatively closed. Only in digital electronic circuits experiment class students can enter the lab that is mostly closed in the remaining time, which greatly limits the students' initiative and enthusiasm in learning digital electronic technology. The digital electronic circuits laboratory is open just to students of the relevant majors under the department, which "shuts out" students of irrelevant majors but particularly interested in digital electronic circuits and goes against the enhancement of lab equipment utilization [5].

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3.2 Experiment examination system is not scientific

In traditional digital electronic circuits experiment examination, students' experiment course scores are given based on their class attendance and lab report completed in combination with the final experiment operation exam. Such examination system is not scientific and has the following disadvantages:

(1) Examination method is too simple

As for existing experimental examinations, most teachers still adopt 70% operation exam (or written exam) plus 30% grade point average (GPA). Although the examination results take students' daily performance into account, it's only scoring based on their class attendance and experiment report, which essentially is still "one-sided" without paying attention to students' language expression and operation abilities as well as their knowledge understanding levels and experiment qualities. This makes students often passive in experiments and some even copy each other's experimental data or lab report and get used to cramming before the final exam, which in turn puts students in a limited space for creative thinking, seriously discourages their initiative and enthusiasm for learning and is, of course, detrimental to their self development [5].

(2) Examination contents are quite limited

The examination contents tend to be confined to experiment textbook, especially to experiments done before, rather than value students' ability and emphasize skill training, and also fail to highlight individualized cultivation based on students' majors and levels and realize the integration of "teaching, learning and performing". As a result, students often cram for the exam, which prevent them cultivating the experimental quality and mastering the professional skills.

4. Exploration and practice of teaching reform in digital electronic circuits experiment course

4.1 Increase design and integrated experiments as bonus optional items

In the practice of experimental teaching, we found that just relying on basic verification experiment is far from enough for developing students' innovative ability in practice, while design and integrated experiments can just play an effective role in this. Therefore, we added the corresponding design experiment and finally combinational logic and sequential logic mixed integrated experiment for almost every experiment based on the original content, and established "optional and bonus" policy for them. This not only further develops students' problem analyzing and solving abilities through comprehensive application of digital electronic circuits theories and the ability to think, design and operate independently, but also offers outstanding students more challenges and the room for stretching their ability, and in turn inspires their subjective initiative and creativity. Combinational logic design experiments such as: use decoder 74LS138 to constitute a data distributor or using 3-8 line decoder to make a full adder; use 8:1 multiplexer 74LS151 and necessary inverter to design a three-person voting circuit; use adder to design a switching circuit that switches excess-3 code into 8421 code, etc. Sequential logic design experiments such as: switch counter 74LS161 into n-scale counter; use bidirectional shift register 74LS194 to design an n-scale Johnson counter and an on-and-off circuit for colored lights, etc. Integrated experiments such as: using data selector, counter and shift register, etc., to design a frequency-switchable on-and-off circuit for colored lights; design a displayable self-correcting system for digital clock circuit and so on.

4.2 "Individualized" teaching under covertly-stratified asynchronous education

To cultivate high-quality innovative talents, we made bold attempts at the reform of traditional experiment teaching modes and methods based on plentiful research. Based on the principle of "profound foundation, wide caliber and innovation orientation" for experimental teaching reforms, we implemented the experimental teaching mode orientated by "integrated and three-level" asynchronous teaching, i.e., the integration of experiment and teaching [6-7], which is divided into: the first level, basic experiments as major compulsory items; the second level, design experiments, one

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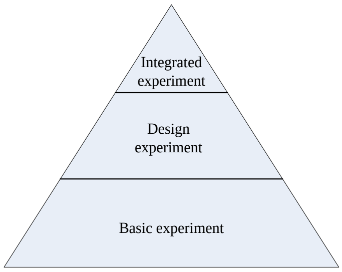
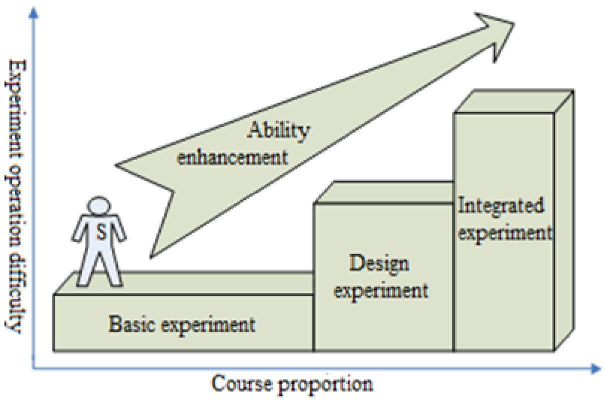
of which must be selected and finished after completing the basic ones; the third level, integrated experiments which are optional as the graduation thesis. The structure of such stratified digital electronic circuits experiment teaching mode and the implementation process are shown in Figure 1 (a) and Figure 1 (b) below.



(a) Pyramid



(b) Stepped

Figure 1.Stratified digital electronic circuits experiment teaching mode

In each level of teaching, the teacher will guide students in different contents and methods by "score-compensatory" way according to the problems faced by each experimental group, to achieve "individualized" guidance. "Score compensation" is a method to urge students to study and solve problems independently and prevent them from asking the teacher for every question and ward off inertia.

Such level-up experimental teaching mode, from low level to high level, from basis to design, from knowledge learning to comprehensive application, allows students to master the basic experimental operation methods and cultivates their scientific thinking and comprehensive design abilities. It not only meets the needs of students at the same level, but also helps in individualized teaching for outstanding students, establishing stratified pyramid talent training programs and providing versatile, high-level and highly skilled diversified talents which meet the social demands [8-9].

4.3 Set procedural "multiple" examination mechanisms

Modern education theory emphasizes multiple evaluation systems established in many ways and cares about the development of students' emotions, attitudes and values. Traditional digital electronic circuits experiment course evaluation system has seriously lagging behind, from school to teacher who only focus on students' learning outcome, but ignore their attitudes and methods and the evaluation of comprehensive abilities of such as language expression, collaboration, operation and problem solving during the learning process. Given this, we established procedural "multiple" examination mechanisms for the digital electronic circuits experiment course.

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Although the results of digital electronic circuits experiment is also constituted by GPA and the experiment operation result, now the GPA no longer just considers the attendance and experiment report, but also increased more detailed considerations about attitudes and behaviors such as being late or leaving early, smart phone addiction, tidying the experiment table, experiment preparation and teamwork, etc. The experiment operation result is no longer determined just by a final experiment operation, but by the result of the average scores of all the experiment classes taken throughout the semester. The examination form even breaks away from traditional written test or looking at the operation results. The examination methods include written test, operation, interpretation, "personalized" questioning (oral test) by teacher, project design and defense, etc. While procedural examination is reflected in the stratified progressive scoring form. The first level is compulsory basic experiments scored from zero to good; the second level is design experiments for limited selection scored from pass to full mark; the third level is optional integrated experiments as bonus questions scored according to the level of completion. More detailed examination process: after each experiment is finished, the representative of each group is acted by a voluntary member or designated by the teacher to explain and operate the experiment. At last, the teacher will ask questions to "screen out the holes" in students' performance and check their mastery degree of the experiment, give scores and put them down, and assist the students in leveling up by "hole patching"; each student in each group must be chosen as the examination object for at least once.

4.4 Teaching practice effect

From 2014 to 2017, the school set digital electronic circuits experiment course for more than 300 students from the major of electronic information science and technology in grades 2013, 2014 and 2015 and the major of applied physics in grades 2013 and 2015 and implemented individualized teaching strategy under creative method education characterized by covertly-stratified asynchronous teaching. Almost all the students showed great interests in the newly added design and integrated experiments. About 92% of them automatically went on to design experiment after finishing the basic one and 52% went further to integrated experiment. It was generally believed that compared to previous experiments, the design and comprehensive ones were more interesting and displayed the real effects of integrated application of different technologies in life more straightforward and went beyond "just theory". 65%-85% of them pronounced a better understanding of theoretical knowledge of this course, which aroused their enthusiasm in learning it autonomously. From basic to design and integrated experiments, the enhancement of knowledge transfer ability is most significant. Finally, all students' performances were improved to different degrees at each stage of the stratified teaching. Some even joked that this covertly-stratified asynchronous teaching mode was like constantly upgrading in a video game, which made learning much funnier and brought a little sense of achievement when knowledge was applied into practice. Meanwhile, the corresponding procedural "multiple" examination systems of this teaching strategy exercised the students' abilities of operation, language expression and psychological quality, and more distinctively, the teacher would ask "personalized" questions after students finishing explanation and operation, so that the teacher could know their learning outcome and the gaps in experiment which could be made up later. After each experiment each group would elect a representative as the object of examination and would be scored by his/her performance, so that they would urge, help and cooperate with each other during the experiment process [10-11]. Examining and scoring for several times and GPA recording put an end to the bad habit of "cramming before the final exam". The findings are shown in Figure 2 and Table 1 below:

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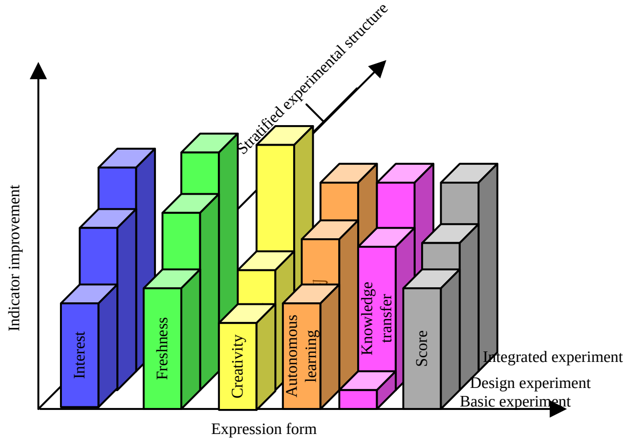

Figure 2.Information bar chart of stratified experimental teaching practice survey

Table 1.Stratified experimental teaching practice survey

Indicator improvement	Expression form					
Stratified experimental structure	Interest	Freshness	Creativity	Autonomous learning	Knowledge transfer	Score
Basic experiment	52%	57%	52%	62%	22%	61%
Design experiment	76%	82%	61%	77%	73%	78%
Integrated experiment	91%	96%	97%	87%	86%	88%

In order to get a clear result of the study on individualized teaching strategy under creative method education, we collected information both before and after the implementation of teaching reforms in digital electronic circuits experiment course featured by covertly-stratified asynchronous teaching during 2009-2012 and 2013-2017. The results are shown in Table 2 and 3.

Table 2.Comparison of the students' interests before and after the teaching reforms

Number of students	Level			
Question	Very interested +2	Interested +1	No -1	Not at all -2
1. Are you interested in covertly-stratified asynchronous teaching mode?	201	93	14	12
2. Are you interested in traditional teaching mode?	13	18	105	206

Based on the data related to the questions raised in Table 2, it is calculated as follows:

Question 1, $F=\sum an/2N= (2\times201+1\times93-1\times14-2\times12)/2\times320=0.714$. The result is a positive value, which represents that the students as a whole were interested in it.

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Question 2, F=∑an/2N=[2×13+18×1+105×(-1)+206×(-2)]/2×342=-0.39. The result is a negative value, which means that they were not interested in it.

Table 3.Comparison of students' creativity evaluation results before and after the teaching reform

Number of students (percentage)	Level			
Time	Excellent	Good	Average	Poor
Before	20(7.8%)	45(17.7%)	155(60.7%)	5(2%)
After	64(20%)	222(69%)	32(10%)	2(0.6%)

By comparing various parameters before and after the implementation, we can see that the effect of covertly-stratified asynchronous teaching is much better than that of general teaching. In addition, the employment rate of this school increased from 69% to 87%; the prize winning rate of college students in various skill competitions increased from 5% to 18%. Students' employment rate and award winning rate were also largely improved.

5. Conclusion

College experimental teaching reform is an indispensable part of the teaching reform. To improve the quality of experimental teaching, we must carry out reforms on traditional experimental teaching as one of our major duties in the new era and transform school education from teacher-oriented "teaching" to students-oriented "learning", from unified-mode education to stratified individualized education, from theoretical knowledge centered to "life practice" focused, and from results emphasized to process valued. In a word, teachers need to continuously improve the teaching method, update the teaching contents and make sure that each experiment is valuable, every student could obtain necessary experimental practice ability and different levels of students could get different degrees of improvement through the teaching process. They must also help students grasp learning skills, so that they can obtain knowledge from various channels and cope with challenges in practice in a calmly manner [12].

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