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The Experimental Research on E-Learning Instructional Design Model Based on Cognitive Flexibility Theory[1]

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Abstract

The paper reports an educational experiment on the e-Learning instructional design model based on Cognitive Flexibility Theory, the experiment were made to explore the feasibility and effectiveness of the model in promoting the learning quality in ill-structured domain. The study performed the experiment on two groups of students: one group learned through the system designed by the model and the other learned by the traditional method. The results of the experiment indicate that the e-Learning designed through the model is helpful to promote the intrinsic motivation, learning quality in ill-structured domains, ability to resolve ill-structured problem and creative thinking ability of the students.

Keywords: Cognitive Flexibility Theory, e-Learning instructional design model, experimental research

1. The objectives and hypotheses of the experimental research

1.1 The objectives of the experimental research

There are a lot of researches on E-learning instructional design model at home and abroad. Most of them focus on the results of the E-learning instructional design model, but few on the process and methods, not to mention the systematic experimental research on it. Due to the lack of attention on the solution to students' ill-structured problems in traditional E-learning design, we apply the E-learning

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instructional design model based on the Cognitive Flexibility Theory (CFT) which was introduced in WCSE 2008 to our teaching experiment [1], aiming at exploring the feasibility and effectiveness of the model in promoting higher-order learning, solving ill-structured problems and improving creative thinking ability. Considering the fact that the higher-order learning is more difficult and acquires more efforts from the learners than lower-order learning, we should pay more attention on the motivation of learners during the experiment. For this sake, we have made some improvement on this E-learning instructional design model. According to Kevin Kruse' ARCS model [2], we have designed systematic motive strategies at different instructional design levels. Kevin Kruse came up with ARCS model in 1983, which divides the motive theory and structure into four elements, providing the systematic method for the introduction of motive diagnoses and strategies to teaching process. The four elements which consist of attention, relevance, confidence and satisfaction, demonstrate the outline and synthesis of motivation concept and theory. The basic principles of this model are as follows: In order to motivate the learner to work or study, we firstly should arouse their interest in the task of the work or study, then make them aware of their close relation to the task and feel capable of completing the task, thus help them yield confidence for it. Finally, we should let them gain the sense of achievement in accomplishing the task. The model reveals the basic components and the detailed process of one's study motivation. It emphasizes that the motivation strategies should point at specific motivation problems not the generalized motivation model.

The Fig.1 shows the improved E-learning instructional design model. In the model, the letter A, R, C, S represents attention, relevance, confidence and satisfaction respectively, and the different instructional level respond to different motivation strategies accordingly. For example, we try to maintain students' attention by changing speech styles, embedding games in the teaching process and altering the ways of presenting learning materials. And we should help students analogize between old and new knowledge, making them acquire the prerequisite skills for learning new things. When learners confront with difficulties in their study, we need to give them appropriate help and provide them with rich reference, specific explanation and cooperative learning opportunities to solve their problems, thus increase their confidence. Moreover, on the following purposes, we provide students the real-life study materials: let students sense the power of knowledge as well as their study achievement, inform them with the information of their learning condition including the study content which they have already learnt and the one which they expect to learn. It also contains the assessment of their task and their academic behavior in class as well as the degree of recognition among classmates. All above will help to increase students' satisfaction and help them gain the positive experience of success.

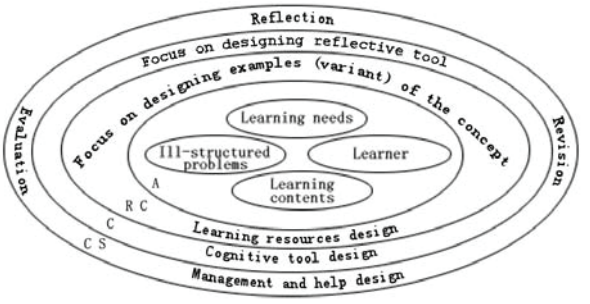

Fig. 1 E-learning system design model based on CFT.

1.2 The basic hypotheses

1) The ability to solve ill-structured problems could be improved by educational intervention.

2) Teaching with the E-learning design model based on CFT complies with the requirements of higher-order learning, which is helpful to the ability of solving the ill-structured problems.

3) Teaching with the E-learning design model based on CFT is beneficial to the development of students' creative thinking ability.

2. Research objects and method

Our experimental research insists on synthetic principles as regard research methods. And we adopt the experimental research method for the better part of the research, which is assisted with other methods, such as interview and class observation. The advantage of the comprehensive application of the methods above, lies in the mutual inspection and verification of the results form these methods, which can ensure the reliability and effectiveness of the research.

The research involves academic performance measurement, psychological measurement as well as educational intervention. Education intervention here refers to the application of the E-learning instructional design model mentioned before in this essay to the instructional design of "The multimedia courseware design and development". At the same time, the educational intervention will also provide the teaching software of this design model and net work learning platform for students to learn by themselves. We have chosen the backbone major course in Educational Technology: "The multimedia courseware design and development", which perfectly meet the need of this experiment. Though the course has given a systematic introduction to the basic theory, instructional design and development process model for CAI courseware, all those can't guarantee the verification operation of these theories in practice. In the contrary, all kinds of courseware designs and development methods vary greatly. And the practice process of this course is full of creativity. On the whole, the course involves the ill-structured problems and meets the need of inspecting the study effect of students in the ill-structured domain.

As for the psychological measurement, it is the measurement for students' creative thinking ability. And the academic performance measurement refers to the measurement for the knowledge and skills of the course of "The multimedia courseware design and development", especially for the measurement of the ability to solve the ill-structured problems. In the experimental research, we have adopted the methods of interview and class observation as well as other research methods. Among them, interview aims at getting to know students' study interests and whether they adapt to the new instructional model. Class observation, on the other hand, is the method mainly to measure students study tendency (including study motivation and strategies).

2.1 Research objects

We conduct the experiment in the two undergraduate classes of 2008(they entered the college in 2008) in the School of Educational Science and Technology, regard class 200801 as the experimental class and class 200802 the comparative class at random. Both classes have 21 students and I am the teacher of these two.

2.2 Methods of measurement

1. The experimental variables

1) Independent variables

Instructional model: In the experimental class, I apply the E-learning instructional design model based on BCFT to my teaching and ask my students to conduct self-directed learning with the help of the related teaching software and the Net learning platform; as for the comparative class, I teach them with the traditional instructional method.

2) Dependent variables

The dependent variables are as follows: learning attitude, learning motivation, the difference of academic performance about the ability to solve the ill-structured problems, and the variation of students' creative thinking ability.

*3) C*ontrol of the irrelevant variables

During the experiment I strictly control all kinds of factors that may affect the effect of the research. As the researcher I try my best to avoid any possible biases and keep a peaceful mind: do not inform the students in the experimental class of the objectives of this experiment, do not create the competitive atmospheres before and after the experiment between the two classes, and ensure the students to keep calm during the experiment. There were not many differences between the two classes when then entered the university as regards to their sex, the areas they were from, and the scores they got in the university entrance examination. As the students of 2008, both of the two classes leant the professional technical courses for the first time and they could be regarded at the same level at the beginning. As a result, this experiment meets the basic requirements of identical- groups experiment.

2. Tools

The book "Creative thinking ability diagnosis scale" written by Richang Zheng is used to measure students' creative thinking ability [3]. The final course test of "The multimedia courseware design and development" and the assessment form of the final outcome of students [4], both are used to measure academic performance. As for the study tendency (study interests, motivation and strategies), the class observation scale is used to measure it. Finally, the method of interview is used to learn students' adaptation level and assessment to this instructional model.

3. Time

The initial part of the creative thinking ability test is arranged in the third week of the second semester during the school year of 2009-2010. And its final part is arranged in the final examination week (the eighteenth week of the school year). Each of the two classes should finish the academic performance test within 100 minutes in class and the experimental outcome outside class. As for the creative thinking ability test, it should be finished about 50 minutes.

2.3 The experimental treatment and process

1. The experimental treatment

The experimental design consists of the initial and final tests between the comparative class and experimental class. The experimental treatment is shown in the table below.

TABLE I Experimental treatment

Classes	The initial test	The experimental treatment	The final test
Experimental class	Creative thinking ability measurement	The application of the E-learning instructional design model based on CFT, learning software and network learning	Academic performance measurement Experimental outwork measurement, Creative thinking

		platform to teaching	ability measurement
Comparative class	Creative thinking ability measurement	The application of the traditional teaching model	Academic performance measurement Experimental outwork measurement, Creative thinking ability measurement

2. The experimental process

The experiment is divided into three phases.

1) The preparation phase (Dec, 2009-Feb, 2010)

①Search for the related literatures at home and abroad.

Formulate and revise experimental scheme.

②Decide the experimental objects.

③Choose instructional contents. Design the teaching plan according to the E-learning instructional design model based on CFT. Use the traditional instructional model in the comparative class. Design and develop teaching software and net work learning platform.

2) Implementation phase (Mar, 2010-Jun, 2010)

①Perform the initial test of creative thinking ability (The third week in the beginning of school).

②Form the third week, apply the new teaching model to teaching in experimental class.

③Develop the teaching software and network learning platform, which are prepared in the first phase.

④In order to know whether the new teaching model can help to activate students' learning enthusiasm, the observation scale is used to observe students' behavior during the experiment. It shows a clear picture of the phase the students in when they deal with some tasks, the difficulties they confront with and the measures they take. As a result, I can provide some necessary information and advice to my students according to the scale.

⑤Have interview with students to learn their opinions and adaptation degree on the new teaching model and the course of "The multimedia courseware design and development".

⑥Test the academic behavior between the experimental class and the comparative class, give a conclusive assessment to their experimental outcome and carry out the final test of creative thinking ability.

3) Materials and data tidy (the results of creative thinking ability, the academic performance and the average score of experimental outcome which is analyzed with SPSS10.0)

3. Research results and analysis

3.1 Students' class behavior

Both of the two classes can actively browse the course materials that teacher offered, search for the related information on the internet, take notes and consult teacher frequently. There are no obvious differences in the learning enthusiasm between the two classes. The comparative class behaves more actively than the experimental class in note-taking. But the experimental class behaves better in the following aspects: "keep attentive in class", "decide a topic themselves then design and produce the corresponding courseware after finishing the required tasks", then "ask the teacher to criticize their outcomes". All the aspects above clearly show that the experimental class have a deeper interest in the courseware-production itself not because of the outer factors (such as the test scores and diploma). The interview with students also testifies to this point. There is no doubt that the design of motivation strategy

system contributes a lot to students' great interests in the course. As for the aspects of "come up with different opinions and make comments in class", "the original home work", there is a sharp contrast between the two classes: The percentage of "always" and "often" is 62% and 77% respectively in the experimental class, while in the comparative class it is 38% and 27%.

3.2 The interview in the experimental class

The following are the opinions of students in the interview:

Firstly, the new instructional model does not bore them when they learn the theory. Because they can have a better understanding to the theory when it is combined with the specific examples.

Secondly, they think they can use these concepts and theories flexibly because they can understand their practical usages from different angels. Thus they can solve the practical problems with ease and come up with different solutions and gain the pure pleasure from it. "It is great!" said the students when asked about their learning experience. Actually it is the "satisfaction" in the ARCS motivation model.

Thirdly, they think it is convenient to record the learning process to reflect on it at proper time with the help of all kinds of tools. They can also discuss with and help each other by the virtue of local area network. Thus they can not only grasp the concepts and theories with the help of teacher and learning material but also learn other students' understanding to these concepts and theories. "You can't learn this in other courses or text books." said the students.

Students also give some advice when they make those positive comments: for instances, the teacher should give more instructions , the learning materials and supported tools should be more diverse, students should be given more time to explore the knowledge by themselves, and some simple knowledge should be taught directly by the teacher for the sake of efficiency. The suggestions above reflect some problems during the implementation of the E-learning instructional design model based on CFT: First, there is an adaptive process for students form the whole-controlled class to the new instructional model. Second, the new model actually asks more of the teacher. The teacher should combine his instructional quantity and opportunity with students learning process closely. Third, this model does not adapt to any fields. The problems that do not involve ill-structured domain can not necessarily be solved through this teaching model.

3.3 The scores of academic behavior and final outcome

The scores of academic behavior and final outcome of the two classes are shown in the form 2. The academic behavior text consists of rudimentary knowledge and integrated knowledge. The score percentage of these two parts is 40% and 60% respectively. In the rudimentary knowledge part, students are required to know the knowledge, grasp it, and analyze its level. This part of test is very simple. In the integrated knowledge part, students are required to understand the concepts flexibly and apply them to practical problems which belong to ill-structured ones. It is clear in form 2 that there is no obvious difference in the rudimentary knowledge part between the two classes ($P>0.05$). But the experimental class gets a higher score than the comparative class in the integrated knowledge part ($P<0.05$). What's more, there is a sharp contrast between the two classes in the score of final outcome ($P<0.01$).

3.4 Creative thinking ability

There is no obvious difference ($P>0.05$) between the two classes when the initial test of "creative thinking ability diagnosis scale" is used to test their creative thinking ability. But sharp contrast appears

when the final test of the scale is carried on (P<0.05). The experimental class obviously gets a better grade than the comparative class.

TABLE II The comparison between experimental class and comparative class in the scores of academic behavior and final outcome （M±SD）

	Rudimentary knowledge	Integrated knowledge	The score of outcome
The experimental class	30.46±2.47	47.26±4.89	80.12±7.58
The comparative class	29.23±2.96	43.64±4.16	73.65±7.29
t	1.50	2.43*	2.81**

“*”represents P<0.05, “**” represents P<0.01

TABLE III The comparison between experimental class and comparative class in creative thinking ability（M±SD）

	The initial test	The final test
The experimental class	64.92±4.13	67.31±3.82
The comparative class	64.54±4.37	64.65±4.14
t	0.30	2.51*

“*” represents P<0.05

4. Discussion

4.1 The adaptive range problems of the E-learning design model based on CFT

The model is adaptive, targeted and limited. First, the instructional strategies advocated in the CFT are suitable for the ill-structured domain but not for all the academic domains as regards different learners, the characteristics and contents of different subjects [5]. Well- structured domains or the concepts or theories that can be grasped by the traditional instructional model, do not need to use this model. For example, it is almost impossible to ask a pupil to express the concept in multiple ways in some particular domains. Second, in respect of the concept with multiple meanings, students will actually feel burdened and perplexed when they are confronted with many different opinions and explanations. In conclusion, we should not expect to apply the new model to any teaching situation in any time. One appropriate expectation to it is to treat it as a work model of all kinds of E-learning instructional design task that you are faced with.

4.2 The effects of the model in its ability to solve students' ill-structured problems

In the experiment, the students in experimental class show great learning interest and form strong internal learning motivation. They have done a better job than the students in comparative class in solving the ill-structured problems and finishing the experimental tasks. All above are within my expectation. In fact, I have applied the new instructional model and got good results early before this research. The work of “Projectile Movement” of the undergraduate of 2004 in Educational Science and

Technology, Huanggang Normal University has won the "The Third Price of National Multimedia Courseware Competition" with the guidance of mine. The students' work "Practical Electronic Technology" has won "The Second Price of University Courseware Competition in Hubei Province" In the National ITAT Education Project Employment Skill Contest in 2007, with the course of "Multimedia Courseware Design and Development" as the competition content, 2 of my students got the second prize, 6 the third prize, and 11 the Award of Excellence. In the same competition in 2008, 2 of my students got the third prize and 11 the Award of Excellence. The graduates have won the good reputation from their employers for their ability in developing the multimedia teaching software.

4.3 The effects of the model in developing students' creative thinking ability

We are very glade to see the great progress students have made in their creative thinking ability during the experiment. At the same time, we need to be aware that there is not a sharp difference between the initial and final test, though the experimental class does a better job than the comparative class. The development of creative thinking ability needs a long and complicated process. I t can not be finished only with the help of a good instructional model but it can make great progress by combing other positive factors.

5. The conclusion and development of the experimental research

Based on the experimental results and the discussion above, we make the conclusions below:

First, the E-learning instructional design model based on the CFT is helpful to promote the intrinsic motivation of students. This can be testified by the class observation and interview. Although the students of the two classes can listen to the teacher carefully in class, over half of the students in experimental class offer to ask the teacher to criticize their extracurricular work after class and they often communicate with teacher and browse the course learning website. The students in experimental class show great interest in the learning content itself and they do not give up study easily when confronted with difficulties, which indicates that they have formed the intrinsic motivation of study. There is no doubt that the motivation strategy system in the model has contributed greatly in the forming of intrinsic motivation.

Second, this instructional design model is greatly helpful to improve students learning quality in some intricate domains as well as their ability to solve the ill-structured problems. According to the interview, students actually have a lot of frustrated experience in the ill-structured domain because the traditional teaching model can not solve the ill-structured problems efficiently. The new instructional model is perfectly suitable to the characteristics of the ill-structured domain. "The new teaching model is fantastic!" said the students. Obviously, the model has greatly helped improve students' learning quality in the higher-order learning and their ability to solve the ill-structured problems, thus help increase their confidence. From this point of view, this model contributes a lot to students learning adaptation. As a result, we believe the model can serve as a good example to solve the problems of learning adaptation.

Third, this model is helpful to develop students' creative thinking ability. Of course, only by combining with other positive factors can this model improve creative thinking ability greatly.

The three points of conclusion above connect with each other closely. The intrinsic motivation is the important driving power for learner to pursue higher-order learning successfully. When students have a thorough, solid and flexible command of the intricate domains, their ability to solve the ill-structured problems will be greatly developed. At the same time, their creative thinking ability will be amazingly improved when they study those difficult domains and solve the ill-structured problems.

In order to develop this research further more, we need to revolve round the following aspects to continue our research: First, in order to explore the more abundant instructional design cases and construct the case library, we need to appeal more teachers to do the action research extensively. Second, we need to perform a deeper and more systematic exploration to the influence of the model on solving the problems on ill-structured domain and creative thinking ability. Our focus should be put on the problems during the operation so as to provide the more detailed practical proofs for this model.

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