EVALUATION OF LEARNING PERFORMANCE OF E-LEARNING IN CHINA: A METHODOLOGY BASED ON CHANGE OF INTERNAL MENTAL MODEL OF LEARNERS

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ABSTRACT
This paper presents a method of assessment on how Human-Computer Interaction (HCI) and animation influence the psychological process of learning by comparing a traditional web design course and an e-learning web design course, based on the Change of Internal Mental Model of Learners. We constructed the e-learning course based on Gagne's learning theory and theory of instructional design; and designed and analyzed questionnaires on the psychological process of learning in order to measure the change in a learner's mental model and performance. The result shows that HCI and animation features of e-learning have been proved to positively influence learners' cognitive perception and structuring, while the psychological process of learning as a whole is positively influenced by these technological features. In addition, the result indicates that the learning theory can be applied during the process of designing e-learning courses, and the theory of cognitive psychology is successfully used in measuring both a learner's psychological process of learning and changes in the mental model.
Keywords: E-learning, Learning performance, Internal mental model, Cognitive learning theory, Assessment

1. INTRODUCTION

The application of information and communication technology (ICT) in education is now making it possible for education to transcend space, time and political boundaries (Kirschner, Kester, & Corbalan, 2007). ICT in such areas as education and training has currently offered new paradigms for university training and the topic of electronic learning (E-learning) has deserved careful attention (Wu J.-H., Tennyson R.

D., Hsia T.-L., & Liao Y.-W., 2008). E-learning refers to the use of electronic devices for learning, including the delivery of content via electronic media such as Internet/Intranet/Extranet, audio or video tape, satellite broadcast, interactive TV, or CD-ROM. This type of learning moves the traditional instruction paradigm to a learning paradigm (Jönsson, 2005), thereby relinquishing much control over planning and selection to the learners. In addition, E-learning can bring the following advantages to learners: cost-effectiveness, timely content, and access flexibility (Lorenzetti, 2005). The rapid development of ICT and great demand for increasing the efficiency and effectiveness of learning drive the development of E-learning.

The growing literature on E-learning education shows how technological, economic and scientific factors are contributing to the development of a new educational panorama (Kirschner & Kester, 2007). A hypercube innovation model was utilized to analyze the differences in technology and learning models (instruction model/environment) used in traditional classroom learning versus E-learning environments. The innovation from traditional classroom learning to E-learning is radical for both the learner and instructor, leading to drastic changes in the technology and learning model (Wu J.-H., Tennyson R. D., Hsia T.-L., Liao Y.-W., & 2008).Based on self-determination theory, Roca & Gagné (2008) proposed an extended Technology Acceptance Model in the context of e-learning service. In the proposed model perceived usefulness, perceived playfulness and perceived ease of use are predicted to be influenced by perceived autonomy support, perceived competence and perceived relatedness (Roca J. C. & Gagné M., 2008). Based on the model of Rogers' innovation adoption theory, every factor of perceived innovative attributes influencing the individual adoption behaviour, namely perceived relative advantage, perceived compatibility, perceived trialability, and perceived observability, was proved to have certain influences on people's adoption of e-learning (Fu Z.T., Yue J., Li D.L., et al., 2007; Zhang L.X., Wen H.J., Li D.L., Fu Z.T., Cui S., 2009).

The present construction of E-learning courses both in the education and business sectors put too much focus on the technological side of designing E-learning courses (Attwell, Holmfeld, Fabian, Karpati, et al., 2003). However, little attention is paid to application of the traditional learning theory in designing E-learning courses. There exists much research which has failed to prove the positive effectiveness of E-learning in the educational sector (Clark & Jones, 2001). This probably may be caused by neglecting the use of learning theory during the

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instructional design of E-learning courses. Applying cognitive psychology into the measurement of a learner's psychological learning process and change of mental model after learning, previous research suggests that Technology Mediated Learning (TML) may improve the student's achievements (Alavi, 1994; Hiltz, 1995; Schutte, 1997; Wetzel, 1994), students' attitudes towards learning (Schutte, 1997), and students' evaluation of the learning experience (Alavi, 1994; Hiltz, 1995). The Internet is rapidly transforming a range of human activities; socio-cognitive theory assumes that engagement in transformed activities, over time, transforms human cognition. Without exception, frequent Internet users cognitively outperformed infrequent Internet users. Tool use increases cognitive capacity and tools represent extension of cognitive processes (Johnson G.M., 2008).

However, research on these issues is limited. This paper applies the cognitive learning theory into designing the E-learning course, in order to analyze the psychological process of learning when a learner learns a course; and tests how the psychological process of learning will be affected by different learning methods. Our research will show that the design of E-learning based on cognitive learning theory will have the expected impact on a learner's internal cognition as measured according to cognitive psychology. The remainder of this paper is organized as follows: Section 2 provides a theoretical background, and discusses the development of previous learning theories and theories of cognitive learning, particularly Gagne's Learning Theory and Theory of Instructional Design. Section 3 explains the theoretical framework and hypotheses based on Gagne's theory and theory of cognitive learning. Section 4 describes designing E-learning courses and choosing variables. Section 5 analyzes data collected from the questionnaires. In Section 6 the conclusions are provided.

2. THEORETICAL BACKGROUND

2.1. Research of Learning Theory

2.1.1 The Development of Learning Theory

Research on learning has been a part of psychology since it began as a science in the 1800s. Learning Theory experienced a three-stage evolution during its development.

The first stage involved learning theory from a behaviorist perspective. In the early 20th century, most of Learning Theory was from a behavioral perspective. In Behaviorism, learning occurs when new behaviors or changes in behaviors are acquired as the result of an individual's response to stimuli. In the early 1900's, behaviorist John Watson launched the behaviorist revolution. Moving from mainstream thought that the proper subject for psychology was not the operation of the mind but rather the examination of objective, observable behavior (Gardner, 1985). This set the stage for others to investigate the idea of cognitive maps in guiding the behavior of animals in problem solving. Skinner (1954) believed that students could be taught to learn through averse stimulation.

In the second stage, Learning Theory focused on an information processing perspective. In the middle of the 20th century, cognitive psychology overtook the position of behavioral psychology. In the 1950s, Learning Theory mainly evolved from the information processing perspective. In the information processing perspective, learning is characterized as a change in knowledge stored in one's memory. It is governed by an internal process rather than by external circumstances. In cognitive psychology, memory is usually divided into three stores: the sensory, the short-term, and the long-term. The sorting of information through these stores is often referred to as the information processing model (Anderson, 1999).

The third stage of Learning Theory evaluates from the constructivist perspective. The constructivist perspective is the view that emphasizes the active role of the learner in building understanding and making sense of information. Moshaman classified constructivism into the following categories: Exogenous Constructivism , Endogenous Constructivism , and Dialectical Constructivism.

2.1.2 Gagne's Learning Theory

Learning is a change in human disposition or capability, which persists over a period of time, and which is not simply ascribable to processes of growth (Gagne, 1977). That is the most famous definition of learning by Gagne and was referenced most frequently by the scholars in the learning and psychology field. Gagne made a great contribution to educational psychology. What mainly concerned him in his research was how to apply the learning theory to the application of instructional design. His book, The Conditions of Learning, written in 1977, Principles of Instructional Design in 1979, and Essentials of Learning for Instruction in 1975 classified the learning type according to the learning result, and built one of the most comprehensive and influential sets of instructional models. Gagne shares both the behaviorism psychology perspective and the cognitive psychology perspective. He is regarded as an experimental psychologist. While much of Gagne's Learning Theory, including signal learning, stimulus-response learning, verbal association and discrimination learning, is based on

behaviorism's stimulus-response (S-R) theory (Novak & Tyler, 1977), Gagne's experiments in his later work also paid attention to cognitive activity during learning, which is considered an intermediary factor between stimulus and response. In his view, learning theory from an information processing perspective is important.

2.1.3 Cognitive Learning: Perception and Structuring

Research in learning was significantly affected by cognitive psychology after the mid 20th century. Learning theory from a cognitive perspective is a general approach that regards learning as an active mental process of acquiring, remembering, and using knowledge. Learning results in a change in knowledge, which leads to in turn a change in behavior. Learning is not directly observable.

According to Alavi, Marakas, & Yoo et al. (2002), cognitive learning theories identify a number of cognitive sub-processes involved in learning, and these sub-processes can be divided broadly into two categories: perception (Ausubel, 1968) and structuring (Norman, 1982).

2.2. Measurement of the psychological process of learning

Much research has failed to prove the positive effectiveness of E-learning in the educational sector (Clark & Jones, 2001; Marttunen & Laurinen, 2001; Johnson, Aragon, Shaik, & Palma-Rivas, 2000; Summer & Hosterler, 2002). That fact is caused by the neglect of related psychological and learning theory during the design process of E-learning. Designers of E-learning courses should not just simply copy the content of the traditional learning to E-learning and randomly add some technological features into E-learning courses. Also, in the past decades, the designers of computer-based learning always paid a lot of attention to the technological side of the designing, while paying little attention to the user side (Attwell et al., 2003). In order to increase the effectiveness and efficiency of E-learning, some psychological theory and learning theory should be applied during the construction of the E-learning course. How the learner's learning process operates and how the learner perceives a new form of learning should be given enough consideration. Technological features should not be randomly added in E-learning. Misuse of technology may mislead the learner and distract the learner's attention, which will negatively influence the learning result. Since Gagne's (1979) theory on instructional design divides the instruction into nine stages and each of the stages implies the corresponding learner's internal cognitive learning process, it is very useful when applying the new technology in the design of the E-learning course.

Previously, an overwhelming amount of research measured the learning result based on certain tests on the subjects' performance. Although this method is useful in measuring the subjects' achievement, it provides little help to study how to increase the effectiveness and efficiency of E-learning in the future. The traditional method of measuring learning results just shows what the present situation is, instead of how the present situation can be changed. Also, there is some research that measures the learning result by taking a cognitive approach. However, they neglect the measurement of the objective performance of the learner. The cognitive measurement of the learning result can show a map on how the learner's internal mental model is influenced, but it doesn't give a map on whether this influence can really increase the learner's ability.

When measuring the structuring process of knowledge, both a subjective measurement and objective measurement are used. Both the subjective questions and the objective questions are based on the Associative Network Model (Collins & Loftus, 1975; Nelson, Bennett, Gee, Schreiber, & Mckinney, 1993; Quillian, 1969). However, the subjective questions take a cognitive approach by asking what the learner thinks. In contrast, the objective questions take a performance approach by asking them to solve real problems in web design. The subjective part along with objective part together can give a more reliable result of the measurement of the learning result.

2.3. Effectiveness and efficiency of E-learning

In the infant stages of E-learning's history, little systemic research on the effectiveness of distributed learning existed (Alavi, Wheeler, & Valicich, 1995; Storck & Sproull, 1995). From then on, with the development of E-learning, more and more research switched their focus on the effectiveness and efficiency of E-learning.

The hottest and most critical topic in research of E-learning in recent years is the effectiveness and efficiency of E-learning, since scientific proof of the value of E-learning is needed. Effectiveness is concerned with the achievement of the intended objectives of the educational experience. Efficiency is concerned with producing the maximum benefits possible for the given expenditure of public money. However, whether the effectiveness and efficiency of E-learning betters traditional learning still remains unresolved.

Some research shows that E-learning does not make a significant difference in effectiveness or efficiency over traditional learning (Clark & Jones, 2001; Marttunen & Laurinen, 2001). Some research even shows that E-

learning is not as good as traditional learning. Summer & Hosterler (2002) also supported that result by showing that traditional groups performed significantly better than the E-learning group.

However, there are also some studies showing different results. Online instruction is proved to have a significantly more positive effect than traditional learning (Buchanan, 2000). In Hertz-Lazarowitz and Bar-Natan's (2002) study of writing classes, they showed that computer-mediated writing is just as effective as using computers plus traditional instruction techniques.

3. THEORETICAL FRAMEWORK OF ASSESSMENT METHODS

3.1. Theoretical Framework

According to Gagne (1977), different types of learning will require not only different types of conditions to initiate the learning, but also lead to different types of learning results. Synchronously, Gagne (1977) classified learning into five categories according to the learning result: Verbal Information Learning, Intellectual Skills, Cognitive Strategies, Attitudes, and Motor Skills.

Intellectual Skills are the capabilities that make the human individual competent. They make up not only the most basic but the most pervasive structure of formal education. They range from elementary language skills like composing a sentence to the advanced technical skills of science, engineering, and other disciplines (Gagne, 1977). According to this description of Intellectual Skills, courses on web design develop intellectual skills. These intellectual skills are categorized into levels. They are discriminations, concrete concepts, defined concepts, rules, and higher order rules. The basic process of learning intellectual skills begins from developing basic concepts to developing rules and applying rules. A good understanding of this process is important to the design of courses in intellectual skills. So in our designing web design courses, we give strong consideration to the characteristics of the intellectual skills. In the design of a web course, we make sure that some basic concepts are taught first, then we try to help learners to develop these concepts into different rules for designing a web site, and finally show them how to apply these rules in real practice.

Both traditional learning and online learning can make use of Gagne's classification of learning to make a better design of the course. However, what is concerned with in this research is how E-learning, a new form of learning with more technological factors, will affect the learner's internal process of learning. From this perspective, Gagne and Briggs' (1979) nine stages of instruction is useful for the purpose of this research, since certain technology factors can be clearly added under this clear framework instructional design. Nine stages of instruction divide the instruction into nine steps, which provide a specific and clear guide for the instructional design. These nine stages of instruction also imply the internal cognitive process. So by influencing the event of instruction, we are influencing the cognitive process. In this research, some technology features are added under the framework of nine stages of instruction. We assume that added technology will change the effectiveness of this instructional design. In turn, the change will lead to the change of the learner's internal cognitive learning process and mental model.

In order to design an E-learning course in web design with the function of HCI and animation, Gagne's (Gagne, 1997; Gagne & Briggs, 1979) classification of learning result and theoretical framework on instructional design are used. Under Gagne's (Gagne, 1997) definition of different learning results, we define our web design learning as an Intellectual Skill. The functions of HCI and animation are added into the E-learning course when applying the nine-stage instructional design theory put forward by Gagne and Briggs (Gagne & Briggs, 1979) to the real design of the E-learning course. Fig. 1 shows the rationale and theoretical framework applied in the research.

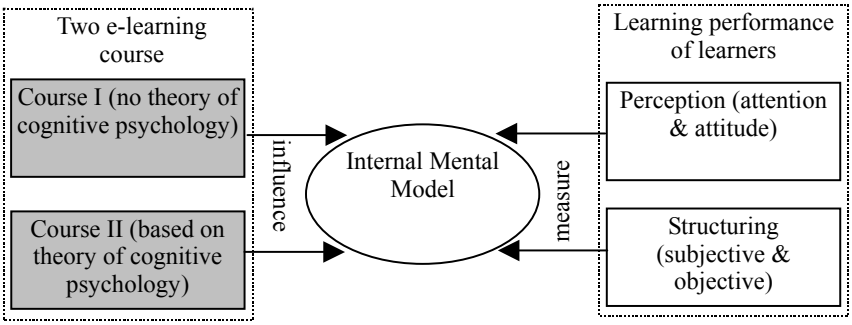

Fig. 1. The rationale and theoretical framework of assessing learning performance.

3.2. Research Hypotheses

Learning is regarded as a process involving knowledge acquisition and change in knowledge structures rather than as having a behavior purpose (Greeno, 1974). According to Ausubel (1968), besides knowledge acquisition (learning), a successful performance (behavior) also requires other abilities that include perseverance, flexibility, improvisation, problem sensitivity, and tactical astuteness. While the behavior is only a possible outcome of learning (Shuell, 1981; Stevenson, 1983), changes in cognitive learning more accurately measure changes in outcomes of learning. So the measurement of the change in the cognitive learning process will be useful. As has been mentioned before, the cognitive learning sub-process includes perception and structuring. Based on the above theoretical framework, this study proposes the following hypotheses.

Hypothesis I: The Human-Computer Interaction (HCI) and animation features of E-learning will positively influence the learning result.
Hypothesis II: The HCI and animation features of E-learning will positively change the learner's cognitive perception.
Hypothesis III: The HCI and animation features of E-learning will positively change the process of structuring of knowledge.
Since cognitive perception stands for the learner's psychological process of learning in the short-term, and structuring of knowledge stands for the psychological process of learning in the long-term, together they represent the complete psychological process of learning. If Hypotheses II and III are proven, it is clearly right to say that the HCI and animation feature of E-learning will affect the psychological process of learning from a short-term perspective to the long-run perspective. Therefore we also have promoted a fourth hypothesis.
Hypothesis IV: The HCI and animation feature of E-learning will positively influence learners' psychological process of learning.

4. DESIGNING E-LEARNING COURSES AND CHOOSING OF VARIABLES

4.1. Design of the Web Design Course

Since this research is based on the comparative study between a traditional course in web design and an E-learning course in web design, design and construction of two versions of the same course in web design was needed. The content and the structure of the traditional course and the E-learning course in web design should be completely identical because it must eliminate the possibility that the different content of the course, rather than employment of technological features of the course, lead to the different learning outcomes. So during the designing process of the E-learning course in web design, the principle of retaining identical content was strictly adhered to.

The content of both the traditional web design course and the E-learning web design course came from a web design course. A web design handbook was printed directly for the traditional learners to use. In order to eliminate the possibility that the color of the images appearing in the learning material would affect the learning result, the handbook was printed with a color printer, so that the color images used in the handbook could be consistent with the images used in the E-learning web design course.

The E-learning version of the web design course was constructed by using software for professional E-learning construction, which allowed the designers to easily integrate the HCI and multimedia into the text content. After the E-learning web design course was constructed, the subjects could get access to the E-learning material on web design through the Virtual Campus by uploading the course.

4.2. The Subjects

There were 60 subjects who participated in this study. For the research purpose, these 60 subjects were divided into two groups, each of which contained 30 subjects. One group was chosen to learn the web design course by the traditional learning method, and the other group was chosen for the E-learning course. Both of the groups were required to learn this web design course in 50 days. After their learning, the questionnaires were sent out for the subjects to complete.

4.3. Independent Variable

The most important part of designing this E-learning web design course involved where to integrate the HCI and animation features into the original content. Human-Computer Interaction (HCI) is the study of the interaction between both the user and computers. Interaction between users and computers occurs at the interface, which will decide which and how information is presented to the user on a screen (Baecker, Grudin, Buxton, & Greenberg, 1995; Nielson, 1993). In our research, certain HCI techniques were employed in the E-learning course for the learners to control: which, when and how the information is presented. Animation is a sequence of frames that presents a smoothly moving image like a film or video. Animation can include digitized video,

computer-generated graphics, or a combination. With the rapid development of Internet technology, animation has become much easier to create and popular on the Web (Spool, Scanlon, Snyder, Schroeder, & DeAngelo, 1999). Animation has the function of increasing comprehension by information visualization (Baecker, 1988; Mackinlay, Robertson, & Deline, 1994). In addition, flash animation was added in the E-learning web design course in order to help the learners to understand the difficult concepts in learning web design.

By reviewing Gagne's (Gagne & Briggs, 1979) nine-stages of instruction, our research added HCI and animation to influence the following three stages: acquire attention, stimulate the recall of prior learning, and present the stimulus content. For example, in order to draw the learner's attention to initiate the learning behavior, we used the interactive course navigation on the very first web page of the E-learning course. In the interface introductions to Flash and Dreamweaver, the function of pop-up windows was used. This new method of learning the software interface drew the learner's interest and encouraged them to continue to explore the function of different panels in the software interface. We used the pop-up window and hyperlinks to help stimulate the recall of prior learning. Some terms and concepts appeared frequently by the form of pop-up windows and hyperlinks, which stimulated the recall of these terms and concepts. Presenting the stimulus content is improved by using both the HCI and animation. For example, in the graphic demonstration of defining a site, learners controlled the paces of the flow of information by choosing the different steps. Two ways of drawing a layer were demonstrated by using two Flash animations. All types of content in the E-learning course were more stimulating, compared with the pure static text content contained in the traditional course's handbook.

4.4. Dependent Variable

A comparative analysis on the effectiveness of HCI and animation on the psychological process of learning was based on the measurement of perception and structuring, since perception and structuring cover the whole sub-processes were involved in the learning (Alavi et al., 2002). Perception involves the discernment of information in short-term cognitive learning (Ausubel, 1968). Structuring is a process that stores information in long-term cognitive learning (Norman, 1982).

Previous research has used the focused attention and attitude to measure perception (Hong, Thong, & Tam, 2004). In order to measure the focused attention, we divided focused attention according to Enns (1990) and Haberlandt's (1997) four varieties of attention. So the focused attention section of the questionnaire of this research was designed according to these four varieties of attention. The attitude section of the questionnaire design was based on the three components of attitudes.

The structuring of knowledge will lead to a change in mental model, which is defined as "all forms of mental representation, general or specific, from any domain, causal, intentional or spatial" (Vosniado & Brewer, 1987). However, previous research did not provide a unique or unanimous way to measure the mental model concept (Wilson & Rutherford, 1989; Staggers & Norcio, 1993). Because the mental model is an internal representation in the memory, it cannot be measured directly. An indirect approach is needed to measure the change of mental model.

One indirect approach to measure the mental model involves representing the internal knowledge structure (cognitive structure) graphically. A lot of literature in education and learning has taken the indirect approach to measure the internal knowledge structure graphically. The literature includes Newell's (1977) association memory approach, Pask's (1976) entailment structure of conversation theory, Minsky's (1977) frame-system theory for memory, Dana's (1993) concept-mapping, Jones' & Vesilind's (1995) concept-mapping and Rumelhar's (1997) network of semantics approach. Usually, these indirect approaches ask the subjects to draw flowchart diagrams to show their internal knowledge representation on what has just been learned. Then, several experts in the related field will judge the diagram drawn by the subjects and score the diagram. Although this approach is an applicable way to measure the change of mental model, it is not very suitable for our research. Representing the internal knowledge structure graphically is more suitable for knowledge that is concept-focused. Since our research was based on a web design course, which both has concepts and specific skills, this research will not use the graphical approach to measure the change of mental model.

Instead, another approach to measure the mental model is to represent the internal knowledge structure by designing questions for subjects to answer. Sein, Bostrom, & Olfman(1987) tested their subject's knowledge structure via questions, and then the tests were scored to measure the quality of subjects' mental models. Lim, Ward, & Benbasat(1997) used open-ended questions to assess the knowledge of their subjects, which were evaluated by related experts for measuring the mental model. In our research, seventeen questions were used to measure the change in the subject's mental model resulting from the process of structuring of knowledge. These seventeen questions were divided into subjective questions and objective questions. The subjective test questions

were designed according to the associative network model, which try to ask the subjects to subjectively demonstrate their ability to form a new structure for web design knowledge. Since the subjective questions alone cannot reflect the real situation, objective questions were also used. The objective questions included specific questions on some web design skills. Both the subjective questions and the objective questions were scored to measure the change in subjects' mental model, and the result of the objective questions were used to measure the subjects' performance and learning result.

The focused attention, attitude, and subjective part of the structuring were measured by using the 5-point Likert scale, where 1 stands for Strongly Agree; 2 stands for Agree; 3 stands for Feel Neutral; 4 stands for Disagree; and 5 stands for Strongly Disagree. All the questions in the questionnaire were asked as affirmative statements. In other words, if a subject chose 1, which stands for Strongly Agree, he or she admitted that they felt positively with the affirmative statement. If a subject chose 5, which stands for Strongly Disagree, he or she admitted that they felt negatively toward the affirmative statement. In summary, for focused attention, attitude, and the subjective part of the structuring, the smaller number always implied a better result.

In the objective part of the structuring, on the contrary, the subjects could choose one or more answers that they thought correct according to their own judgment. Then the number of correct answers to the questions was converted into category data for the convenience of this research. All the objective structuring questions in the questionnaire were evaluated according to the same standard stated above, so that the consistency of evaluation of the learning result was ensured.

4.5. Control Variables

The learning result could be affected by some cognitive and psychological characteristics of the subjects. According to Hiltz (1995), the level of academic ability, motivation, and degree of effort have been shown to positively correlate with the learning outcomes in computer-based learning. In addition to the differences in learners' cognitive and psychological characteristics, students' comfort with their onscreen image was observed as affecting their behavior in the synchronous distance learning environment (Webster, 1997). Other individual difference including age, gender, personal computer experience, Internet experience, and even previous E-learning experiences may affect the learning result.

In order to eliminate the possibility that individuals' differences rather than the technical features of the E-learning would affect the result of this research, those individual differences were controlled by randomly choosing the subjects and randomly dividing the subjects into two groups. The subjects were volunteers found through an advertisement on the Internet.

5. DATA ANALYSIS

60 subjects finally successfully took the web design course created by this research. They were equally divided into two groups at random. 30 subjects were selected to learn the web design course by the traditional learning method, and the other 30 subjects learned the web design course by the method of e-learning. The response rate to the questionnaire was 100%, since the sample was small and easy to control. Also, the promised gift for responding to the questionnaire motivated the subjects to respond quickly.

5.1. Construct Reliability of the Questionnaire

Cronbach's Alpha is a good way to measure construct reliability (Cooper & Schindler, 2003). The higher the Cronbach's Alpha is, the more reliable the construct is. The variables in the questionnaire of this research demonstrate adequate reliability. For the traditional questionnaire, the Cronbach's Alpha is 0.7844 for focused attention, 0.7805 for attitude, 0.8373 for the subjective parts of the structuring, and 0.8136 for the objective parts of the structuring. For the E-learning questionnaire, the Cronbach's Alpha is 0.7986 for focused attention, 0.8192 for attitude, 0.8654 for the subjective parts of the structuring, and 0.7603 for the objective parts of the structuring.

5.2. Basic Statistics Information of the Subjects

Among the 60 subjects, 6.7% were between 18 and 22 years old, 55% were between 23 and 25 years old, 28.3% were from 26 to 30 years old. There were more females than males among the subjects. Female subjects accounted for 56.7% of the total subjects. Most of the subjects held a bachelor degree, which accounted for 65% of the total subjects. 28.3% held a master's degree, and 6.7% were high school student graduates. Most of the subjects did not have work experience. On average, the subjects had from four to six years of experience using computers and Internet. None of the subjects claimed to have experienced e-learning before. Most of the subjects (68.3%) did not have e-learning experience before. None of the subjects previously had much knowledge about web design. Most of the subjects (81.7%) took this course because they wanted to increase their skills in web design. Most of the subjects took this course seriously and devoted much effort, except for one subject who tried

very little when learning this course. No subjects reported feeling uncomfortable with the onscreen images.

5.3. Control and Manipulation Checks

Pearson's correlation coefficients were used to test whether cognitive learning and learning result had a significant relationship with the subjects' age, gender, education level, work experience, experience with computer, experience with Internet, motivation, degree of effort, and comfort with onscreen images.

A surprising finding is that there was no statistically significant relationship between individual characteristics (age, gender, academic ability, motivation, degree of effort, experience in using personal computers or the Internet, previous experience in E-learning, and comfort with onscreen images) and the learning result. Although Hiltz's (1995) research showed that the level of academic ability, motivation, and degree of effort have been shown to positively correlate with the learning outcomes in computer-based learning, our research did not further prove that research result. Moreover, our research also did not reveal any relationship between a subject's comfort with onscreen images and the learning result, which was used by Webster (1997) to prove as having a relationship. However, this is not to say that the previous research is wrong. Several reasons may have caused the different findings in our research. The reliability of subjects' answering the questionnaire will cause the difference in research findings. It is possible that the subjects in this research did not answer some questions frankly. When the question, such as the degree of effort put in the learning process, was asked, the subjects may have felt embarrassed to say that they paid little effort. Also, the subjects may also have felt embarrassed to say that they took the course for the free gift. Finally, the similarity of the individual characteristics in our research may have been a little bit too concentrated.

5.4. Hypothesis Testing

The t-test was used for hypothesis testing. Table 1 and Table 2 show the hypothesis testing results for the learning outcomes among the two groups of people. Since the objective questions about structuring in the questionnaire were constructed to test the subjects' real ability to use web design tools, this part of the questionnaire can also be treated as a performance test. On average, the subjects in the E-learning group had a better score. The average score of the subjects in the traditional learning was 26.57, while the average score of the subjects in the E-learning was 33.6. In this instance, the difference is statistically significant between the score of subjects from the traditional learning group and the E-learning group.

Table 1 Means of the total score of the objective test.

Pair 1	Mean	N	Std. Deviation	Std. Error Mean
Total score of the objective test for subjects in traditional learning	26.57	30	6.63	1.21
Total score of the objective test for subjects in e-learning	33.60	30	6.36	1.16

Table 2 T-test for the subjects total score in the objective questions.

Pair 1	Paired Differences					t	df	Sig.(2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% confidence interval of the difference				
				Lower	Upper			
Total score of the objective test for subjects in traditional learning - Total score of the objective test for subjects in e-learning	-7.03	7.95	1.45	-10.00	-4.07	-4.848	29	0.000

Since the age, gender, education level, work experience, experience with computer, experience with using the Internet, motivation, degree of effort, and comfort with onscreen images were not factors that affected the learning result in this research, the HCI and animation features provided the only differences between the traditional learning and E-learning groups, which may explain the different learning result. Therefore, Hypothesis I is supported: the HCI and animation features of E-learning will positively influence the learning

result.
The result of the data also shows that applying the traditional cognitive learning theory into the design of the E-learning course was successful. In designing the E-learning web design course, much more attention was focused on adding the HCI and animation features to E-learning, in order to influence the learner's psychological process of learning. Since the design process was based on Gagne's (1979) theory of instructional design, the result of the data clearly prove the success of the application of that learning theory. Also, the result strongly proves the consistency between the traditional cognitive learning theory and cognitive psychology. Every one of Gagne's (1979) stages of instruction implies the corresponding learner's internal cognitive process. The result of the measurement of the learner's psychological process of learning matches the expected influence of the technological features during designing the E-learning based on Gagne's (1979) theory of instructional design.

Table 3 presents the mean results of focused attention, attitude, and structuring (both subjective and objective). For focused attention, attitude and structuring (subjective), the mean in the traditional learning group was higher than the mean in the E-learning group, showing that the subjects in the E-learning group felt more positively than those in the traditional learning group. For structuring (objective), the mean in the traditional learning group was lower than that in the E-learning group, showing that the subjects in the E-learning group objectively had a better structuring ability than those in the traditional learning group.

Table 3 Paired sample statistics for 4 variables.

Items		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Mean of the focused attention of the subjects in traditional learning	3.7747	30	0.4753	8.679E-02
	Mean of the focused attention of the subjects in the e-learning	2.5920	30	0.5200	9.493E-02
Pair 2	Mean of the attitude of the subjects in traditional learning	3.9440	30	0.5911	0.1079
	Mean of the attitude of the subjects in the e-learning	2.6337	30	0.5130	9.365E-02
Pair 3	Mean of the structuring (subjective) of the subjects in traditional learning	3.6850	30	0.5158	9.417E-02
	Mean of the structuring (subjective) of the subjects in the e-learning	2.8663	30	0.5752	0.1050
Pair 4	Mean of the structuring (objective) of the subjects in traditional learning	2.6567	30	0.6626	0.1210
	Mean of the structuring (objective) of the subjects in the e-learning	3.3600	30	0.6360	0.1161

The t-test (see Table 4) shows that the differences are statistically significant. Since the subjects' age, gender, education level, work experience, experience with computer, experience with the Internet, motivation, degree of effort, and comfort with onscreen images were not factors that affect the learning result in this research, the HCI and animation features were the only difference between the traditional learning and E-learning, that may have led to the different result. Hypothesis II and III therefore are supported. The HCI and animation features used in E-learning change the subject's focused attention and attitude positively, namely influencing the learners' cognitive perception. So the learner's cognitive perception is positively affected by these technological features. Both the subjective structuring and objective structuring tests also show that HCI and animation features of E-learning will positively change the process of structuring of knowledge.

Table 4 Result of T-test for 4 variables in measuring the psychological process of e-learning.

Mean of the subjects in traditional learning - Mean of the subjects in the e-learning	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% confidence interval of the difference				
				Lower	Upper			
Pair 1 the focused attention	1.1827	0.6716	0.1226	0.9319	1.4334	9.645	29	0.000
Pair 2 the attitude	1.3103	0.6586	0.1202	1.0644	1.5562	10.898	29	0.000
Pair 3 the structuring (subjective)	0.8187	0.6283	0.1147	0.5841	1.0533	7.137	29	0.000
Pair 4 the structuring(objective)	-0.7033	0.7946	0.1451	-1.0000	-0.4066	-4.848	29	0.000

Cognitive perception and structuring are two sub-process of the psychological process of learning. Since the HCI and animation feature of E-learning has been proved to positively influence a learner's cognitive perception and structuring, the psychological process of learning as a whole is positively influenced by these technological features. Hypothesis IV therefore is supported, as well.

Compared with the cognitive perception, the t-test for the structuring shows a lower paired difference. This shows that the technology features of E-learning will have more impact on the cognitive perception than on the structuring process of knowledge. The reasons possibly leading to this result above are as follows: first, although both cognitive perception and the structuring process of knowledge will be positively influenced by HCI and animation features, cognitive perception that is part of the short-term psychological process of learning is more likely to be easily affected. In other words, compared with structuring, which is a much more complicated internal processes, it is possible that the focused attention and attitude are more easily affected. The processing of information in our memory experiences a short-term and then long-term process (Atkinson & Shiffrin, 1968). Since the focused attention and attitude are important factors that affect the short-term memory (Anderson, 1999; Miles, 2003), the HCI and animation will have a more direct impact on these short-term related factors. Compared with the focused attention and attitude, structuring is a long-term factor. So the impact of technological features on structuring will be indirect. Additionally, for the subjects, measuring focused attention and attitude is probably easier than measuring structuring. People can easily express what they like or dislike, but it is difficult to express what they have actually learned.

6. CONCLUSION

The data analysis has demonstrated that HCI and animation features of the E-learning process positively influence the learning result and the psychological process of learning, including cognitive perception and the process of structuring of knowledge. The findings of this research have a good implication for the design of E-learning packages and for research measuring the psychological process of learning. From the perspective of designing E-learning courses, this research provides a good framework for designing an E-learning package. This research provides a good example of how to use traditional psychological learning theory to guide the design of E-learning courses. The research also clearly shows that a scientific design of E-learning courses under previous learning theory is effective.

The research demonstrates that technological features of E-learning can positively influence the psychological process of learning. Due to the limited capability of a small sample chosen, and the characteristics of the subjects in the sample lacking diversity, however, we cannot show how much the result would be different if the subjects had a lower level of education and lower level of computer literacy.

Further research should continue studying how the technological features of E-learning influence the psychological process of learning. The research tries to measure the psychological process of learning in a general way that classifies the psychological process of learning into two broad categories. Further research can try to carry on this study within a narrower classification of the psychological process of learning.

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