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The Effect of e-learning on the Promotion of Optoelectronics Technology and Daily Livings Literacy among Students in Universities of Technology

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***Abstract*—**This study aims to analyze the effect of e-learning on photonics technology and daily livings among college students. The course contents of photonics technology and daily livings are first drafted based on research discussions and expert interviews. Having expert questionnaires with Delphi Technique for three times, the knowledge units and items for the course of photonics technology and daily livings are established. The e-learning materials and the drafts of instructional strategies, academic achievement, and learning attitude scales are then developed. With expert inspection, reliability and validity test, and experimental instructions, the scales and the material are further revised. Finally, the formal instructions are implemented to test the effect of different instructional methods on the academic achievement of photonics technology and daily livings among students in universities of technology. The research results show that e-learning could effectively promote academic achievement and learning attitude, and the students with e-learning obviously outperform the ones with trandition instructions.

***Keywords*—**E-learning, Photonics Technology and Daily Livings, Academic Achievement

I. Introduction

SINCE the global development of photonic market being led by display panels in 2000, the scale of global optoelectronic market has been promoted. Photonics technology has played a primary role in various fields in recent years and has been connected with daily livings. For example, laser, DVD, LED, liquid crystal display, optical fiber communication, optical precision measurement, laser treatment, laser machining, digital cameras, stereoscopic holography, lighting, optical micro electro mechanical systems, optoelectronic semiconductors, and biophotonics are closed related with daily livings. Meanwhile, it has continuously been popular in various applications that it has stepped into the market scale of trillion dollars[1]. Lin & Chen [2] defined photonics industry as all industries for manufacturing products related to photonics with optics being the facilities, equipment, and systems for key components.

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Photonics Industry & Technology Development Association (PIDA) classified photonics industry into optics, optical displays, optical I/O, optical storage, and optical communication [3]. Technology has changed the living environment of human being as well as enhanced the rapid change of social structure and culture. With the breakthrough of photonics technology, the development has extended to information, communication, medical treatment, industries, career, defense, energy, and biotechnology. Moreover, with the emergence of digital era, a lot of traditional industries have been developed toward digitalization that the boom of photonics industry is expected.

The 21^{st} century is regarded as the knowledge economy era. The one who can master knowledge and develop wisdom will be the winner. With multimedia, instructions have been changed through the evolution of information media. From the aspect of modern education, learning is no longer a passive instruction of acceptance, but an interactive learning. Teachers should have students apply their capability of self-thinking and inspire the potential of self-learning in the interactive learning courses. E-learning has become a trend in modern society. In face of the rapid change of environments, it becomes a key factor to master the development of knowledge, to enhance personal knowledge, and to utilize network environments for learning and effectively achieving the learning objectives. The methods and habits for information exchange have been changed because of the great leap forward of information technology in recent years. Such a trend has also affected the educational system that e-learning, as a new model, has been introduced into traditional instructions. The learning platform for e-learning contains virtual offices and classrooms which not only present the same situation as leaning in classrooms, but the teaching and learning activities could also be assynchronously proceeded [4, 5].

In the civilization process, technology change has become ordinary that technology could change the living environment of human beings and enhance the rapid change of social structure and culture. Photonics technology is closely related to daily livings and has enhanced the tide of global information network that e-learning will become the trend in the era. For this reason, this study tends to establish digital contents which conform to the actural demands, build e-learning environments, and precede experimental instructions through the development of e-learning module in order to understand the effect of e-learning on photonics technology and daily livings among students in universities of technology.

II. Literature Review

A. Photonics technology

Photonics is the combination of optics and electricity. A part of traditional optics studies the information transmission with short pulse, named photonics, while a part of electricity studies the electric phenomenon, named electronics. Photonics technology therefore presents both the technology of optics and electronics. Nevertheless, the definition of photonics industry is rather strict in Japan that merely the industries related to laser and optical fiber could be regarded as photonics industry [6]. The definition is relatively broad in Taiwan. Executive Yuan, R.O.C.(Taiwan) [7] defined photonics as the intersection of optics and electronics. The development of photonics technology used to be utilized for defense and aerospace industries which did not consider too much about costs. Presently, it is widely used in inforamtion, communication, automation, medical treatment, and daily livings. According to the classification of Bureau of Employment and Vocational Training, photonics industry refers to the manufacturers which produce and apply the elements of photonics technology and precede business practices with optics as the facilities, equipment, and systems for key components. Photonics industry is divided into optics, optoelectronic displays, optical I/O, optical storage, optical communication, laser, and other optoelectronic applications [8]. Hsu [9] mentioned that the experts in industries and academia considered the necessity of planning the programs of opto-semiconductors, optoelectronic materials and elements, display technology, photovoltaics, photonics patent and copyright, and biophotonics for photonics technology in five years. From the technical structure of photonics technology, the compentence of photonics technology is mainly classified with industries. Besides, in regard to the culticvation of photonics technology, the work contents and the required techniques do not conform to the present standard because of the continuous development of technology. For this reason, the core courses and the industrial demands should be emphasized for human resource cultivation in photonics technology industry.

B. E-learning and academic achievement

An achievement evaluation aims to evaluate the academic achievement of students. It measures the learned knowledge and skills of students with achievement tests, applies science and technology to collecting the learning behaviors and achievement of students, and analyzing, studying, and evaluating the academic achievement of students based on the instructional objectives [10]. In this case, an academic achievement is regarded as an important instructional reference, which could help teachers understand the beginning behaviors, explore the learning effectiveness, and diagnose the learning difficulties of students. The evaluation could be implemented before instructions, in the instructions, and after the instructions. Most achievement evaluations are preceded after the instructions in order to test the academic achievement of students [11].

Fu [12] compared the academic achievement between e-learning and traditional instructions of clothing production and found the prior knowledge and the intelligence of computers being the factors in learning results; and the optimal academic achievement appeared on the integration of e-learning and tradictional instructions. From the study on construction safety training via e-Learning, Ho and Dzeng [13] concluded that appropriate educational training models and courses could enhance the academic achievement of e-learning. In the study on investigating students'perceived satisfaction, behavioral intention, and effectiveness of e-learning, Liaw [14] mentioned the significant correlations between the behavioral intention of e-learning and the effectiveness among learners. Apparently, e-learning showed positive effects on the academic achievement of students.

C. E-learning and learning attitude

Attitude is regarded as psychological reactions of an individual interacting with people, things, and objects in the society. It further forms a consistent and continuous routine of psychological reactions which facilitates the indidual in maintaining the original attitude. Attitude therefore is internal which could be induced from the appearance and performance of behaviors; and, it presents direction, valence, measurability, and learnability [15]. In other words, attitude could be the psychological status related to belief, value, and personality, with which people would generate specific behaviors [16], or the status of consciousness and feeling . Learning attitude therefore was the behavior tendency of learners who were affected by the school, curriculum, instruction, environment, classmates, and oneself in the learning situation.

Wang et al. [17] concluded the positive effects of various computer-aided learning strategies on computer-aided learning attitude. In the study on assessing agricultural insurance agents attitude towards e-learning application in teaching them, Yaghoubi, Shokri & Gholiniy [18] pointed out the active learning attitude towards digial lessons when the students presented practical skills on computers and networks. In the study on personalized E-learning system with self-regulated learning assisted mechanisms for promoting academic achievement, Chen [19] mentioned that the cultivation of good learning attitude and self-adjustable learning capability were the key objectives in e-learning.

III. Methodology

A. Experimental design

With quasi-experiment, both control group (traditional instruction) and experimental group (e-learning) were taught the same lessons by the same teacher so as to have consistent variables. The e-learning materials for photonics were divided into five chapters, namely basic photonics engineering, optics applications, basic optoelectronic displays, solar cell applications, and biophotonics applications.

This experiment was designed to control all variables that it was important to master the experimental situation. The experimental instructions needed to consider both internal and external validity. The former would ensure the differences among dependent variables by proper control and deleting irrelevant variables, dependent on the variables. The latter referred to the application level of variables and dependent variables that the larger the adaptability, the higher the external validity.

The considerations of the inernal and external validity were listed as follows.

1. Students in two classes in a university of technology were selected as the research subjects. The number of participants in each group was close in order to avoid the effect of differences.
2. The applied cognition scale and learning attitude scale appeared good reliabiltiy and validity that they were regarded as stable measurements to avoid effects. Moreover, the participants for the post-test and the measurements were identity in order not to affect the internal validity.
3. The interval between the pretest and the post-test was nine weeks that the post-test was not affected by pretest learning, memory, and experiences. The interval was regarded appropriate.
4. The participants were in the same department, but the students were not aware of themselves being the experimental subjects. It could avoid John Henry Effect that control group tried to compete with experiment group, or Hawthorne Effect that experimental group tended to improve the performance.

B. Participants

Students who majored in liberal education in the academic year of 2010 in a university of technology in central Taiwan were selected as the participants. Total 128 students were selected into different groups for a nine-week experimental instruction.

C. Measurement

1. E-learning materials for photonics technology and daily livings

The materials were developed based on SCORM (Sharable Content Object Reference Model) [20]. It proceeded questionnaire survey with Delphi technique for three times and developed the standardized learning units with Analytic Hierarchy Process. The e-learning contents contained five chapters and 20 units. Furthermore, e-learning lesson were proceeded trial instructions and revisions for completing the projecting files. Besides, the projecting files were created scripts for being established in Learning Management System (LMS). Finally, each file was stored with texts and films. When data exchange was required among different platforms, the files were transmitted with text and film formats. In this case, a platform with SCORM standard could apply the materials that the resources could be exchanged.

2. Cognition scale for photonics technology and daily livings

The course of photonics technology and daily livings was divided into five chapters, in which the covered knowledge units and items were analyzed. According to the analyzed course contents, the recognition test list for photonics technology and daily livings course was developed. With expert inspection and revision, 54 single-choice questions were selected from the original 60 questions. The KR20 of the overall scale appeared .82, showing favorable reliability.

3. Learning attitude scale for photonics technology and daily livings

The learning attitude scale, developed by Chen [21], was classified into learning anxiety (6 questions), learning confidence (6 questions), learning interest (5 questions), and initiative (5 questions). With item analysis and factor analysis of the pretest questionnaire, four questions were deleted. The K. M. O. reached .776; the Cronbach α coefficient of the overall scale appeared .869; the Cronbach α coefficients of the sub-scales showed learning anxiety .824, learning interest and initiative .903, and learning confidence .816; and the total explained variance was 59.569.

IV. Results

A. Variance Analysis of learning attitude and academic achievement with different instructions

Before the experiment, the learning attitude and academic achievement pretest of both groups did not achieve significant differences ($t = .782$, $p > .05$; $t = .148$, $p > .05$), presenting that the same beginning behavior in the pretest of cognition and the learning attitude, as shown in Table I.

TABLE I
ANALYSIS OF PRETEST IN DIFFERENT GROUPS

Variable	Group	N	Mean	t
Learning attitude	Control group	67	71.925	.782
	Experimental group	61	70.738	
Academic achievement	Control group	67	22.343	.148
	Experimental group	61	22.213	

Before One-way ANCOVA, the in-group homogeneity of regression coefficient should be tested. The analysis showed that the learning attitude and academic achievement of both groups did not achieve significance ($F = 3.510$, $p > .05$; $F = 2.815$, $p > .05$). It presented the parallel in-group regression line in experimental group and control group that the relationship between covariables and dependent variables should be taken into account and the mean needed to be adjusted for One-way ANCOVA. From Table II, the learning attitude and academic achievement of both groups appeared remarkable differences where the learning attitude and the academic achievement appeared 0.896 and 0.991, respectively, in the experimental effect size which were regarded as high effect size (>0.8)[22]. Consequently, the learning attitude and academic achievement after the experimental instructions would appear significant differences. Besides, with Post Hoc, the average score of experimental group was higher than it of control group.

TABLE II
ANALYSIS OF COVARIANCE ON THE POST-TEST IN LEARNING ATTITUDE AND ACADEMIC ACHIEVEMENT OF BOTH GROUPS

Variable	Variance	df	SSCP	F	Post Hoc		effect size
Learning attitude	Covariable	1	712.693	8.155**	4.211*	2>1	0.896
	Between groups	1	2198.472	25.150***			
	In group	125	2413.193				
	Sum	128					
Academic achievement	Covariable	1	7506.057	108.098***	13.892***	2>1	0.991
	Between groups	1	888.331	12.793***			
	In group	125	72.098				
	Sum	128					

*P<.05, *** P<.001; 1 for control group, and 2 for experimental group.

TABLE III
PAIRED-T TEST ANALYSIS O THE PRETEST AND POST-TEST IN LEARNING ATTITUDE AND ACADEMIC ACHIEVEMENT

Group	Item	N	Mean	SD	t
Control group	Learning attitude pretest	67	71.926	8.078	1.342
	Learning attitude post-test	67	73.821	12.920	
	Academic achievement pretest	67	22.343	4.870	9.073***
	Academic achievement post-test	67	30.433	7.121	
Experimental group	Learning attitude pretest	61	70.738	9.101	6.701***
	Learning attitude post-test	61	77.951	6.106	
	Academic achievement pretest	61	22.213	5.096	16.370***
	Academic achievement post-test	61	45.623	9.583	

*** P<.001

B. Variance Analysis of the pretest and post-test in learning attitude and academic achievement

From Table 3, the t value of the pretest and post-test in the learning attitude of control group appeared 1.342(p>.05), not reaching significance, while the t value of the pretest and post-test in the academic achievement revealed 9.073(p<.05), reaching

From Table IV, the t value of the pretest and post-test in the learning attitude of control group appeared 1.342(p>.05), not reaching significance, while the *t* value of the pretest and post-test in the academic significance. On the other hand, the t value of the pretest and post-test in learning attitude and academic achievement of experimental group showed 6.701(p<.05) and 16.370 (p<.05), respectively, reaching significance. It presented no difference in the learning attitude of control group after the experimental instruction, but appeared differences in the academic achievement. However, the learning attitude and academic achievement of the students with this experimental instruction presented remarkable differences.

V. CONCLUSION AND DISCUSSION

A. E-learning of photonics technology and daily livings could enhance the learning attitude

Kuo & Lee [23] pointed out learning attitude being the key in favorable academic achievement. The digital materials of photonics technology and daily livings aimed to assist students in solving the learning difficulties in photonics so that students achieved significant differences after e-learning. Traditional instructions focus on presenting single code on textbooks that it is rather dull and could easily result in the lack of learning interest and positive learning attitude. E-learning offers the contents of cooperation, interaction, network system, and multimedia as well as a learning environment that learners are promoted the problem-solving and thinking capabilities and enhanced the positive attitudes[24]. Simonson, Smaldino, Albright & Zvacek [25] regarded attitude, experience, recognition, and learning style as the indices in the process of e-learning, which could affect individual learning and orientation of perception and fight-for-flight reaction. Apparently, e-learning not only could affect learning attitude through different instructional models, but could acquire better learning effects through the experiences in the e-learning environment [26].

B. E-learning of photonics technology and daily livings could increase academic achievement

Cognitive psychology claims that learning contains the applications of memory, motivation, abstraction, metacognition, and thinking; cognitivism regards learning as an internal process in which learners would apply various types of memory. Nonetheless, traditional instructions focus on paper-contents that students absorb and understand the descriptive knowledge from textbooks. With the lack of real pictures or videos, students cannot definitely and powerfully establish the connection with knowledge, as people acquire internal messages through senses that the capacity of short-term memory is limit. When the received messages could be properly analyzed, the learned knowledge is likely to be implanted in the long-term memory [27]. Furthermore, e-learning could predict the sustainability of students that learning interest, environment, peer effect, and learning attitude are considered as the key factors in e-learning [28].

C. E-learning of photonics technology and daily livings could promote academic achievement and learning attitude

Tung, Lin & Tan [29] designed web-based materials for students to interact with computers in which teachers played the role of guiding and assisting. With the prior knowledge and experiences, the learners were the center while the teacher was the assistant; students would discuss with peers or interact with the teacher. The research outcomes showed that virtuality-based instructions presented significant effects on the learning of synchrotron radiation; the scores of pretest and post-test were improved up to 26%; the scores of science could affect the learning of synchrotron radiation; and, 75% students were in favor of such instructions and considered it being helpful to understand the concept of synchrotron radiation. In terms of academic achievement, the instructional design assisted with information technology could enhance the positive attitude of learners and encourage the learning motivation so that it could rapidly and effectively assist learners in achieving the learning objectives [30].

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