THE EFFECTIVENESS OF E-LEARNING FOR BLENDED COURSES IN COLLEGES: A MULTI-LEVEL EMPIRICAL STUDY

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ABSTRACT

Teaching and learning are no longer restricted to traditional classrooms, while e-learning (electronic learning) has become one of the powerful supporting tools which have diversified the traditional context of learning in colleges. With the rapid development of technology, the Internet as a delivery platform has motivated colleges to invest their resources on developing online programs. Meanwhile, the blended course, which combines online components with the conventional face-to-face components, has emerged as alternative mode of teaching and learning and a substantial supplement. With opportunities and barriers as well, however, the development and management of e-learning are still challenging, especially for the continuous improvement of students' learning effectiveness via e-learning for blended courses. This paper applies the socio-technical systems theory to review and integrate theories on students' e-learning from a macro view. To make up the insufficiency of related research, literature review is conducted first, and an analysis model is constructed to thoroughly explore factors affecting e-learning effectiveness. Later, through a questionnaire survey on students' adoption of e-learning and subsequent multi-level data analysis, hypotheses on the relationship of the influencing factors and the research model are verified. Results show that e-learning effectiveness (usefulness of e-learning, use, and e-learning performance) is simultaneously or alternately affected by direct or moderating factors of the technical system and the social system at the learning environment level and the individual level. Compared with the existing research, this paper uses a more comprehensive system view to construct the theoretical model and empirically verify it. The results can be a reference for future researchers and managers of e-learning in colleges.

Keywords: e-Learning, Socio-technical System, Multi-level Analysis

1. INTRODUCTION

As e-learning is emerging as the new paradigm of modern education, the blended course, which combines online components with the conventional face-to-face components, has emerged as alternative mode of teaching and learning and a substantial supplement. E-learning has become one of the powerful supporting tools which have diversified the traditional context of learning in colleges. On one hand, e-learning is not confined to geographical barriers. Students can engage in self-directed learning, and learning resources can be repeatedly used. On the other hand, e-learning provides flexible learning materials and consistent information. The learning content is easy to update. With the rapid development of technology, the Internet as a delivery platform has motivated colleges to invest their resources on developing online programs.

Researchers from various fields have been trying to evaluate the effectiveness of e-learning. However, some of them are focused on technology-based components of e-learning system [17] and some are focused on human factor of e-learning system [27]. These individual assessment frameworks comply with the needs only partially. Students' e-learning system consists of many subsystems, such as personal factors, technical environment, and social environment. Without a multi-level analysis, it is not possible to grasp a comprehensive view of applications of e-learning in

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college/university from the system perspective. After reviewing literature associated with e-learning, Ozkan and Koseler [33] proposed that systematic and multi-level consideration of evaluation of e-learning systems is necessary and considering the social issues, the socio-technical systems approach adopted in Kontoghiorghes [25] should be employed.

Therefore, the objective of this paper is to answer and explain which learning environment factors and individual factors affect students' e-learning effectiveness. To answer the above-mentioned issue, we will follow the research procedure to answer the following questions: How to define students' e-learning effectiveness? What are the main factors that affect students' e-learning effectiveness? Of these factors, which are the factors at the college/university environment level? Which are the factors at the individual level? How do these factors affect students' e-learning?

Altogether, this study aims to: (1) apply the socio-technical systems theory to review and integrate theories about student e-learning from a macro view and construct the research framework of this study; (2) construct a multi-level analysis model and propose hypotheses, through literature review; (3) verify the theoretic model and relationship between research variables through multi-source and multi-stage questionnaire survey and multi-level analysis of the data; and (4) propose conclusions based on empirical evidence and explain factors affecting students' e-learning effectiveness and how to design and manage e-learning.

2. LITERATURE REVIEW

2.1 Students' e-Learning and Evaluation of Its Effectiveness

In terms of American Society of Training and Education [1], e-learning refers to the use of electronic devices for learning, including the delivery of content via electronic media such as internet, audio or video, satellite broadcast, interactive TV, CD-ROM, and so on. And the application of e-learning includes online learning, virtual classrooms and digital collaboration, etc.

Based on Newstrom's [31] procedural view as well as the summative and formative indexes of training effectiveness and the classical diffusion theory, we propose a three-level framework of students' e-learning effectiveness, as shown in Figure 1.

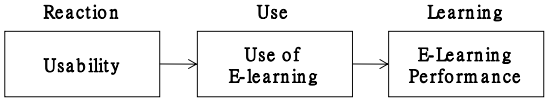

Figure 1: The three-level framework of students' e-learning effectiveness

Following the study of Kim [22], we use "usability" to estimate users' attitudes, encompassing users' perceived satisfaction, effectiveness, and efficiency towards the e-learning system. Hence, usability, the attitude toward e-learning system, can respond to the "reaction" level of Kirkpatrick's four-level theory of training evaluation, [23,24] the first level before learning, behaviors, and results. With similar idea introduced by the classical diffusion theory, users evaluate the advantages of a new technology, bringing positive attitude towards the system, before they continuously using the new technology.

In the classical diffusion theory, moreover, "use" is a main variable for effectiveness assessment of the introduction of new technologies and systems. The main difference between e-learning and traditional learning models lies in application of digital technologies. Researchers of students' e-learning adopt the view of technology use and consider the uniqueness of technology use in students' e-learning, suggesting that "use of e-learning" should be included in the e-learning framework. [10,11]. Students get a chance to learn from e-learning system after the system was used by students. Therefore, after the reaction level – usability, "use of e-learning" should be the formative key factor of the summative variable of e-learning effectiveness - e-learning performance, referring to knowledge and skills getting from learning through e-learning for the blended course.

2.2 Socio-technical Systems and a Multi-level Theoretic Framework

Falconer [12] points out that organizational learning involves multiple levels of an organization. In an integrative review of literature associated with e-learning effectiveness, researchers have proposed that a systematic and multi-level consideration of students' e-learning effectiveness is necessary [7,33] and the socio-technical systems approach adopted by Kontoghiorghes [25] should be employed. In this paper, we apply the socio-technical systems approach to review and integrate factors affecting students' e-learning effectiveness from a macro view and construct a multi-level analysis model. The socio-technical system consists of two interdependent subsystems, namely the social system and the technical system. The social system encompasses organizational culture, interpersonal relations, values, beliefs, motivations, interactive patterns, learning, and adaptability to changes. The technical system encompasses mechanical facilities, technical methods, and professional knowledge. [30,35,47]

However, in a multi-level framework, how do the technical system and the social system influence students' e-learning effectiveness? Salmon [42] discusses e-learning in a book titled *e-Moderating*,

emphasizing that digital technology is an important "moderator" in learning activities, as it is a condition and an environment that can assist learners in learning activities. Besides, individual applications of technology are also influenced by effects of social relations that exist between people, such as the reward system and power structure [48]. Chu and Chu [7] point out that the extant empirical research on students' e-learning effectiveness does not fully support a positive relationship between e-learning and learning effectiveness. They argue that there may be moderators between e-learning and learning effectiveness, so further exploration of the moderators is necessary. Therefore, we employ the socio-technical systems view to construct a multi-level analysis framework, with a focus on the effects of each subsystem at the individual level–students' e-learning effectiveness.

3. CONCEPTUAL FRAMEWORK, HYPOTHESES, AND RESEARCH DESIGN

According to literature review, students' e-learning effectiveness can be divided into three levels, which are respectively dominated by three variables, including usability, use of e-learning and e-learning performance. We identify a set of key individual and learning-environment factors, which impacts these three dependent variables of e-learning effectiveness mainly based on theoretical streams. As shown in Figure 2, ease of use is referred to 'technology acceptance model (TAM)', while media richness is referred to the 'media richness theory'. They both follow the stream of the classical diffusion theory. Learning attitude, extrinsic motivation and learning climate are referred to 'social learning theory', and motivation theories. We also have verified the variables and relationships after interviews of students from different blended courses in colleges. Hypotheses are inferred and proposed in the following paragraphs.

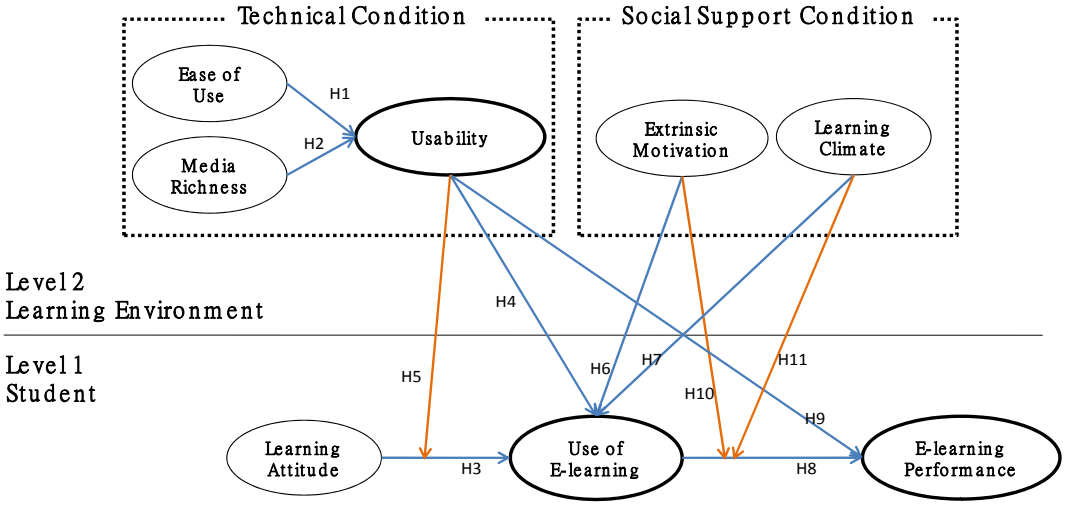

Figure 2: Conceptual framework

3.1 Usability of e-Learning

In terms of technology acceptance model (TAM) [10], perceived ease of use is the antecedent of perceived usefulness. This idea has been validated, especially in empirical study of e-learning [39,49]. And according to the media richness theory [9], media richness refers to using multiple and most appropriate digital media to present learning content. Therefore, we propose:

H1: Perceived ease of use positively influences usability of e-learning system.

Many studies of e-learning have revealed that application of a plurality of media [21] and interactive media [16] can draw learners' attention and effectively enhance their learning effectiveness. Studies of the Internet also point out that the rich information media embedded in websites can enhance satisfaction of website users (e.g., [38]).

Lee [26] indicated that media richness is important factor of e-learning. Hackman and Walker [14] also indicated that media richness contributes to increasing e-learning satisfaction after the empirical study of the use of television for teaching. Researchers, such as Chen et al. [4], Liu et al. [29] and Sun & Cheng [46], all indicates that media richness will affect learner's satisfaction and the assessment of e-learning system usability. Therefore, we propose:

H2: Media richness positively influences usability of e-learning system.

3.2 Use of e-Learning

In a learning environment, "motivation" refers to the incentive that propels students to be devoted to learning activities and intrinsic motivation is the critical success factor of e-learning. Ryan et al. [40] have developed the self-determination theory and proposed the subsequent research that motivation is a continuum of self-determination levels which reflect the perceived locus of causality. Motivations in the highest level are intrinsic motivations (enjoy doing it) and extrinsic motivations including autonomous motivation (worth doing) and controlled motivation (supposed to do it; must do it). Learning attitude stands for the behavior of one who likes the course he/she takes, and enjoys participating in the activities of this course. Therefore, for the blended course, good learning attitude may also turn into an intrinsic motivation, the enthusiasm, for using e-learning for participating in the activities of the course. In the study of e-learning, Saade et al. [41] indicated when students' intrinsic motivation is stronger, their willingness to use e-learning will be higher. Therefore, we propose:

H3: Learning attitude positively influences students' use of e-learning.

Besides, many empirical studies conducted on the basis of the classical diffusion theory have pointed out that users' positive attitude to a technical system can help to increase their intention to use the system. Ong et al. [32] and Chiu et al. [5] also discovered through a research of students' e-learning that increase of user satisfaction will positively influence students' intention to continue using the e-learning system. In this paper, the construct of usability of e-learning system encompasses students' perceived satisfaction, effectiveness, and efficiency, so we propose:

H4: Usability of e-learning system positively influences students' use of e-learning.

Information systems can help increase learning efficiency [15,19] and technical systems play the role of an "e-moderator" [42]. A useful e-learning system can provide a better system environment for learning, allowing students of better learning attitude, the intrinsic motivation, to learn in a good environment and meet the requirements for their blended course. Learning content can more effectively enhance students' intention to use e-learning when transferred by a better e-learning system. Hence, satisfaction of an e-learning system, better usability, can reinforce the "motivation to use" induced by better learning attitude, propelling students to have more intention to continue using e-learning. Based on the above discussion, the following hypothesis is proposed.

H5: Usability of e-learning system reinforces the positive influence of learning attitude on students' use of e-learning.

Both intrinsic and extrinsic motivation of learning is very important in students' engagement in the learning experiences. Extrinsic motivation can be defined as external factors that stimulate learners and these external factors can be behaviors of teachers, learning topics, learning-teaching strategies, teaching-learning process, interaction between the students and teachers and so on [44]. Extrinsic motivation is one way that encourages students to commit themselves to instructional goals to increase their achievement such as earning a grade or degree [43, 45]. Therefore for blended courses when teachers provide encouragement, praise, reward, and higher scores in grades for use e-learning, these extrinsic motivations will increase students' use of e-learning.

H6: Extrinsic motivation positively influences students' use of e-learning.

Learning climate is defined as the learning atmosphere among all students of the same course. A positive learning climate encourages and stimulates the exchange of ideas, opinion, information, and knowledge [37]. According to social learning theory, learners will imitate others' learning behaviors via observing their learning activities. The more students take part in e-learning activities for their blended course, will the more others in the same course be encouraged to join them. Prior research [36] shows that social interaction has a direct effect on the usage of an e-learning system, and the study of Chou and Liu [6] has indicated that learning climate is an important antecedent of using an e-learning system. Therefore, we propose:

H7: Learning climate positively influences students' use of e-learning.

3.3 e-Learning Performance

The main difference between e-learning and conventional learning models lies in application (usage) of digital technologies. Researchers of e-learning adopt the view of technology use and consider the uniqueness of technology use in e-learning, suggesting that "use" should be encompassed in the e-learning framework [10,11]. Transfer of teaching via e-learning system requires students to use e-learning in a self-directed manner; otherwise, the learning effectiveness can't be achieved. The more students using e-learning, the more they may get from this alternative of learning activities. Therefore, we propose:

H8: Students' use of e-learning positively influences e-learning performance.

Usability encompasses users' perceived satisfaction, effectiveness, and efficiency towards the e-learning system, and in other words, the reaction

level of Kirkpatrick's four-level framework of training evaluation. [23,24] The research of training transfer indicates that trainee's "reaction" to training, i.e. satisfaction, affects training outcomes (e.g., [2]). Studies based on the theory of reasoned action (TRA) and TAM also have a similar argument that user's reaction to technology use affects user performance [10]. The empirical evidence in Johnson et al. [20] suggests that usability has positive effects on e-learning outcomes, including e-learning performance. Therefore, we propose:

H9: Usability of e-learning system positively influences students' e-learning performance.

Students' individual activities may be subject to the influence of the learning environment. Chu and Chu [7] indicated that previous studies haven't fully supported the positive relationship between e-learning and learning effectiveness. Besides, there may be important moderators between them, so further exploration is required. We argue that the social supports from learning environment, including "extrinsic motivation" and "learning climate" are influential.

In addition to students' use of e-learning, connecting goal settings and reward plans to e-learning performance can increase the instrumentality of e-learning and thus enhance the motivation for e-learners. Besides, extrinsic motivations provide learning utility, such as praises, rewards, identification, encouragement, and higher scores in grades, and can elevate the value of e-learning behaviors. Researchers of the cognitive evaluation theory argue that extrinsic motivation and intrinsic motivation have interaction effects on behaviors [3]. Thus, we propose following hypotheses:

H10: Extrinsic motivation reinforces the positive influence of students' use of e-learning on e-learning performance.

H11: Learning climate reinforces the positive influence of students' use of e-learning on e-learning performance.

3.4 Participants, Procedures, and Measures

To verify the proposed hypotheses and the overall model, we invited 32 classes of undergraduates in National Taipei University in Taiwan. The questionnaire was collected in one month at the end of the second semester in 2009. After 43 responses with missing or incomplete answers were excluded, a total of 1227 valid students' responses from 32 classes were obtained.

All measures (with 3-4 items) of constructs were modified from measures of former empirical studies, developed according to previous empirical studies of good reliabilities (e.g. [28,34]) and modified on the basis of related theories. In this study, students' e-learning performance was measured by self-evaluation (questions for example, "I have made a breakthrough in understanding the learning subjects through e-learning."), which may distinguish e-learning performance from overall learning outcome they get from their blended course. Principal component analysis of exploratory factor analysis (EFA) was conducted to verify the construct validity of the questionnaire. Results shows the factors were as the constructs expected, and all of good factor loadings. Besides, according to the factor analysis results, all the constructs were tested for reliability, results showing all greater than 0.8 (0.834 - 0.932).

4. DATA ANALYSIS AND RESULTS

4.1 Aggregation Statistics

This research was designed to conduct a multi-level analysis. Because many variables were induced from data of many individuals, theoretically, there should be a certain degree of consistency or consensus between individuals. Therefore, consistency between individuals in the perception of a specific phenomenon is a key criterion that determines whether a group variable can be generated. Besides, variance of the variable should be tested by explaining the group variable and measuring the mean reliability at the group level. We conducted the test by measuring r_{wg} (within group agreement), intra-class correlation coefficient ($ICC_{(I)}$), and reliability at the group level ($ICC_{(II)}$). The results show that all the r_{wg} values (0.61 – 0.92) are greater than the 0.6 threshold suggested by James [18].

Table 1: The effects on usability

Dependent: Usability		
Independent	**Model A1**	**Model A2**
Ease of Use	0.886 ***	0.520 ***
Media Richness		0.469 ***
R^2	0.786	0.872
ΔR^2		0.086 ***
F	110.05 ***	98.91 ***

* p<0.05；** p<0.01；*** p<0.001

With Hierarchical Linear Modeling (HLM) analysis, estimated on the basis of the null model (Model B1 in Table 2), $ICCI_{(I)}$ of "use of e-learning" is 0.13; and estimated on the basis of the null model (Model C1 in Table 3), $ICC_{(I)}$ of "e-learning performance" is 0.14. Both $ICC_{(I)}$ values are greater than the 0.059 standard proposed by Cohen [8]. Besides, both of the $ICC_{(II)}$ values (0.802 for use of e-learning; 0.812 for e-learning performance) are greater than the 0.6 standard proposed by Glick [13].

4.2. Hypotheses Testing Results

Results for usability. For small sample size of the group level in this study, we apply the significance level of p-value = 0.1. H1 and H2 predict that perceived ease of use and media richness will be associated with the usability of e-learning system. The result of Model A2 in Table 1 presents ease of use (β=0.520, p<0.001) and media richness (β=0.469, p<0.001) are significantly related to usability of e-learning, providing support to H1 and H2. Therefore, both perceived ease of use and media richness influences the usability of students' e-learning for blended courses in colleges.

Results for use of e-learning. To test H3 to H7, we estimated HLM models in which students' learning attitude was the level 1 (student level) predictor (Model B3 in Table 2), after computer self efficacy been controlled, Model B2, and then regressed the intercept coefficients obtained from level 1 on the measures of learning-environment-level usability of e-learning, learning climate, and extrinsic motivation in class at level 2 (Model B4). Meanwhile, we estimated the cross-level reinforcing effect from usability of e-learning system to the relationship between students' learning attitude and their use of e-learning (Model B5). As Model B5 reported in Table 2, students' learning attitude and their use of e-learning has a significantly positive relationship ($\hat{\gamma}$ =0.364, p<0.001), which is also moderated (reinforced) by the usability of e-learning system (cross-level effect, $\hat{\gamma}$ =0.356, p<0.01). Usability also has a directly positive relationship ($\hat{\gamma}$ =0.522, p<0.001) with students' use of e-learning, as well as extrinsic motivation ($\hat{\gamma}$ =0.308, p<0.1) from level 2. Students' use of e-learning for blended courses is positively influenced by students' learning attitude, the usability of e-learning system, and the extrinsic motivation in class. Besides, with better usability of e-learning system, students of better learning attitude will more likely use e-learning for blended course. However, learning climate is not significantly related to use of e-learning. Therefore, the results support H3 to H6, but do not support H7.

Results for e-learning performance. With HLM models, we followed a similar procedure in testing H8 to H11. H8 and H9 predict that students' use of e-learning (level 1) and the usability of e-learning system (level 2) will be associated with students' e-learning performance, while H10 and H11 predict that extrinsic motivation and learning climate in class will reinforce the influence from students' use of e-learning to their e-learning performance. As Model C5 shown in Table 3, the results reveal that both students' use of e-learning ($\hat{\gamma}$ =0.380, p<0.001) and the usability of e-learning system ($\hat{\gamma}$ =0.898, p<0.001) are positively related to students' e-learning performance. Moreover, the cross-level interactions of extrinsic motivation ($\hat{\gamma}$ =0.114, p<0.05) and learning climate ($\hat{\gamma}$ =0.170, p<0.1) in class are both significant, showing that both of these two learning-environment variables reinforce the relationship between students' use and their final performance of e-learning. Hence, H8 to H11 are supported.

Table 2: The effects on use of e-learning

	Dependent: Use of E-learning				
Independent	**Model B1 Null Model**	**Model B2 Control**	**Model B3 Students**	**Model B4 Environment**	**Model B5 Interaction Effects**
Level 1					
(Constent)	3.116 ***	3.107 ***	3.099 ***	3.117 ***	3.103 ***
Computer Self Efficacy		0.246 ***	0.143 **	0.137 **	0.135 **
Learning attitude			0.347 ***	0.333 ***	0.364 ***
Level 2					
Usability				0.583 ***	0.522 ***
Learning Climate				0.165	0.168
Extrinsic Motivation				0.293 †	0.308 †
Cross-Level					
Learning Attitude × Usability					0.356 **
Between-Group Residual Variance	0.118 ***	0.096 ***	0.078 ***	0.037 ***	0.035 ***
Within-Group Residual Variance	0.746	0.714	0.673	0.672	0.667
$\mathbf{R^2_{within\text{-}group}}$			0.100		
$\mathbf{R^2_{between\text{-}group}}$				0.686	0.703
Model Deviance	3182.96	3127.37	3056.63	3039.44	3034.81

† P<0.1; * P<0.05; ** P<0.01; *** P<0.001

Table 3: The effects on e-learning performance

Independent	Dependent: E-learning Performance				
	Model C1 Null Model	Model C2 Control	Model C3 Students	Model C4 Environment	Model C5 Interaction Effects
Level 1					
(Constent)	3.471 ***	3.464 ***	3.440 ***	2.013 ***	3.489 ***
Computer Self Efficacy		0.183 ***	0.091 **	0.089 **	0.085 ***
Use of E-learning			0.377 ***	0.359 ***	0.380 ***
Level 2					
Usability				0.632 ***	0.898 ***
Cross-Level					
Use of E-learning × Learning Climate					0.114 *
Use of E-learning × Extrinsic Motivation					0.170 †
Between-Group Residual Variance	0.075 ***	0.064 ***	0.037 ***	0.006 *	0.002 *
Within-Group Residual Variance	0.455	0.436	0.338	0.338	0.335
$R^2_{within\text{-}group}$			0.257		
$R^2_{between\text{-}group}$				0.920	0.973
Model Deviance	2577.76	2528.09	2213.91	2184.57	2160.10

† P<0.1; * P<0.05; ** P<0.01; *** P<0.001

4.3. Discussion

Among all hypotheses, H7 is not supported by the result of HLM analysis. That means learning climate, referring to learning condition of students in a class as a whole, doesn't seem directly to impact students' use of e-learning. For particularity of e-learning, "autonomy and independence" exist in most circumstances when students use e-learning, while far away from the class, and also their classmates. This may explain why the influence of learning climate is not significant to students' use of e-learning.

5. CONCLUSION AND SUGGESTIONS

Responding to social-technical system theory, factors of technical system and social support system simultaneously or alternately affect effectiveness of students' e-learning. This stands for the viewpoints of existing social-technical studies (e.g. [25,33]). Here in this study, we have illustrated usability of e-learning and its antecedents, ease of use and media richness, are essential factors of the technical system; while extrinsic motivation and learning climate are important factors of the social system. These factors directly impact or moderate the influence to students' use of e-learning and their e-learning performance. Therefore, managers of e-learning in universities need to take both technical factors and social factors into account while trying to develop and improve students' e-learning performance.

Usability of an e-learning system is an important determination of students' use of e-learning and the performance. A well-designed e-learning system can not only enhance students' intention to use the system but also help them obtain learning effectiveness. This finding is consistent with conclusions of many studies on technology use and e-learning. However, through a multi-level research framework, we explore the moderating role of technology at the learning environment level. The finding indicates that students' use of e-learning induced by the learning attitude can amplify the effects of a good e-learning system. Our empirical evidence also supports Salmon's [42] argument about the moderator of e-learning in *e-Moderating*.

Ease of use and media richness of e-learning are key indicators in students' evaluation for the usability of an e-learning system. "What kind of e-learning system is a satisfactory learning system?" is a focal issue in many existing studies. Through literature review, we induced the development process of this research domain. In early years, the research of e-learning technologies was focused on system quality and service quality of the supporting systems. Later, researchers began to shift their focus onto information quality, i.e. quality of e-learning materials. In recent years, compared with the system aspect, researchers paid more attention to the content aspect, i.e. sufficiency, richness, and presentation of the learning content. Therefore, many recent

researchers have employed the media richness theory proposed by Daft and Lengel [9] to propose the importance of content richness and use of multimedia in e-learning. Findings in our study also support this viewpoint.

The better learning attitude, the students are more earnest in use of e-learning, especially with an e-learning system of better usability. Taking e-learning as an alternative to get knowledge, intrinsic motivation of students devoted to learning activities is the critical success factor of e-learning. This finding also stands for the study of Saade et al. [41] which indicated when students' intrinsic motivation is stronger, their willingness to use e-learning will be higher. Meanwhile, to meet the demand for higher learning efficiency, a useful e-learning system can provide a better system environment for learning, allowing students with intrinsic motivations of learning to learn in a good environment.

Extrinsic motivation encourages students to use e-learning, and provides incentive to learn better on e-learning as well. Extrinsic motivations, including encouragement, praise, reward, and higher scores in grades, serve as an effective "situational" factor (strong instrumentality of the expectancy theory) that not only modifies students' behavior to use e-learning, but also enhances students' learning motivation to learn well.

Learning climate does not directly impact students' use of e-learning, but provides advantageous environment for students to improve e-learning performance. Many studies of learning theories have pointed out that "learning climate" in a class affects students' behaviors inconspicuously. From the learning perspective, the social learning theory also provides a foundation for this argument. Compared to other direct factors in the current study, such as usability, extrinsic motivation, and learning attitude, learning climate is not significantly directly influence students' behavior of using e-learning, but it still builds social motivation for those of using e-learning to learn more.

A "useful" e-learning system should be defined by users. Managers of e-learning in universities may collect responds from both students and lecturers regularly, to modify the system for meeting the need of various classes. Moreover, to improve effectiveness of e-learning in universities is not only a technical issue. The lecturers, who may provide extrinsic motivation and developing a learning climate in their classes, play an indispensable role for students to use e-learning constantly and earnestly.

Limitations and Future Research. Due to the constraint of research needs, a non-random sampling method and self-report survey were adopted. As a result, there was limitation on generalization of the theories. Moreover, drawing on existing research, for the present study we identified a set of key individual and contextual correlates of students' e-learning effectiveness for blended courses after interviews of college students. But, there are likely to be other factors that have impacts. For example, value, adaptability to changes related to social system, and facilities and professional knowledge related to technical system are additional factors to be considered in the future. However, compared with the existing research, this paper uses a more comprehensive system view to construct the theoretical model and empirically verify it. The results can be a reference for future researchers and managers of e-learning in colleges.

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大學混成課程之數位學習成效：跨層次實證研究

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摘要

當數位學習成為大學傳統教學外多元的強大工具，教與學就不再侷限在傳統教室內了。隨著科技的發展並以網際網路為傳遞平台，大學校院願意投資資源在發展線上課程，同時，結合持續性支持系統之線上內容與傳統面對面課堂內容的混成課程，已快速成長為教與學的新選擇。然而，數位學習的發展與管理仍具挑戰，是機會但也有阻礙，特別是針對透過數位學習進行混成課程之學生的學習成效。本研究以宏觀角度，應用社會技術系統理論，探討並整合學生數位學習的相關理論。為補充相關研究之不足，首先透過文獻探討瞭解影響數位學習成效之前因，以建立分析模式；接著，透過已使用數位學習之學生問卷調查並進行跨層次分析，驗證影響因素間關係的假說及研究模式。結果顯示數位學習成效（數位學習易用性、使用，及數位學習績效）交替或同時受到來自學習環境層次與個人層次中，技術系統與社會系統的直接或干擾因素的影響。比較現有研究，本文運用廣泛的系統觀點建構理論模式並以實證檢驗，研究結果可供未來研究者及大學數位學習管理者參考。

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