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Abstract
This study makes an attempt to extend technology acceptance model (TAM) and presents a respecified conceptual model to examine the factors associated with college students' use of asynchronous e-learning systems. A web-based learning platform was employed to assist the learning of an undergraduate-level course, management information systems (MIS), in a well-known institute of technology in the southern part of Taiwan. A cross-sectional survey was conducted. The partial least squares method was applied to validate the reliability and validity of the measurement model and assess the proposed conceptual model in this study. The empirical results indicated that college students showed great readiness and positive intentions towards the use of such e-learning system for the professional courses and suggested potential benefits from its use in the long term. The findings of this study not only can proffer practical implications for on-line professional course learning and teaching in business education, but also may serve as instrumental guidelines for e-learning system to be designed effectively to improve students' interests and motivations in virtual learning environments.

Keywords: e-learning, theory of reasoned action (TRA), technology acceptance model (TAM)

Introduction

Today, the use of the Internet and Web technologies as an instructional tool has been regarded as an alternative education form which provides a solution for current instructional problems and creates an innovative education environment. Miscellaneous e-learning systems are becoming remarkable channels for distributing and delivering education resources. The e-learning environments that have grown and expanded dramatically as new technologies have expanded the possibilities for communication, interaction, and multimedia handling. Various types of e-learning systems have been developed recently; these systems integrate a variety of functions to facilitate the learning activities.

With e-learning systems, instructional delivery and communication between instructors and students can be performed synchronously or asynchronously. Such systems provide a variety of instructional aids and communication methods, and offer learners or instructors great flexibility as to the time and place of instruction. As a result, these e-learning systems may

better accommodate the needs of learners or instructors who are geographically dispersed and have conflicting schedules (Strambi and Bouvet, 2003). Even though the Internet is becoming a new medium for learning material delivering and skills/knowledge learning, the mechanisms of e-learning applications are not completely understood, and the relative theoretical backgrounds are also not well established. The underdevelopment in this area necessitates researchers in several disciplines to join together to clarify what factors actually influence students' intention to use e-learning systems and what is the influence level of each factor on students' perceptions in such a virtual learning environment.

As the wide spread of e-learning courses continues to influence students all over the world, it is critical to understand the factors to improve teachers' instruction and students' learning. Moreover, the integration of Internet technology with online learning has shifted the focus from a teacher-centred classroom toward a learner-centred environment which empowers the learners with the control over the course contents and the learning process (Fotos and Browne, 2004). In this regard, students' perceptions on the use of e-learning systems need to be carefully examined. This study contributes to the literature by identifying what factors affect students' propensities and deliberately constructing a comprehensive conceptual framework to validate the influence level of each factor on students' behavioral intentions to use an e-learning platform.

Theoretical Development
The Characteristics of E-learning Environments
The e-learning environments apply web-based technology in education has created a valuable learning environment and has impressed students and teachers. In such a virtual environment, e-learning systems can provide interactivity, flexibility and repetitive exposure to enhance learning efficiency considerably. These systems can be used to integrate instructional materials, e-mails, live chat sessions, online discussions, forums, quizzes and assignments. One of the main advances brought by the integration of technology into various sorts of learning curricula is the increased interaction. As for students' learning in web-based settings, it is believed that the establishment of positive relationships between teachers and students plays an essential role in fostering students' positive perceptions of the learning environment as well as the creation of a positive online classroom atmosphere (Strambi and Bouvet, 2003). As well, the students who would voluntarily take e-learning courses usually have different needs concerning their learning situations and each of the students possesses different study pattern comparing students in the conventional classroom; therefore, a highly flexible environment would be necessary in order to accommodate the variety among students' needs and proficiency levels. Studies have suggested that building flexibility into learning environments can fully support students' various learning styles, interests, and skill levels, and consequently draw forth students' positive attitude towards learning.

In contrast to traditional classrooms, e-learning environments can provide much more learning resources and more opportunities for interactions in different ways, which complements learners' individual differences. E-learning allows learners and instructors to communicate, collaborate, and interact with each other regardless of their temporal or physical locations. Yang and Liu (2007) indicated both positive and negative aspects of the application of technology to e-learning environments. Among the positive aspects were that e-learning environments stretched the spatial and temporal barriers, provided greater flexibility and student convenience, more positive overall learning experience, and improved access/interaction with the instructor. While the negative aspects documented were reduction in face-to-face interaction, concerned about technology, and increased student workload and

costs. Faculty members have faced new challenges related to the increasing time spent on course presentation and interaction with students. With the above concerns and dissatisfaction with e-learning in prior studies, people have searched for another instructional delivery solutions. The e-learning has been discussed as a promising alternative.

Technology acceptance model and Theory of Reasoned Action

Technology acceptance model (TAM), proposed by Davis (1989), is derived from the Fishbein and Ajzen's Theory of Reasoned Action (TRA) and is developed to predict the individual's acceptance of information technology. TAM has been the most widely used model since its introduction in 1980s. The core theme of TRA is that an individual's behavior is determined by his/her attitude toward carrying out that behavior; furthermore, the attitude toward behavior is influenced by individual's beliefs about the possible outcomes resulted from performing the behavior and the evaluations of the value of the possible outcomes (Ajzen and Fishbein, 1980). Consistent with TRA, TAM posits that individuals' actual system use is determined by behavioral intentions, and the behavioral intentions are determined by attitudes toward using. Both perceived usefulness and perceived ease of use have direct effect on attitude toward using and the influence of other external variables on behavioral intentions is fully mediated by these two beliefs of usefulness and ease of use.

TAM, with the original idea of tracing the influence of external factors on internal beliefs, attitudes, and intentions, has been utilized as fundamental model for identifying cognitive as well as affective determinants with reference to the acceptance of using specific computer-based technology in diverse contexts (Davis, Bagozzi and Warshaw, 1992; Venkatech and Davis, 2000; Yi and Hwang, 2003; Ong, Lai and Wang, 2004; Ndubisi, 2006, Pituch and Lee, 2006). By and large, TAM has been empirically verified as a powerful and valuable instrument specifically designed for identifying determinants with regard to predicting the intentions of particular innovative technology usage. Although the original formulation of TAM included attitude as a construct mediating the effects of beliefs on intentions, subsequently attitude was dropped from the specification of TAM (Agarwal and Karahanna, 2000). The following plausible hypotheses were so proposed:

H1: Behavioral Intentions (BI) has a direct effect on Actual Use (AU) of e-learning systems.
H2: Perceived Usefulness (PU) has a direct effect on Behavioral Intentions (BI) to use e-learning systems.
H3a: Perceived Ease of Use (PEOU) has a direct effect on Behavioral Intentions (BI) to use e-learning systems.
H3b: Perceived Ease of Use (PEOU) has a direct effect on Perceived Usefulness (PU).

External variables

Perceived Enjoyment

In TAM related research, motivational variables have been identified to be important determinants and predicators on users' intentions toward system usage. Enjoyment, defined by Davis, Bagozzi, and Warshaw (1992) as "the extent to which the activity of using the computer is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated", was identified to be an important motivational variable in regard to usage intentions (Davis et al., 1992). Venkatesh (1999) argued that users who perceive training experience to be enjoyable are more likely to perceive the system to be useful. Yi and Hwang (2003) extended the technology acceptance model by incorporating motivation variables in order to predict the use of web-based information system and the results indicated that enjoyment has significant effect on usefulness. Concerning web-based

learning, according to a survey conducted by Taylor and Gitsaki (2004), students reported that the use of the Web had made the course more enjoyable which results in their willingness of continuing to use the Web as the learning tool to assist the learning process. Thus, the following hypotheses are proposed:

H4: Perceived Enjoyment (PE) has a direct effect on Perceived Usefulness (PU).

System Features
In TAM related research, system characteristics have been examined to be external variables towards users' acceptance of information technology through the mediation of perceived usefulness. Davis (1993) suggested that system features can be fully mediated by TAM model on systems use behavior. Igabaria Guimaraes, and Davis (1995) confirmed in their study the effects of system features on perceived usefulness. Based on the prior research, the following hypotheses are proposed:

H5: System features (SF) of e-learning systems have a direct effect on Perceived Usefulness (PU).

Characteristics of teaching materials
Media richness theory (Daft and Lengel, 1986) can serve as a sound base for grounding effects of characteristics of teaching materials in an e-learning system context. Richness theorists argued that for effective communication to occur, a medium must have a capacity that allows message senders and receivers to achieve shared meaning. Failing to use a medium with the requisite level of richness implies that message recipients may experience ambiguity as a result of multiple, conflicting interpretations of a message (Daft and Lengel, 1986; Timmerman and Kruepke, 2006). Related research suggested that web-based course experiences could be enhanced by using a variety of media with various degrees of richness (Arbaugh, 2005). In addition, incorporating both video and sound into educational environments enhances learning because learners are able to process audio and video images independently in his generative model of multimedia learning (Mayer, 1997). Concerning the technological characteristics of teaching materials in an e-learning system context, it makes logical sense to infer that the increased use of various sorts of media on course websites may greatly enhances students' perceived ease of use on the e-learning system course experience.

H6: Characteristics of teaching materials (CTM) of e-learning systems have a direct effect on Perceived Ease of Use (PEOU).

Self-efficacy
In the context of this study, self-efficacy is interpreted as learner's self-confidence in his or her ability to learn in the e-learning environments. Venkatesh and Davis (1996) presented a model of the antecedent of perceived ease of use and the finding indicated that computer self-efficacy has a significant impact on perceived ease of use. The study also suggested that, in order to increase the acceptance of new systems, there is a necessity of devoting training efforts to effectively manipulate efficacy. Venkatesh (2000) conducted three longitudinal field studies to test the model of determinants of perceived ease of use and found that computer self-efficacy serves as one of the key anchors for an individual to form system-specific perceived ease of use. Based on the previous studies, the following hypothesis is proposed:

H7: Self-Efficacy (SE) has a direct effect on Perceived Ease of Use (PEOU).

The conceptual framework
Drawing on the above discussions, this study proposed a comprehensive model and developed an instrument for measuring students' intentions to use this system. As can be seen from Figure 1, the conceptual framework hypothesizes that perceived enjoyment (PE) and e-learning systems characteristics (SC) are underlying determinants of perceived usefulness (PU); characteristics of teaching materials (CTM) and self-efficacy (SE) are the underlying determinants of perceived ease of use (PEOU) of e-learning systems; the constructs, PU and PEOU, influence students' behavioral intentions to use the technology, while behavioral intentions, in turn, influence actual use of the system. The core theme is then structured as that PU and PEOU have indirect effects on actual use of IT through the mediation of individual's behavioral intentions and other external variables including, PE, SC, CTM, and SE on behavioral intentions is fully mediated by the two constructs of beliefs (PU and PEOU) on the behavioral intentions to use e-learning systems. Because TAM is used as the baseline model of this study, the hypothesized relationships in TAM will be verified in the context of e-learning systems.
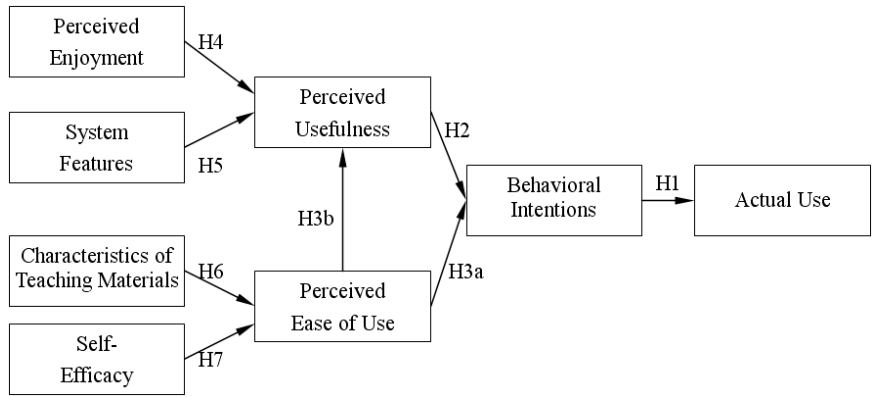

Figure 1: The conceptual framework

Research Methodology
A cross-sectional field survey was conducted with data collected from a technical-vocational college in Taiwan. The empirical stage of this study began with developing the relative constructs of students' intentions to use the e-learning system and generated the relative measures as broad as possible. Then, an iterative interview process was applied for scales refinement. Next, the partial least squares (PLS) method, a component-based structural equation modeling technique, was employed to structure and to validate the casual relationships between the underlying determinants (perceived enjoyment, system features, characteristics of teaching materials, and self-efficacy), belief (perceive usefulness, and perceived ease of use), the behavioral intentions to use the e-learning systems, and actual use of the systems. By considering the tangible expected outcomes of their perceptions and intentions, we expect to be able to assess the nomological and predictive validities of psychometric properties of these latent variables.

Instrument Development

To develop the instrument, a number of prior relevant studies were reviewed to ensure that a comprehensive list of measures was included. All measures for each construct were taken from the previously validated instruments and modified. For instance, those for perceived usefulness, perceived ease of use, behavioral intentions to use and actual use were adapted in our model from previous studies on TAM. The construct of system features was derived from the study of Davis et al. (1992). The measures for perceived enjoyment were captured using three items derived from Yi and Hwang (2003). The construct of characteristics of teaching materials was derived from our underlying conceptualization regarding the research framework. The scales for self-efficacy were based on the prior work of Venkatesh (2000). The survey questionnaire consisted of two parts. The first recorded the subject's demographic information. The second recorded the subject's perception of each variable in the model proposed in this study. The demographic variables assessed were gender, age, major, experiences of learning, and web usage. The second section asked each subject to indicate his or her degree of agreement with each item. Data were collected using a 7-point scales with the anchors 1 means strongly disagree; 4 is for neutral; and 7 indicate strongly agree, respectively.

As mentioned previously, the initial measurement item list of relative constructs in questionnaire was generated; an iterative personal interview process (including faculties, teaching assistants, and representative students) was conducted to refine the instrument. These interviews enabled the researchers to gauge the clarity of the items presented in the survey instrument, to assess whether the instrument was capturing the desired phenomena, and to verify that important aspects had not been omitted. Changes were made and several iterations were conducted; the process was continued until no further modification was needed. Feedback was served as a basis for correcting, refining and enhancing the experimental scales. Some scales were eliminated, because they were found to represent essentially the same aspects as others with only slight wording differences. Some scales were modified because the semantics appeared ambiguous or irrelevant to the perceived acceptance of the e-learning system of interest.

Sample characteristics

The empirical data were collected using a large scale survey administered in a well-known institute of technology located in the southern part of Taiwan. The subjects for this study were students who have ever taken the MIS course and had the experience to use the asynchronous e-learning platform. This MIS course is a compulsory course for all students in the night college of the business school at this institute. The course is required as part of their undergraduate bachelors degree. Students taking the course are of different majors including management information systems, business administration, information technology, healthcare management, and biotechnology. The data was gathered by means of a self-administered questionnaire. All students who have ever enrolled in this course were coded and randomly selected from the administration affairs system of this institute. The randomly selected students were self-administered the 25-item questionnaire after the final examination to ensure that all subjects have actually used the e-learning systems. For each question, respondents were asked to circle the response which best described their level of agreement. Finally, a total of 252 questionnaires out of the 398 distributed were collected, giving response rate of 63.32 percent. Thirty-eight participants gave incomplete answers and their results were dropped from the study. This left 214 sets of data for statistical analysis, a 53.8 % valid return rate. The profile of respondents is shown as in the following Table 1.

Results

The empirical data collected were analyzed using the partial least squares (PLS) method which is particularly suitable for a model with formative indicators for latent variables (Chin, 1998). First, the measurement model is assessed, in which construct validity and reliability of the measures are assessed. Second, the structural model with hypotheses is tested. The statistical analysis strategy involved a two-phase approach in which the psychometric properties of all scales were first assessed through confirmatory factor analysis (CFA) and the structural relationships were then validated by the bootstrap analysis.

Table 1: The profile of respondents

Variable	Classification	Freq.	%	Variable	Classification	Freq.	%
Gender	Male	86	40%	Learning Condition	Part time	150	70%
	Female	128	60%		Full time	64	30%
Major	MIS	60	28%	Experience of Web usage	Less than 1 Yrs	27	13%
	Business Mgmt.	65	30%		1 to3 Yrs	57	27%
	IT	38	18%		3 to 6 Yrs	88	41%
	Healthcare Mgmt.	32	15%		6 to 10 Yrs	37	17%
	Biotechnology	19	9%		More than 10 Yrs	5	2%

Measurement assessment

The analysis of measurement model is performed in relation to the attributes of individual item reliability, construct reliability, average variance extracted (AVE), and discriminant validity of the indicators as measures of latent variables. The assessment of item loadings, reliability, convergent validity, and discriminant validity is performed for the latent constructs through a confirmatory factor analysis (CFA). All of the items developed and operationalized definitions of constructs are based on the review of refereed theories, relative literature and researches in related field. The alpha-coefficients were used to represent for each of the constructs in the model proposed (Hair, Anderson, Tatham and Black, 1998) In order to assure the confirmatory nature in the study, validity and reliability of the scales should be confirmed adequately. As shown in the following Table 2, all items have significant factor loadings above .707 as suggested by Hair et al. (1998) in order to achieve the desired 50% of explained variance.

Table 2: Results of Confirmatory Factor Analysis

Construct	Item	Loading	Construct	Item	Loading
Perceived Enjoyment (PE)	PE1	0.95	Perceived Usefulness (PU)	PU1	0.87
	PE2	0.95		PU2	0.91
	PE3	0.94		PU3	0.89
System Feature (SF)	SC1	0.83		PU4	0.89
	SC2	0.88	Perceived Ease of Use (PEOU)	PEOU1	0.81
	SC3	0.87		PEOU2	0.86
	SC4	0.88		PEOU3	0.85
Characteristics of teaching materials (CTM)	CTM1	0.91		PEOU4	0.87
	CTM2	0.92		PEOU5	0.87
	CTM3	0.87	Behavioral Intentions (BI)	BI1	0.96
Self-efficacy (SE)	SE1	0.92		BI2	0.95
	SE2	0.90	Actual Use (AU)	AU1	1.00
	SE3	0.88			

All constructs in the model exhibit good internal consistency as evidenced by their composite reliability scores. The composite reliability coefficients of all constructs in the proposed conceptual framework (Figure 2) are adequate, ranging from 0.92 for the construct of system characteristics to 0.96 for perceived enjoyment. To assess discriminant validity (Chin, 1998), (1) indicators should load more strongly on their corresponding construct than on other constructs in the model and (2) the square root of the average variance extracted (AVE) should be larger than the inter-construct correlations. The percent of variance captured by a construct is given by its average variance extracted (AVE). To show discriminant validity, each construct square root of the AVE has to be larger than its correlation with other factors. As the results shown in the following Table 3, all constructs meet this requirement. Finally, the values for reliability are all above the suggested minimum of 0.7 (Hair et al., 1998). Thus, all constructs display adequate reliability and discriminant validity. All constructs share more variance with their indicators than with other constructs. Thus, the convergent and discriminant validity of all constructs in the proposed conceptual framework can be firmly assured.

Table 3: Inter-correlations among factors

Construct	# of Item	PU	PEOU	BI	PE	CTM	SC	SE	AU	Composite Reliability
PU	4	0.89*								0.94
PEOU	5	0.57	0.85							0.93
BI	2	0.61	0.61	0.96						0.95
PE	3	0.68	0.57	0.78	0.95					0.96
CTM	3	0.60	0.68	0.64	0.65	0.90				0.93
SC	4	0.63	0.60	0.62	0.65	0.86	0.87			0.92
SE	3	0.54	0.76	0.60	0.62	0.63	0.62	0.90		0.93
AU	1	0.62	0.63	0.89	0.77	0.67	0.63	0.64	1.00	1.00

*Diagonal elements are the square roots of AVE.

Test of the Structural Model

The structural model is evaluated to confirm to what extent the causal relationships specified by the proposed model are consistent with the available data. PLS was again used to assess the individual-level structural model. The predictive validity of a PLS model can be

determined by examining the R^2 values of the endogenous constructs (Hulland, 1999). The path coefficients and explained variances for the proposed model in this study are shown in Figure 2.
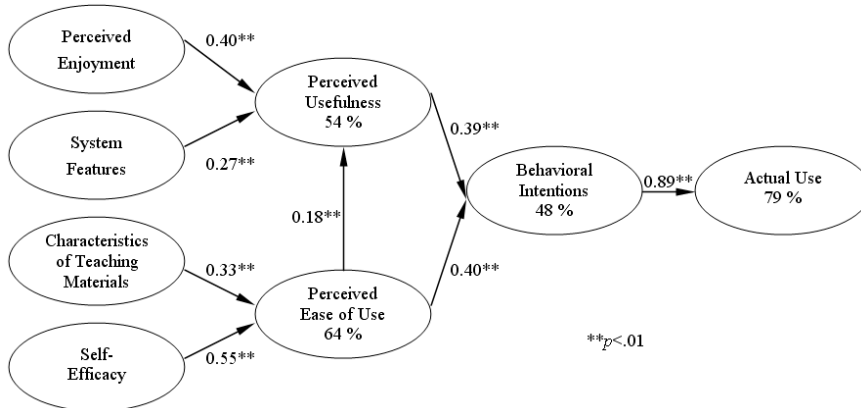

Figure 2: PLS Results

Factor loadings of indicators of all constructs can be read between the lines as loadings in a principal components factor analysis. T-statistics and standard errors were generated by applying the bootstrapping procedure. All of the constructs in this study were modeled as reflective and most of the constructs in the model were measured using multiple indicators, rather than summated scales. Behavioral intentions accounts for 79.1% of the variance in actual use and is also contributed by perceived usefulness and perceived ease of use with the explained variance of 47.6%. Perceived enjoyment and system characteristics together explain 54.1% of the variance in perceived usefulness, while characteristics of teaching materials and self-efficacy explain 63.8% of the variance in perceived ease of use.

An F test is applied to test the significance of the effect size for the model as it explains all dependant variables are significant (p =.000). Therefore, overall, the model has strong explanatory power for the construct of "Actual Use" of e-learning systems. The significant path coefficients, the effect size, and the value of the R^2 all provide supports for the proposed conceptual framework. As can be seen from Figure 2, PLS results provide good supports for the Hypotheses H1, H2, H3a, and H3b effectively drawn from the measurement of the TAM. This finding is consistent with that obtained by Davis, Bagozzi and Warshaw (1989). Hypotheses H4, H5, H6, and H7 are also firmly supported by the significant path coefficients. That is the underlying determinants, PE, SC, CTM, and SE would apparently influence students' perceptions on the usefulness and ease of use of the e-learning systems. System developers might have to collaborate with instructors to design and implement an e-learning system with good interaction, flexibility, friendly interface, and a joyful learning cyberspace to facilitate students' willingness to use e-learning systems. In addition, the results also suggest that university staffs (program directors and instructors) might then have to take more time and efforts to effectively cultivate students' self-confidence to use e-learning systems.

Conclusions
In order to build up a comprehensive theoretical foundation and to realize the mechanism for e-learning environments, it is critical for researchers around the world to underscore the

continuations of rigorous scientific approaches, educational theories, and well-targeted procedures and techniques in the e-learning research fields. This empirical study was motivated by a broad interest in understanding students' behavior intentions toward the use of e-learning systems. In addition, we also conducted a series of follow-up interviews with 10 subject matter experts including 7 instructors and 3 system developers to justify the results. Most of these experts indicated that the research findings regarding the actual use of this e-learning system can precisely reflect the real condition in the institute. Some of the interviewees, indeed, argued that the e-learning related education sectors should find effective ways to induce students' interests and motivate students to learn on their own initiatives. Six of them even suggested that universities and colleges should place efforts on providing diverse e-learning courses to satisfy students' diverse needs. They also asserted the importance of the innovativeness on the advancement of e-learning systems and course wares.

Before considering the implications, it is important to acknowledge the limitations of this study. First, the sample has a bias toward the data source gathered from the respondents in only one institute of technology, which may not represent the opinions in other colleges and universities in Taiwan. Second, the research was conducted in Taiwan, the findings in the study might not hold true in other countries. Thus, other samples from different areas or nations should be gathered to confirm and refine the factor structure of the instrument, and to assess its reliability and validity. Third, subjects in this study were voluntary and thus inevitably subject to self-selection biases. Conceivably, users who were interested in, had used, or were currently using e-learning were more likely to respond. Finally, the R-square reported by the current research represents another limitation: there may be a need to search for additional variables (e.g., personal innovativeness, gender difference, internet experience, level of education) to enhance the ability to predict actual use of e-learning systems more accurately.

Providentially, by applying the extended model as a theoretical framework, this study may help practitioners and researchers have better comprehensions on how college students will respond to e-learning, and increase user acceptance by improving the techniques and processes by which they are implemented. Also, it can help researchers considerate our findings for development and evaluation of e-learning theories. The major implications of this study are illustrated as the followings:

1. Our results demonstrate the constructs, *perceived enjoyment* and *system features*, significantly influence students' perceptions on the *usefulness* and the constructs, *characteristics of teaching materials* and *self-efficacy*, affect students' perceptions on the *ease of use* of e-learning systems. *Perceived enjoyment* and *self-efficacy* have the most significant direct effects on *perceived usefulness* and *perceived ease of use* on e-learning. Correspondingly they must provide joyful contents and effectively designed and implemented the e-learning systems with care to avoid the risk to attenuate students' interests and activation.

2. Perceived ease of use was found to be another important antecedent of perceived usefulness. User-friendliness is also important for the success of e-learning and will increase students' perceptions on perceived usefulness.

3. TAM can be well extended to predict students' behavioral intentions and actual use in an e-learning context.

To sum up, this study aims to enrich our understanding of college students' behavioral intentions toward e-learning system usage. There is no doubt that the validation of a measure or a conceptual framework concerning the e-learning systems cannot be established only on the basis of this single study. Measure validation requires the assessment of the measurement properties over a variety of samples in similar and different contexts. The future research can place efforts on developing the instrument for measuring students' behavioral intentions to use synchronous or blended web-based learning systems in e-learning environments. Also, more attentions can be heading towards understanding the antecedents and consequents of other e-learning systems.

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