

Predictors of students' perceived course outcomes in e-learning using a Learning Management System

David Kwok

Republic Polytechnic, Singapore

This study examined the factors that influence students' perceived course outcomes in e-learning using the Learning Management System (LMS), and the extent to which the factors significantly predict course outcomes. A total of 255 polytechnic students completed an online questionnaire measuring their responses to 5 constructs (lecturer support, interaction with peers, perceived ease of use, perceived usefulness and course outcomes). Data analysis was conducted using structural equation modeling. Results showed that perceived usefulness and interaction with peers were significant predictors of course outcomes, whereas perceived ease of use and lecturer support did not. However, perceived ease of use had an indirect relationship with course outcomes through perceived usefulness. Lecturer support also had an indirect relationship with course outcome through interactions with peers. Overall, the four antecedent variables contributed to 77.0% of the total variance in course outcomes. Based on the study findings, implications for educators and researchers are discussed.

Keywords: Course outcomes; e-learning; Learning Management System

Introduction

Electronic learning (E-learning) is becoming prevalent in tertiary education, with many universities increasing their provision and higher number of students signing up for online learning (Liaw, 2008). The growth in e-learning is attributed to the inherent advantages in terms of manpower, cost, flexibility, and convenience (Ozkan and Koseler, 2009). As Sun, Tsai, Finger, Chen, and Yeh (2008) described, e-learning has 'liberated' interactions between learners and educators from the limitations of time and space through the asynchronous and synchronous learning possibilities.

The rapid development of information communication technologies (ICT) provides tools to expand and support e-learning in education (Findik Coskuncay & Ozkan, 2013). Higher educational institutions are now reviewing their teaching and learning strategies to adapt new e-learning technologies such as knowledge discovery system, e-collaboration tools, and enterprise information portal to help in achieving their pedagogical goals (Cigdem & Topcu, 2015). However, tapping on the e-learning benefits require an effective and efficient delivery mechanism or Learning Management Systems (LMS) to prepare, operate and manage the e-learning process (Kim & Lee, 2007).

The e-learning system can be viewed as having several human and non-human entities interacting together in a LMS environment to achieve the intended course outcomes (Eom, Wen, & Ashill, 2006). As enrolments in e-learning courses continue to increase in higher education, it is pertinent for educators to be aware of the factors that contribute to student success in e-learning. Despite the numerous studies on the various factors that predict successful e-learning (e.g. Johnson, Hornick, & Salas, 2008; Sun et al., 2008; Lee & Wong, 2013), few of these studies were conducted in the LMS environment.

There is also a plethora of studies that employed student achievement, perceived learning and student satisfaction independently to measure success in e-learning (e.g. Alshare, Freeze, Lane, & Wen, 2011; Eom, Wen, & Ashill, 2006; Lim, Morris, & Yoon, 2006). However, few studies have employed the combined measures of perceived learning and student satisfaction as course outcomes in evaluating successful e-learning. Thus, the major goal of this study is to investigate the factors contributing to the perceived course outcomes in e-learning, as measured by perceived learning and student satisfaction, in a LMS environment.

The remainder of the paper is organised as follows. First, I introduce the background of LMS and the relevant literature related to e-learning success. Second, I present the research model and hypotheses. Next, I describe the research methods and present the results. Finally, I discuss the implications of the findings, along with limitations of the study and future research agenda.

Review of Related Literature

Background of LMS

LMS can be broadly defined as an IT platform used by educators to administer, document, track, report and deliver curriculum to students (Naveh, Tubin, & Pliskin, 2010). While LMS varies in specific functionalities, Coates, James, and Baldwin (2005) described the LMS as an institutional-wide and internet-based systems that typically provides an array of pedagogical and course administrative tools of differing complexities and potentials. A variety of e-tools is typically found in LMS including discussion boards, forum, chat, online grading, online assessment, file sharing, management of assignments, syllabi, schedules, announcements and course plans (Findik Coskuncay & Ozkan, 2013). LMS can be implemented to strengthen e-learning programs that blend in-class teaching and online teaching within the learning process (Cigdem & Topcu, 2015).

Despite the increased adoption of LMS by higher educational institutions, there has not been a widespread change in pedagogical practices to take advantage of the functionalities afforded by the LMS (McGill & Klobas, 2009). Consistent with this observation, there is also very little understanding of how the LMS impacts teaching and learning (Coates, James, & Baldwin, 2005). In the recent survey conducted by Educause Center for Analysis and Research (ECAR) on higher education technology employing 75,000 students and 17,000 faculty from 151 tertiary institutions in USA, it was found that while majority of faculty and students valued the LMS as an enhancement to their teaching and learning, student satisfaction is highest for basic LMS features and lowest for advanced features to foster collaborations and engagement in learning (Dahlstrom, Brooks, & Bichsel, 2014). The study also indicated that one reason why the faculty was not taking advantages of the advanced LMS capabilities was because of no clear evidence to show that technology has a positive impact on student learning outcomes.

Despite the numerous studies on LMS that have been conducted in terms of its technology acceptance (De Smet, Bourgonjon, De Wever, Schellens, & Valcke, 2012; Sanchez & Hueros, 2010), and how the use of the LMS is related to teaching and learning (Liaw, 2008; Mijatovic, Cudanov, Jednak, & Kadijevich, 2013), little is known how the LMS could benefit learning and influence student success of e-learning in achieving course outcomes. The following section discusses the literature on e-learning success in a collaborative online learning environment using the LMS.

E-learning success research

There is a corpus of literature that focuses on the range of factors that influence the use and satisfaction of e-learning systems, and most of these studies were conducted in the context of online collaborative learning (e.g. Arbaugh & Benhunan-Fich, 2007; Kang & Im, 2005; Liaw & Huang, 2007; Marks, Sibley, & Arbugh, 2005). Swan (2001) examined the factors that affect student satisfaction and perceived learning in an asynchronous online learning and found that clarity of design, interaction with instructors, and active discussion among participants significantly influenced student satisfaction and perceived learning. Sun et al. (2008) found that learner computer anxiety, instructor attitude toward e-learning, e-learning course flexibility, e-learning course quality, perceived usefulness, perceived ease of use, and diversity in assessment are critical factors that affect learners' satisfaction. Arbaugh and Benbunan-Fich (2007) investigated the role of interactions in e-learning, and found that while collaborative environments were associated with higher levels of learner-learner and learner-system interaction, only learner-instructor and learner-system interactions were significantly associated with higher perceived learning.

Based on two studies conducted for a sample involving 2196 students using LMSs from 29 Austrian universities, it was found that course content that facilitated self-regulated learning led to higher student satisfaction (Paechter & Maier, 2010), and students' assessment of the instructors' e-learning expertise and their counselling and support to the students were the best predictors for student learning achievement and course satisfaction (Paechter, Maier, & Macher, 2010).

Lim, Morris, and Yoon (2006) suggested that course outcomes can be an index for evaluating the quality of an e-learning course. Course outcomes comprise of both cognitive (e.g. learning gains and perceived learning application) and affective (e.g. satisfaction) variables (Lim et al., 2006; Paechter, Maier, & Macher, 2010). User satisfaction is one of the most important factors in determining the success of a system implementation in Information System research (Delone & McLean, 1992). Previous research indicated that student satisfaction is an important outcome that influenced the students' decision to continue or drop-out of an e-learning course (Levy, 2007).

In this study, perceived course outcomes consisting of perceived learning and satisfaction will be employed as the dependent variable, while perceived usefulness, perceived ease of use, lecturer support, and interaction with peers are considered as independent variables. For the purpose of this study, e-learning contents and online learning activities were delivered using the LMS. Hence, the research questions are as follow:

1. What are the factors that significantly influence perceived course outcomes among polytechnic students?
2. To what extent do the factors predict the perceived course outcomes among polytechnic students?

Research Model and Hypotheses

Perceived Ease of Use

Perceived ease of use is "the degree to which a person believes that using a system would be free of effort" (Davis, 1989, p.320). In the case of e-learning system, perceived ease of use was found to directly influence perceived usefulness (e.g. Sanchez & Hueros, 2010; Sumark, Hericko, Pusnik, & Polancic, 2011; De Smet, Bourgonjon, Wever, Schellens, & Valcke, 2012; Lee, Hsieh & Chen, 2013). When learners perceived the e-learning to be easy to use, it is likely that they will be satisfied with the system (Sun et al., 2008; Teo & Wong, 2013). In another study, it was found that when learners perceived an e-learning system is easy to use, they tend to devote more time to learning the contents, thus leading to higher satisfaction (Lee, 2010). The following hypotheses were formulated:

H₁: Students' perceived ease of use will significantly influence their perceived usefulness of e-learning.

H₂: Students' perceived ease of use will significantly influence their perceived course outcomes in e-learning.

Perceived Usefulness

Perceived usefulness is defined by Davis (1989) as "the degree to which a person believes that using a particular system will enhance job performance" (p.320). An e-learning system is perceived to be useful if the learners believe that the system will help them acquire the desired knowledge and skills to perform well in their studies (Teo & Wong, 2013). Studies have found that perceived usefulness has a positive relationship with learners' satisfaction with the e-learning system (Sun et al, 2008; Teo & Wong, 2013). Therefore, it is hypothesised:

H₃: Students' perceived usefulness will significantly influence their perceived course outcomes in e-learning.

Lecturer Support

In e-learning, the lecturer plays a critical role as a facilitator in providing support to troubleshoot and resolve both hardware and software issues (Yuksel, 2009). When learners face problems with e-learning, timely assistance to resolve the problems would encourage the learners to continue with the learning, which include interacting with the peer students and lecturers. Past research had shown that lecturer's timely response to learners' needs and problems had significantly influence learners' satisfaction (Arbaugh, 2002; Thurmond, Wambach, Connors & Frey, 2002). Hence, the following hypotheses were proposed:

H₄: Students' perceived lecturer support will significantly influence their perceived ease of use of e-learning.

H₅: Students' perceived lecturer support will significantly influence their perceived interaction with peer students in e-learning.

H₆: Students' perceived lecturer support will significantly influence their perceived course outcomes in e-learning.

Interaction with Peers

In e-learning, interaction with peers allows learners to share information, receive feedback and evaluate their own learning progress (Piccoli, Ahmad, & Ives, 2001). For instance, when using asynchronous learning tool such as discussion forum, students could post comments, review other students' comments, and respond to these comments. Over a period of time, such student to student interactions should lead to deeper and broader information processing, more knowledge transfer and deeper learning than if learning is done in isolation (Johnson, Hornik, & Salas, 2008). Marks, Sibley and Arbaugh (2005) found that online student-to-student activities had a positive influence on perceived learning, suggesting that learning is facilitated by communications among the students themselves. Other studies indicated that students' role in interaction most significantly predict student learning and /or satisfaction (Arbaugh, 2002; Borthick & Jones, 2000; Poole, 2000; Arbaugh & Rau, 2007). Hence, the following hypotheses were proposed:

H₇: Students' interaction with peers will significantly influence their perceived ease of use with e-learning.

H₈: Students' interaction with peers will significantly influence their perceived course outcomes with e-learning.

H₉: Students' interaction with peers will significantly influence their perceived usefulness with e-learning.

Method

Participants

Participants were 255 third-year students of a particular polytechnic taking a blended learning module on Laboratory Management. Among the participants, 160 (62.7%) were females and 95 (37.3%) males. A majority of 154 (60.4%) students were Chinese, 51(20.0%) Malay, 32 (12.5%) Indian and 17(7.1%) other races. The mean age of the participants was 19.88 years (*SD* = 1.68). All of the participants owned and used laptops in school, and they have access to the LMS to support their e-learning or face-to-face lessons. The e-learning portion of the module included participants taking part in the lecturer-led online forum discussion and completing online quizzes. An LMS was employed to these e-learning activities in this study.

Procedures

All third-year students who took the Laboratory Management module were invited to participate in the study. For those students who agree to take part in the study, they were given a link to access a website to complete the online questionnaire. All participants were briefed on the purpose of the study, and were informed that their participations were strictly voluntary and anonymity safeguarded. The participants have the rights not to participate or withdraw from the study any time. Participants were also informed that no module credit will be given for participating in the study and their responses do not affect their assessment grades. On average, the respondents took not more than 20 minutes to complete the questionnaire. This research study was approved by the Ethics Review Committee at the institution where the research was undertaken.

Measures

A questionnaire employed in this study comprised of items adapted from several empirical studies using the e-learning systems or LMS (e.g. Naveh, Tubin, & Pliskin, 2010; Paechter, Maier, & Macher, 2010; Sun et al., 2008; Teo & Wong, 2013).

The questionnaire was pilot tested with a group of students and reviewed by a panel of lecturers for face and content validity. It comprises 15 statements on perceived ease of use (3 items), perceived usefulness (3 items), interaction with peers (3 items), lecturer support (3 items) and perceived course outcomes (3 items). Participants were asked to give their responses to each of the statement on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). When answering the questions in the questionnaire, the respondents were asked to relate their experience using the LMS for the e-learning lessons which they had completed. Demographic data such as gender and age were also collected in the questionnaire.

Statistical Analysis

The analysis of the study was carried out in two stages using a measurement model and structural model (Anderson & Gerbing, 1998). The first stage involved building a measurement model based on a confirmatory factor analysis (CFA), and examining the descriptive statistics, and assessing the validity and reliability. The second stage involved building a structural equation model of the latent constructs, and testing the hypothesised relationships among the constructs.

Results

Descriptive Statistics

The mean ratings of all the five constructs were between 3.54 and 4.16, and above the mid-point of 3.00 of the scale (see Table 1). This indicated an overall favourable response to the constructs measured in the study. The standard deviations ranged from .09 to 1.17, which revealed a wide spread around the mean. The skewness ranged from -.69 to -.05 and kurtosis ranged from -.40 to .65 were all within Kline's (2005) suggested cut-offs of absolute values greater than 3 and 10 respectively, indicating univariate normality.

The Mardia's coefficient in this study was found to be 91.95, below the recommended value of 255 ($p(p+2) = 15(17) = 255$ where p is the number of observed variables in the study) by Raykov and Marcoulides (2012). Hence, multivariate normality is met. Therefore, the data is suitable for the purpose of structural equation modeling.

Table 1: Descriptive statistics of the constructs

Construct	Item	Mean	SD	Skewness	Kurtosis
Perceived Ease of Use (PE)	3	4.16	1.07	-.45	-.27
Perceived Usefulness (PU)	3	3.81	1.14	-.50	-.08
Lecturer Support (LS)	3	4.61	.97	-.69	.65
Interaction with Peers (IP)	3	3.54	1.17	-.05	-.40
Perceived Course Outcomes (CO)	3	4.04	1.06	-.69	.32

Exploratory Factor Analysis

The items were subjected to the principle component factor (PCF) analysis with an oblique (promax) rotation. The Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy was found to be .91, exceeding the recommended threshold for factor analysis of .6 (Tabachnik & Fidell, 2012). Results from the Barlett's test of sphericity provided further support for performing the EFA: Chi-square, $\chi^2(105) = 3147.76$, $p < .001$. The number of resultant five factors was extracted, in line with the specific variables intended to be measured in the proposed research model. The total variance explained by the five factors is 84.06%. All the items had standardised factor loadings of over .60, and the present study accepted this threshold as practical significant (Hair, Black, Babin, Anderson, & Tatham, 2006).

Test of the Measurement Model

The measurement model was tested using structural equation modeling (SEM), a multivariate technique that combines factor analysis and multiple regressions to simultaneously examine a series of interrelated dependence relationships among measured variables and latent variables as well as several latent constructs (Hair et al., 2006). Maximum likelihood estimation is used in SEM to generate a full-fledged measurement model and it is a robust estimation method, capable of handling large sample size and distribution that deviates from normality (Arbuckle, 2009).

The standardised factor loading of each item on the construct in the measurement model is shown in Table 2. All parameter estimates are significant at the $p < .001$ level, as indicated by the t -values. The R^2 values for all items are above .50, indicating that the each item explained more than half of the variance of the latent variable (construct) that they belong to. As a measure of internal consistency, the Cronbach alpha values of the constructs, which ranged from .86 to .91 are high, and above the .70 threshold recommended by Nunnally and Bernstein (1994).

The fit indices for the measurement model were computed using structural equation modeling with AMOS 18.0 (Arbuckle, 2009). Six fit indices were used to assess the goodness of fit for the measurement model, and these comprise of χ^2/df ratio; goodness-of-fit index, GFI; comparative fit index, CFI; Tucker-Lewis index, TLI, standardised root mean residual, SRMR and root mean square error of approximation, RMSEA. In order to have an acceptable fit for the measurement model, χ^2/df is expected to be less than 3.0; GFI, TLI and CFI are expected to exceed .9, and RMSEA and SRMR should be less than .08 (Kline, 2005; Hair et al., 2006). The result showed that there was adequate model fit in the measurement model ($\chi^2/df = 2.39$; TLI = .95; CFI = .97; GFI = .91; RMSEA = .07; SRMR = .08), which provided support to proceed with testing the structural model.

Table 2: Results of the measurement model

Latent Variable	Item	SFL (>.70)*	SE	t-value	R ²	AVE (>.50)*	Cronbach's alphas (>.70)*
Perceived Ease of Use						.71	.89
	PE1	.789	.054	15.857**	.789		
	PE2	.889	.054 ^a	16.463**	.889		
	PE3	.902	.063	19.632**	.902		
Perceived Usefulness						.72	.91
	PU1	.845	.042	22.446**	.845		
	PU2	.839	.054 ^a	15.537**	.839		
	PU3	.873	.061	15.803**	.873		
Lecturer Support						.83	.91
	LS1	.868	.044	21.091**	.868		
	LS2	.949	.054 ^a	17.387**	.949		
	LS3	.835	.048	18.834**	.835		
Interaction with Peers						.64	.86
	IP1	.775	.063	15.345**	.775		
	IP2	.894	.054 ^a	16.370**	.894		
	IP3	.796	.063	13.887**	.796		
Perceived Course Outcomes						.72	.90
	CO1	.825	.049	16.435**	.825		
	CO2	.802	.048	15.264**	.802		
	CO3	.903	.054 ^a	16.537**	.903		

Note: SFL = Standardised Factor Loading; AVE = Average Variance Extracted
Average Variance Extracted was computed using $(\sum\lambda)^2 / (\sum\lambda)^2 + (\sum\delta)$.

* Indicate an acceptable level of reliability and validity

** $p < .001$

^a This parameter was fixed at 1.00 for specification purposes.

Convergent and Discriminant Validities

Convergent validity examines whether the respective items are measuring the construct that they purported to measure. The item reliability assessed by its factor loadings of the individual items into the underlying construct was between .78 and .90 (see Table 2). This exceeded the threshold of .70 set by Hair et al. (2006), indicating convergent validity at the item level. The average variance extracted (AVE) is the amount of variance captured by the construct in relation to the variance attributable to measurement error. As recommended by Fornell and Larcker (1981), the AVE is deemed adequate if it is equal or exceeds .50. As shown in Table 2, the AVEs ranged between .64 and .83 for all constructs. These exceeded the threshold value of .50, and hence convergent validity of the constructs is adequate. Overall, convergent validity for all measurement items in this study is adequate.

Discriminant validity is the extent to which a construct is absolutely distinct from other constructs (Hair et al., 2006). Discriminant validity was assessed by comparing the square root of the AVE for the given construct with the correlations between that construct and all other constructs. As shown in Table 3, the square root of the AVEs were greater than the off-diagonal numbers in the rows and columns in the matrix, and suggested that the construct is more strongly correlated with its items than with other constructs in the model. Hence, discriminant validity of all constructs is acceptable, and deemed adequate for further analyses.

Table 3: Discriminant validity for the measurement model

Construct	PE	PU	LS	IP	CO
PE	(.84)				
PU	.66**	(.85)			
LS	.44**	.42**	(.91)		
IP	.57**	.66**	.36**	(.80)	
CO	.61**	.74**	.45**	.65**	(.85)

* $p < .01$; diagonal numbers in parenthesis indicate the square root of the average extracted variance.

Test of the Structural Model

Based on the result, the fit indices ($\chi^2/df = 2.16$; TLI = 0.96; CFI = .97; GFI = .92; RMSEA = .07; SRMR = .07) indicated a good fit with the structural model. Figure 2 shows the resulting path coefficients of the research model. The hypotheses in this study were examined by testing the significant relationships of the variables in the predicted direction. Perceived course outcomes were significantly predicted by perceived usefulness ($\beta = .46, p < .001$) and interaction with peers ($\beta = .41, p < .001$), but not for lecturer support ($\beta = .11, n.s.$) and perceived ease of use ($\beta = .01, n.s.$). As for perceived ease of use, interaction with peers ($\beta = .64, p < .001$) and lecturer support ($\beta = .20, p < .001$) were identified to be significant predictors. In terms of perceived usefulness, perceived ease of use ($\beta = .31, p < .001$) and interaction with peers ($\beta = .54, p < .001$) were significant predictors. Interaction with peers was significantly influenced by lecturer support ($\beta = .41, p < .001$).

The results of the hypothesis testing showing the standardised path coefficients and t-values were summarised in Table 5. Out of the total 9 hypotheses, 7 were supported. The explanatory power of the model for individual variables was examined using the resulting R^2 for each dependent variable. Perceived course outcomes are found to be significantly determined by the antecedents, resulting in an R^2 of .765. In other words, perceived ease of use, perceived usefulness, interaction with peers and lecturer support explained 76.5% of the variance in perceived course outcomes. Three other endogenous variables, i.e. perceived usefulness, perceived ease of use and interaction with peers had their variances explained by their determinants in magnitude of 62.9%, 56.7% and 21.2%.

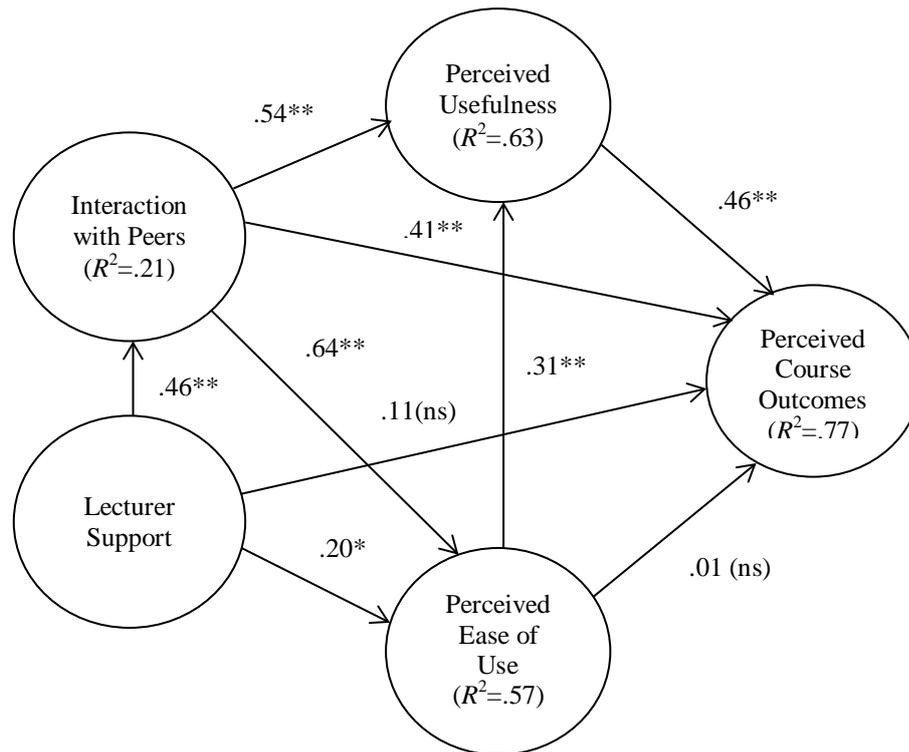


Figure 1: Standardised path coefficients in the research model
 (** $p < .001$, * $p < .01$, ns: non-significant)

Table 5: Results of hypothesis testing

Hypotheses	Path	Path Coefficient	Standardised Estimate	t-value	Results
H ₁	PE → PU	.311	.086	3.602**	Supported
H ₂	PE → CO	.006	.068	.096	Not Supported
				(n.s.)	
H ₃	PU → CO	.395	.075	5.299**	Supported
H ₄	LS → PE	.201	.061	3.276*	Supported
H ₅	LS → IP	.475	.071	6.659**	Supported
H ₆	LS → CO	.095	.044	2.167	Not Supported
				(n.s.)	
H ₇	IP → PE	.622	.071	8.715**	Supported
H ₈	IP → CO	.339	.083	4.102**	Supported
H ₉	IP → PU	.521	.090	5.786**	Supported

** $p < .001$, * $p < .01$, n.s. refers to non-significant

Assessment of Direct, Indirect and Total Effects

There are multiple interactions that exist among the four factors that have an influence on perceived course outcomes directly or indirectly. Table 6 shows the direct, indirect and total effects of the exogenous and endogenous variables associated with each of the 5 variables in the study. The total effect on a variable is the sum of the respective direct and indirect effects. Based on Cohen's (2013) guidelines, standardised estimates (or path coefficients) with values of less than .1 are considered small, less than .3 are medium, and more than .5 are large.

Interaction with peers is the determinant of perceived course outcomes with a large total effect of .749, followed by lecturer support, perceived usefulness, and perceived ease of use with total effect sizes of .485, .460 and .151 respectively. As for perceived usefulness, a large total effect of .736 was contributed by interaction with peers, whereas lecturer support and perceived ease of use contributed moderate total effects of .401 and .312 respectively. For perceived ease of use, interaction with peers was a strong determinant with total effect of .639 followed by lecturer support with total effect of .495.

Among the four exogenous variables, perceived course outcomes had the largest amount of variance attributed to the four determinants at approximately 77%. This is largely attributed to the total effects contributed by interaction with peers, lecturer support and perceived usefulness.

Table 6: Direct, Indirect and Total Effects of the Research Model

Outcome	Determinant	Standardised Estimates		
		Direct	Indirect	Total
Perceived Course Outcomes (CO) ($R^2 = .77$)	PU	.460	-	.460
	PE	.008	.143	.151
	LS	.110	.375	.485
	IP	.406	.343	.749
Perceived Usefulness (PU) ($R^2 = .63$)	PE	.312	-	.312
	IP	.536	.199	.736
	LS	-	.401	.401
Perceived Ease of Use (PE) ($R^2 = .57$)	LS	.201	.294	.495
	IP	.639	-	.639
Interaction with Peers (IP) ($R^2 = .21$)	LS	.460	-	.460

Discussion

The aims of this study were to investigate the factors that influence students' perceived course outcomes, and to determine the extent to which the factors significantly predict perceived course outcomes. LMS was employed as a platform to deliver the e-learning in this study. It was hypothesised that perceived course outcomes (CO) as a dependent variable, is predicted by four independent variables on perceived ease of use (PE), perceived usefulness (PU), lecturer support (LS) and interaction with peers (IP). Using structural equation modeling, the research model was tested and the results showed a good model fit with the data. Among the 9 hypotheses tested in the research model, 7 were supported and 2 not supported. The four independent variables accounted for 77% of the total variance in the students' perceived course outcomes. It is noteworthy that 13% of the variance was not explained and accounted for by the model which suggested a limitation of this study and potential for future research. Except for PE and LS, PU and IP were significant predictors of perceived course outcomes. Except for PU, all the 3 other variables (i.e. LS, PE and IP) had indirect effects on CO.

In this study, perceived usefulness had a positive and significant influence on perceived course outcomes. On closer examination, perceived usefulness items had higher and significant correlations with satisfaction item ($.63 \leq r \leq 0.71$, $p < .01$) than with perceived learning achievements ($.57 \leq r \leq .63$, $p < .01$) in the perceived course outcomes. One possible explanation for this is that when students perceived the e-learning contents and online activities to be useful in helping them to perform well in their studies, their levels of satisfaction with e-learning would increase and perceived learning achievements higher. The positive and significant influence of students' perceived usefulness on the satisfaction can be found in a few studies related to the use and adoption of e-learning (Sun et al., 2008; Yuan & Ma, 2008; Teo & Wong, 2013).

Interaction with peers had a significant influence on perceived course outcomes. Interaction with peers also had the largest total effect on perceived course outcomes ($\beta = .749$, $p < .01$), compared with 3 other variables. Due to the limited literature on perceived course outcomes, this result is somewhat consistent with previous studies which found that active discussion among students significantly influenced students' satisfaction and perceived learning (Swan, 2001); learner-learner interactions positively predicted perceived learning (Arbaugh & Rau, 2007), and significantly affect students' satisfaction (Eom, Wen, & Ashill, 2006). In this study, the results showed that the students perceived that participating in the online discussion forum is critical to learning, and they derived satisfaction through participating in the online collaborative learning activities.

Although perceived ease of use did not have a significant influence on perceived course outcomes, the result suggested that it has an indirect effect on perceived course outcomes through perceived usefulness. Employing the steps used in the mediation analysis recommended by Sobel (1982), the result showed that perceived usefulness is a significant mediator between perceived ease of use and perceived course outcomes ($z = 8.64, p < .01$), reducing the effect of PE \rightarrow CO by 94.7%. Hence, the finding indicated that perceived course outcomes are not affected by perceived ease of use alone, however when students perceived e-learning to be useful, the perceived ease of use becomes an important consideration in influencing perceived course outcomes.

The results showed that lecturer support is not a significant predictor of perceived course outcomes. Applying the mediation analysis (Sobel, 1982) again, interaction with peers is found to be a significant mediator between lecturer support and perceived course outcomes ($z = 5.45, p < .01$), reducing the effect of LS \rightarrow CO by 77.3%. Therefore, lecturer support alone may not exert a significant influence on perceived course outcomes. The instructional roles of the lecturers in supporting students' learning by providing feedback to the students' work could be extended through encouraging more students to interact with each other in the online activities, as these could have significant influence on the perceived course outcomes.

Limitations and Future Research

This study validated a model by testing the factors that significantly predict students' perceived course outcomes in e-learning using a LMS. However, several limitations of this study should be considered for future research to improve the generalizability of the results. First, the participants of this study were predominantly polytechnic students taking a Laboratory Management module with the School of Applied Science; therefore the results of the study may be only applicable to the population represented. Future studies should extend to multiple modules and student representations.

Second, this study employed a particular learning management system to deliver the e-learning, and hence further testing with different LMS using different functionalities could be conducted in future. Third, the study employed a self-reported questionnaire which may be subjected to social desirability bias, where respondents have the tendency to over-report or under-report their responses.

Finally, 77% of the total variance in the perceived course outcomes can be explained by the four factors in the study, leaving 13% unexplained. Therefore, there is a need to examine other variables (e.g. learner characteristics, course delivery, facilitating conditions etc.) to improve the predictive power of the model.

Implications of the Study

Despite the limitations, there are a number of potential implications that this study raises for researchers, educators offering e-learning courses using the LMS. First, the study showed that perceived ease of use, lecturer support and interaction with peers explained 63% of the variance in perceived usefulness. Based on this finding, course developers and lecturers should take these three determinants of perceived usefulness into consideration for the design of e-learning contents and online learning activities. The LMS should be easy to navigate and online contents easily accessible. Course lecturers could play important roles to support student learning by giving them timely feedback on their work, encouraging students to participate more actively during the online discussion, and giving assignment to students where they could work collaboratively online.

Second, this study found that interaction with peers had the largest total effect on the perceived course outcomes. Hence, course lecturers could formulate strategies to promote more student-student interactions such as employing peer feedback as an instructional tool for students to evaluate students' work, exploring the use of leader board functionality in the LMS to give virtual points rewards to motivate students for participating in the online discussion forum, and designing an assessment rubric on the number of postings made by the individual students.

Finally, although interaction with peers and perceived ease of use do not have a direct and significant influence on perceived course outcomes, these variables should not be dismissed completely. Through the mediators, interactions with peers and perceived ease of use were found to exert indirect

influence on perceived course outcomes, thus explaining the inter-relationships among the variables in the research model that influence perceived course outcomes. For instance, perceived ease of use had an indirect influence on perceived course outcomes through perceived usefulness. Students' perception of the ease of use with the e-learning system could enhance perceived course outcomes when they also find that the e-learning is useful to them. Course lecturers could help students to be more effective and productive in their learning by exploring the use of LMS functionalities to design more collaborative and engaging online learning activities for them.

Conclusion

Based on a theoretical framework, this study proposed and tested a research model that examined the impact of the four factors (i.e. perceived ease of use, perceived usefulness, instructor support, interaction with peers) on perceived course outcomes in e-learning using the LMS among polytechnic students. The study showed that perceived usefulness and interaction with peers were significant predictors of perceived course outcomes, whereas perceived ease of use and lecturer support were not significant. The findings of this study have important implications for educators and researchers to be cognisant of the four key factors, and how these interact with each other, in the instructional design of e-learning courses using the LMS to ensure success in students' e-learning.

Appendix

Items Used in the Study

Lecturer Support

- LS1 My lecturer gave me adequate feedback about my comments.
- LS2 My lecturer supported my learning when the lesson was conducted on LMS.
- LS3 My lecturer conducted the lesson smoothly using LMS.

Interaction with Peers

- IP1 I used the LMS to communicate with my team members.
- IP2 LMS helped me to work well with my team members.
- IP3 I could share information with my team members easily through LMS.

Perceived Ease of Use

- PE1 LMS was easy to use.
- PE2 LMS was easy to navigate.
- PE3 I found it easy to get LMS to do what I wanted it to do.

Perceived Usefulness

- PU1 Using LMS would improve my learning in this module.
- PU2 Using LMS made my learning more productive.
- PU3 I find LMS useful in my learning.

Course Outcomes

- CO1 I gain new knowledge from the e-learning lessons using LMS.
- CO2 I have increased my knowledge of the subject using LMS.
- CO3 Overall, I am satisfied with the e-learning lessons using LMS.

References

- Alshare, K. A., Freeze, R. D., Lane, P. L., & Wen, H. J. (2011). The impacts of system and human factors on online learning systems use and learner satisfaction. *Decision Sciences Journal of Innovative Education*, 9(3), 437-461.
- Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, 103(3), 411.
- Arbaugh, J., & Rau, B. L. (2007). A study of disciplinary, structural, and behavioral effects on course outcomes in online MBA courses. *Decision Sciences Journal of Innovative Education*, 5(1), 65-95.
- Arbaugh, J. B. (2002). Managing the on-line classroom: A study of technological and behavioral characteristics of web-based MBA courses. *The Journal of High Technology Management*

- Research*, 13(2), 203-223.
- Arbaugh, J. B., & Benbunan-Fich, R. (2007). The importance of participant interaction in online environments. *Decision Support Systems*, 43(3), 853-865.
- Arbuckle, J. (2009). *Amos 18 user's guide*: SPSS Incorporated Armonk, New York, USA.
- Borthick, A. F., & Jones, D. R. (2000). The motivation for collaborative discovery learning online and its application in an information systems assurance course. *Issues in Accounting Education*, 15(2), 181-210.
- Cigdem, H., & Topcu, A. (2015). Predictors of instructors' behavioral intention to use learning management system: A Turkish vocational college example. *Computers in Human Behavior*, 52, 22-28.
- Coates, H., James, R., & Baldwin, G. (2005). A critical examination of the effects of learning management systems on university teaching and learning. *Tertiary Education and Management*, 11, 19-36.
- Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*: Academic press.
- Dahlstrom, E., Brooks, D. C., & Bichsel, J. (2014). The Current Ecosystem of Learning Management Systems in Higher Education: Student, Faculty, and IT Perspectives: Research report. Louisville, CO: ECAR, September 2014. Available from <https://net.educause.edu/ir/library/pdf/ers1414.pdf>.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319-340.
- De Smet, C., Bourgonjon, J., De Wever, B., Schellens, T., & Valcke, M. (2012). Researching instructional use and the technology acceptance of learning management systems by secondary school teachers. *Computers & Education*, 58(2), 688-696.
- DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research*, 3(1), 60-95.
- Eom, S. B., Wen, H. J., & Ashill, N. (2006). The determinants of students' perceived learning outcomes and satisfaction in university online education: An empirical investigation. *Decision Sciences Journal of Innovative Education*, 4(2), 215-235.
- Findik Coskuncay, D., & Ozkan, S. (2013). A Model for Instructors' Adoption of Learning Management Systems: Empirical Validation in Higher Education Context. *Turkish Online Journal of Educational Technology-TOJET*, 12(2), 13-25.
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 39-50.
- Green, L. S., & Denton, B. (2012). Examination of factors impacting student satisfaction with a new learning management system. *Turkish Online Journal of Distance Education*, 13(3), 189-197.
- Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (6 ed.): New Jersey: Prentice-Hall International.
- Johnson, R. D., Hornik, S., & Salas, E. (2008). An empirical examination of factors contributing to the creation of successful e-learning environments. *International Journal of Human-Computer Studies*, 66(5), 356-369.
- Kang, M., & Im, T. (2013). Factors of learner–instructor interaction which predict perceived learning outcomes in online learning environment. *Journal of Computer Assisted Learning*, 29(3), 292-301.
- Kim, S.-W., & Lee, M.-G. (2008). Validation of an evaluation model for learning management systems. *Journal of Computer Assisted Learning*, 24(4), 284-294.
- Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd Ed.). New York: Guilford Press.
- Lee, Y.-H., Hsieh, Y.-C., & Chen, Y.-H. (2013). An investigation of employees' use of e-learning systems: applying the technology acceptance model. *Behaviour & Information Technology*, 32(2), 173-189.
- Levy, Y. (2007). Comparing dropouts and persistence in e-learning courses. *Computers & Education*, 48(2), 185-204.
- Liaw, S.-S. (2008). Investigating students' perceived satisfaction, behavioral intention, and effectiveness of e-learning: A case study of the Blackboard system. *Computers & Education*, 51(2), 864-873.
- Liaw, S. S., & Huang, H. M. (2007). Developing a collaborative e-learning system based on users' perceptions. In *Computer Supported Cooperative Work in Design III* (pp. 751-759). Springer Berlin Heidelberg.
- Liaw, S.-S., Huang, H.-M., & Chen, G.-D. (2007). Surveying instructor and learner attitudes toward e-learning. *Computers & Education*, 49(4), 1066-1080.
- Lim, D. H., Morris, M. L., & Yoon, S.-W. (2006). Combined effect of instructional and learner variables on course outcomes within an online learning environment. *Journal of Interactive Online Learning*,

5(3), 255-269.

- Marks, R. B., Sibley, S. D., & Arbaugh, J. (2005). A structural equation model of predictors for effective online learning. *Journal of Management Education*, 29(4), 531-563.
- McGill, T. J., & Klobas, J. E. (2009). A task–technology fit view of learning management system impact. *Computers & Education*, 52(2), 496-508.
- Mijatovic, I., Cudanov, M., Jednak, S., & Kadijevich, D. M. (2013). How the usage of learning management systems influences student achievement. *Teaching in Higher Education*, 18(5), 506-517.
- Naveh, G., Tubin, D., & Pliskin, N. (2010). Student LMS use and satisfaction in academic institutions: The organizational perspective. *The Internet and Higher Education*, 13(3), 127-133.
- Nunnally, J., & Bernstein, I. H. (1994). *Psychometric theory*. New York, NY:McGraw-Hill.
- Ozkan, S., & Koseler, R. (2009). Multi-dimensional students' evaluation of e-learning systems in the higher education context: An empirical investigation. *Computers & Education*, 53(4), 1285-1296.
- Paechter, M., & Maier, B. (2010). Online or face-to-face? Students' experiences and preferences in e-learning. *The Internet and Higher Education*, 13(4), 292-297.
- Paechter, M., Maier, B., & Macher, D. (2010). Students' expectations of, and experiences in e-learning: The relation to learning achievements and course satisfaction. *Computers & Education*, 54, 222-229.
- Piccoli, G., Ahmad, R., & Ives, B. (2001). Web-based virtual learning environments: A research framework and a preliminary assessment of effectiveness in basic IT skills training. *MIS Quarterly*, 401-426.
- Poole, D. M. (2000). Student participation in a discussion-oriented online course: A case study. *Journal of Research on Computing in Education*, 33(2), 162-177.
- Raykov, T., & Marcoulides, G. A. (2012). *An introduction to applied multivariate analysis*: Routledge.
- Sánchez, R. A., & Hueros, A. D. (2010). Motivational factors that influence the acceptance of Moodle using TAM. *Computers in Human Behavior*, 26(6), 1632-1640.
- Šumak, B., Heričko, M., Pušnik, M., & Polančič, G. (2011). Factors affecting acceptance and use of Moodle: An empirical study based on TAM. *Informatica*, 35(1).
- Sun, P.-C., Tsai, R. J., Finger, G., Chen, Y.-Y., & Yeh, D. (2008). What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education*, 50(4), 1183-1202.
- Swan, K. (2001). Virtual interaction: Design factors affecting student satisfaction and perceived learning in asynchronous online courses. *Distance Education*, 22(2), 306-331.
- Tabachnick, B. G., & Fidell, L. S. (2012). *Using multivariate analysis* (6 ed.): Pearson.
- Teo, T. (2010). Development and validation of the E-learning Acceptance Measure (EIAM). *The Internet and Higher Education*, 13(3), 148-152.
- Teo, T., & Wong, S. L. (2013). Modeling key drivers of e-learning satisfaction among student teachers. *Journal of Educational Computing Research*, 48(1), 71-95.
- Thurmond, V. A., Wambach, K., Connors, H. R., & Frey, B. B. (2002). Evaluation of student satisfaction: Determining the impact of a web-based environment by controlling for student characteristics. *The American Journal of Distance Education*, 16(3), 169-190.
- Yuen, A. H., & Ma, W. W. (2008). Exploring teacher acceptance of e-learning technology. *Asia-Pacific Journal of Teacher Education*, 36(3), 229-243.
- Yuksel, I. (2009). Instructor competencies for online courses. *Procedia-Social and Behavioral Sciences*, 1(1), 1726-1729.

Kwok, D. (2015). Predictors of students' perceived course outcomes in e-learning using a Learning Management System. In T. Reiners, B.R. von Konsky, D. Gibson, V. Chang, L. Irving, & K. Clarke (Eds.), *Globally connected, digitally enabled*. Proceedings ascilite 2015 in Perth (pp. FP:143-FP:155).

Note: All published papers are refereed, having undergone a double-blind peer-review process.



The author(s) assign a Creative Commons by attribution licence enabling others to distribute, remix, tweak, and build upon their work, even commercially, as long as credit is given to the author(s) for the original creation.