Critical success factors for e-learning acceptance: Confirmatory factor models ☆

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Abstract

E-learning, one of the tools emerged from information technology, has been integrated in many university programs. There are several factors that need to be considered while developing or implementing university curriculums that offer e-learning based courses. This paper is intended to specify e-learning critical success factors (CSFs) as perceived by university students. The published e-learning critical success factors were surveyed and grouped into 4 categories namely, instructor, student, information technology, and university support. Each category included several measures. The categorization was tested by surveying 538 university students. The results revealed 8 categories of e-learning CSFs, each included several critical e-learning acceptance and success measures. The level of criticality of each measure was represented by its validity coefficient. Confirmatory factor modeling approach was used to assess the criticality of the measures included in each CSF category.
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1. Introduction

1.1. Literature review

Recently, information technology has been viewed as a solution to universities' cost and quality problems. Information technology in teaching and learning has created a need to transform how university students learn by using more modern, efficient, and effective alternative such as e-learning. E-learning concept has been around for decades and is one of the most significant recent developments in the information systems industry (Wang, 2003). E-learning can be viewed as the delivery of course content via electronic media, such as Internet, Intranets, Extranets, satellite broadcast, audio/video tape, interactive TV, and CD-ROM (Urdan & Weggen, 2000). E-learning is one of the new learning trends that challenge the traditional "bucket theory" or the banking concept of education (Freire, 1994). The banking concept of education assumes that the instructor owns the knowledge and deposits it into the passive students who attend the class (Freire, 1994). E-learning has been viewed as synonymous with web-based learning (WBL), Internet-based training (IBT), advanced distributed learning (ADL), web-based instruction (WBI), online learning (OL) and open/flexible learning (OFL) (Khan, 2001).

The term Critical success factor (CSF) first appeared in the literature in the 1980s when there was interest in why some organizations seemed to be more successful than others, and research was carried out to investigate the success components (Ingram, Biermann, Cannon, Neil, & Waddle, 2000). CSFs are "*those things that must be done if a company is to be successful*" (Freund, 1988). CSFs should be few in number, measurable and controllable. Although there is a large number of research articles on e-learning, few of them address the most important issue of e-learning critical success factors. Papp (2000) explored distance learning from a macro perspective and suggested some critical success factors that can assist faculty and universities in e-leaning environment development. Papp's e-learning CSFs included intellectual property, suitability of the course for e-learning environment, building the e-learning course, e-learning course content, e-learning course maintenance, e-learning platform, and measuring the success of an e-learning course. Papp (2000) suggested studying each one of these CSFs in isolation and also as a composite to determine which factor(s) influence and impact e-learning success. Benigno and Trentin (2000) suggested a framework for the evaluation of e-leaning based courses, focusing on two aspects: the first is evaluating the learning, and the second is evaluating the students' performance. They considered factors such as student characteristics, student–student interaction, effective support, learning materials, learning environment, and information technology.

Volery and Lord (2000) drew upon the results of a survey conducted amongst 47 students enrolled in an e-learning based management course at an Australian university. They identified three CSFs in e-learning: *technology* (ease of access and navigation, interface design and level of interaction); *instructor* (attitudes towards students, instructor technical competence and classroom interaction); and *previous use of technology* from a student's perspective. Soong, Chan, Chua, and Loh (2001) using a multiple case study, verified that the e-learning CSFs are: human factors, technical competency of both instructor and student, e-learning mindset of both instructor and student, level of collaboration, and perceived information technology infrastructure. They recommended that all these factors should be considered in a holistic fashion by e-learning adopters. According to studies conducted by Dillon and Guawardena (1995) and Leidner and Jarvenpaa (1993), three main

variables affect the effectiveness of e-learning environments: technology, instructor characteristics, and student characteristics. Using a survey on the perception of e-learning among postgraduates enrolled at Curtin Business School, Helmi (2002) concluded that the three driving forces to e-learning are information technology, market demands, and education brokers such as universities.

In an attempt to provide a pedagogical foundation as a prerequisite for successful e-learning implementation, Govindasamy (2002) discussed seven e-learning quality benchmarks namely, institutional support, course development, teaching and learning, course structure, student support, faculty support, and evaluation and assessment. Based on a comprehensive study by Baylor and Ritchie (2002), the impact of seven independent factors related to educational technology (planning, leadership, curriculum alignment, professional development, technology use, instructor openness to change, and instructor computer use outside school) on five dependent measures (instructor's technology competency, instructor's technology integration, instructor morale, impact on student content acquisition, and higher order thinking skills acquisition) were studied using stepwise regression. The study resulted in models explaining each of the five dependent measures.

The purpose of e-learning, like any other learning approach, is to achieve the learning objectives. The objectives attainment measures can be environmental, technological, student related, and instructor related. In e-learning some of the crucial CSFs are technological, such as bandwidth, hardware reliability, and network security and accessibility. Another e-learning CSF is student engagement in learning models. E-learning models are synchronous (real time), asynchronous (anytime and anywhere), or a mix of the two. There are numerous tools that instructors can use to adopt an e-learning model: mini-lectures, electronic/conventional discussion, active/cooperative learning and many others. The third e-learning CSF is student related. Students must be motivated and committed. In e-learning based courses, students take the responsibility of their learning pace.

The objective of this study is to specify the CSF of e-learning acceptance by students. The study aims at categorizing the e-learning CSFs and specifying the critical factors within each category using confirmatory factor models.

1.2. E-learning CSF categories

E-learning CSFs within a university environment can be grouped into four categories: (1) instructor; (2) student; (3) information technology; and (4) university support.

As for all educational endeavor, the instructor plays a central role in the effectiveness and success of e-learning based courses. Collis (1995) and Willis (1994) believed that it is not the information technology but the instructional implementation of the IT that determines the effectiveness of e-learning. Webster and Hackley (1997) proposed three instructor characteristics that affect e-learning success: (1) IT competency; (2) teaching style; and (3) attitude and mindset. Volery and Lord (2000) suggested that instructors provide various forms of office hours and contact methods with students. Instructors should adopt interactive teaching style, encourage student–student interaction. It is so important that instructors have good control over IT and is capable of performing basic troubleshooting tasks.

University students are becoming more diverse and demand for e-learning based courses is increasing (Papp, 2000; Volery & Lord, 2000). Students need to have time management, discipline,

and computer skills in order to be successful in the e-learning era. Student prior IT experience such as having a computer at home and attitude towards e-learning is critical to e-learning success. As stated before, research concludes that e-learning based courses compare favorably with traditional learning and e-learning students perform as well or better than traditional learning students (Beyth-Marom, Chajut, Roccas, & Sagiv, 2003). This shows that students like to use e-learning if it facilitates their learning and allows them to learn any time any where in their own way (Papp, 2000).

Information technology (IT) explosion resulted in changes in education. E-learning integration into university courses is a component of the IT explosion; as a matter of fact IT is the engine that drives the e-learning revolution. The efficient and effective use of IT in delivering e-learning based components of a course is of critical importance to the success and student acceptance of e-learning. So ensuring that the university IT infrastructure is rich, reliable and capable of providing the courses with the necessary tools to make the delivery process as smooth as possible is critical to the success of e-learning. IT tools include network bandwidth, network security, network accessibility, audio and video plug-ins, courseware authoring applications, Internet availability, instructional multimedia services, videoconferencing, course management systems, and user interface.

E-learning projects that were not successful in achieving their goals did not have access to technical advice and support (Aldexander, McKemzie, & Geissinger, 1998; Soong et al., 2001). If the technical support is lacking, the e-learning will not succeed. University administration support to e-learning is essential for its success. This study limited the e-learning CSF categories to those that were reported in the literature while including newly used items within each CSF category.

2. Method

2.1. Participants

The courses selected for the study combine both e-learning and traditional learning tools and all of them are laptop-based courses and use active and student centered learning methods. Traditional learning tools used in the selected courses are required attendance, regular textbook, and presence of instructor during the scheduled class time. E-learning tools used are electronic student–student and student–instructor communication, asynchronous course material delivered through a Blackboard (adopted course management information system) course web, in-class active and collaborating learning activities, and student self-pacing pattern.

Data were collected through an anonymous survey instrument administered to 900 undergraduate university students during the Fall semester of 2002. Respondents for this study consisted of 538 (334 females and 204 males) – a response rate of 60% – undergraduate students enrolled in five 100-level mandatory laptop-based courses distributed over 37 class sections. The students involved in this study were obliged to use the technology for all aspects of the course. All the selected courses were offered by the AACSB accredited college of Business and Economics at the United Arab Emirates University (UAEU). UAEU has 5 campuses located in 4 different geographical sites. Table 1 summarizes the demographic profile and descriptive statistics of the

Table 1
Demographic profile and descriptive statistics of surveyed students

Item	Frequency	Percentage
Gender		
Male	204	37.9
Female	334	62.1
Age		
17–19	210	39.0
20–22	313	58.2
23–25	12	02.2
26–28	3	00.6
Years at UAEU		
1–2	381	70.82
3–4	153	28.44
5–6	4	00.74
Years of e-learning		
1	208	38.7
2	197	36.6
3	133	24.7
PC ownership		
Yes	474	88.1
No	64	11.9

respondents. Student ages ranged from 17 to 28 years, with a mean age of 19.98 years (SD = 1.256). Students came from 18 different middle eastern countries and cultural backgrounds. They have an average GPA of 2.6 with a standard deviation of 0.54. Participants had 8 majors, namely accounting, economics, finance and banking, general business, management, management information systems, marketing, and statistics. The exposure to e-learning technologies of the participating students varied from 1 to 3 years, 38.7% had 1 year of exposure, 36.6% had 2 years, and 24.7% had 3 years of exposure. All students participated voluntarily in the study.

2.2. Instrument

A survey instrument for specifying the critical success factors within each category was developed. The survey instrument consisted of 5 sections, a section for each CSF category in addition to a demographic characteristics section. Each CSF category was observed via a group of indicators. Numerous instruments have been developed to measure e-learning satisfaction. Therefore, various potential indicators exist to measure each CSF category.

The instructor characteristics construct section included 13 indicators (INS1–INS13) which assessed the characteristics of instructors (see Appendix for the indicator details). Indicators INS1–INS11 were adopted from Volery and Lord (2000) to capture instructor's attitude towards the technology, teaching style, and control of the technology. The last two items INS12

and INS13 were adopted from Soong et al. (2001) to complete measuring the instructor's teaching style.

Twenty-two indicators were used in assessing the students' characteristics construct (STD1–STD22). The first two indicators measured the student motivation to use e-learning. Indicators STD3–STD7 measured the student technical competency. Items STD8–STD10 measured student's attitudes about the active learning activities that are facilitated using e-learning. Items STD11–STD15 measured student interactive collaboration. The first 15 indicators were adopted from Soong et al. (2001). Seven additional indicators were developed to measure the effectiveness of e-learning course content, structure, and design from student perception (see Appendix for details).

Thirteen indicators were developed to measure the technology reliability, richness, consistency, and effectiveness which represented the information technology construct. The first eight indicators (TEC1–TEC8) were adopted from Volery and Lord (2000). The 8 indicators measured the on-campus ease of Internet access and browsing, browsing speed, course websites ease of use, user interface efficiency, student–student communication reliability, and student–instructor communication. The last five items (TEC9–TEC13) were developed to capture the effectiveness of the IT infrastructure and services available at UAEU. They measured consistency of computers access using the same authentication, computer network reliability, and student information system efficiency.

The university support section consisted of 5 items (SUP1–SUP5) and all of them were developed to capture the effectiveness and efficiency of the university technical support, library services and computer labs reliability.

Some of the items were negatively worded. All items used a five-point Likert-type scale of potential responses: strongly agree, agree, neutral, disagree, and strongly disagree. The instrument was pre-tested by a random sample of 70 students. Minor changes to the order and wording of the items resulted from the pre-testers opinions. The survey instruments were distributed during laptop-based lectures and were left to the students to be filled and returned later. Around 900 instruments were distributed, 538 usable responses were used giving a 60% response rate. The students were informed that all data were anonymous and were to be used in assessing the acceptance of e-learning technology at the university instruction environment. Table 2 shows the mean and variance of each item in the e-learning assessment instrument.

3. Structural equation modeling approach

Structural equation modeling (SEM) techniques have been used heavily in measuring user acceptance of information technology (Chau, 1997; Venkatesh, Morris, Davis, & Davis, 2003). In technology uptake, several published studies have adopted the SEM approach in their studies. Examples include (Adams, Nelson, & Todd, 1992; Barki & Hartwick, 1994; Chau, 1997; Chwelos, Benbasat, & Dexter, 2001; Goodhue, Klein, & March, 2000; Hartwick & Barki, 1994; Igbaria & Parasuraman, 1989; Koufaris, 2002; Lederer, Maupin, Sena, & Zhuang, 2000; Moon & Kim, 2001; Rai, Lang, & Welker, 2002; Straub, Loch, & Hill, 2001; Venkatesh, 2001; Venkatesh & Davis, 2000).

Table 2
Descriptive statistics of e-learning CSF indicators

Item	Mean	SD
INS1	3.82	1.01
INS2	3.68	1.07
INS3	4.00	1.02
INS4	3.99	1.00
INS5	4.00	0.99
INS6	3.92	0.97
INS7	3.94	1.00
INS8	3.86	1.02
INS9	3.89	0.98
INS10	3.91	1.02
INS11	3.86	1.03
INS12	3.73	1.03
INS13	3.87	1.01
TECH1	4.18	0.99
TECH2	3.82	1.13
TECH3	3.88	0.98
TECH4	4.05	0.90
TECH5	3.99	0.88
TECH6	3.75	0.95
TECH7	3.96	1.01
TECH8	4.01	0.96
TECH9	3.99	1.05
TECH10	3.95	0.97
TECH11	3.91	1.04
TECH12	4.13	0.91
TECH13	3.88	0.98
STUD1	3.87	1.04
STUD2	3.58	1.06
STUD3	4.05	1.06
STUD4	4.00	1.00
STUD5	3.82	1.01
STUD6	3.96	1.04
STUD7	4.01	1.05
STUD8	3.59	1.013
STUD9	3.73	0.99
STUD10	3.54	1.07
STUD11	3.22	1.07
STUD12	3.30	1.11
STUD13	3.59	1.01
STUD14	3.10	1.04
STUD15	3.57	1.03
STUD16	3.68	1.00
STUD17	3.61	1.05
STUD18	3.68	1.04
STUD19	3.91	0.96
STUD20	3.73	1.00

Table 2 (*continued*)

Item	Mean	SD
STUD21	3.84	0.98
STUD22	3.81	0.94
SUP1	4.04	0.96
SUP2	3.86	0.94
SUP3	3.85	0.93
SUP4	3.69	1.00
SUP5	3.73	0.97

As recommended by Segars and Grover (1993), the confirmatory factor (or measurement) model should be assessed first and "fixed" before the structural equation model is examined. The validity of the confirmatory factor model can be assessed by confirmatory factor analysis using LISREL. As mentioned by Chau (1997), there is a number of measures generated by LISREL to evaluate the goodness of fit of the research model. The most popular index is perhaps the chi-square (χ^2) statistic. This statistic tests the proposed model against the general alternative in which all observed variables are correlated (in LISREL terms, unconstrained). With this index, significant values indicate poor model fit while non-significant values indicate good fit. This is why it is also called a "badness-of-fit" measure. Hartwick and Barki (1994) used four other measures of overall model goodness of fit: χ^2/degrees of freedom, Non-Normed Fit Index (NNFI), Comparative Fit Index (CFI), and Average Absolute Standardized Residual (AASR). In another study, Segars and Grover (1993) included several other measures of model fit: Goodness-of-fit Index (GFI), Adjusted Goodness-of-fit Index (AGFI), Pit Criterion, and Root Mean Square Residual. Segars and Grover (1993) recommended acceptance range for each measure of model fit, these ranges were readapted by Chau (1997). Poor goodness-of-model-fit indicates possible model misspecifications. Two parts of the LISREL output, standardized residuals and modification indices, can be used to help determine possible sources of the lack of fit.

Generally, LISREL consists of two distinct parts: the confirmatory factor model and the structural equation model (Chau, 1997; Segars & Grover, 1993). The confirmatory factor model specifies the relations of the observed factors to their posited underlying constructs. The structural equation model specifies the relationships of the constructs to one another as posited by research models (Chau, 1997). Based on the discussion presented in this section, the following section examines the confirmatory factor models of each e-learning CSF category.

4. Examination of the confirmatory factor models

Confirmatory factor models (CFMs) approach was conducted to specify and validate the underlying critical indicators in each of the e-learning CSF categories (instructor characteristics, student characteristics, technology, and university support). The CFM specifies the relations of the observed indicators to the e-learning CSF category. The purpose of the CFM is to describe how well the observed indicators serve as critical measurement of e-learning CSF category. LISREL version 8.52 was used to develop the polychoric correlation and asymptotic covariance matrices used in generating the factor loadings because all the items were represented by ordinal variables.

4.1. Instructor confirmatory factor model

Fig. 1 shows the 13 items (INS1–INS13) proposed to measure the instructor characteristics construct (INS) as a critical factor of e-learning acceptance by students. Standardized factor loadings or standardized validity coefficients are shown in Fig. 1 indicating high validity. The observed measures showed moderate fit of the model. The model yielded a χ^2 statistic of 141 and a *p*-value of 0.00 which suggested a moderate fit. The ratio χ^2/DF is 2.23, which is below the maximum allowed value of 3.0. The GFI, NNFI, CFI and AGFI values are 0.99, NFI is 0.98, and RMSEA is 0.05, all within acceptable levels. Standardized residuals and modification indexes provided by LISREL output suggested that the four indicators INS1, INS2, INS7, and INS8 should be separated from the other instructor characteristic indicators. The four indicators are related to the instructor's style and control of the e-learning tools. Therefore, the INS confirmatory factor model was split into two models: INS-A and INS-B. Fig. 2 shows the two measurement models. The observed LISREL fit measures satisfied the recommended values. This testifies to the validity of the indicators used to capture the instructor characteristics factor. INS7 and INS8 yielded the maximum validity coefficients of 0.88 and 0.91, respectively. They represent the most valid indicators of the instructor's control on e-learning technologies and tools. Since INS10 and INS13 had the maximum validity coefficient of 0.86, they are the most valid indicators of the instructor's teaching style and attitude towards adopting e-learning. All *t* values of the branches were significant (above 2.00).
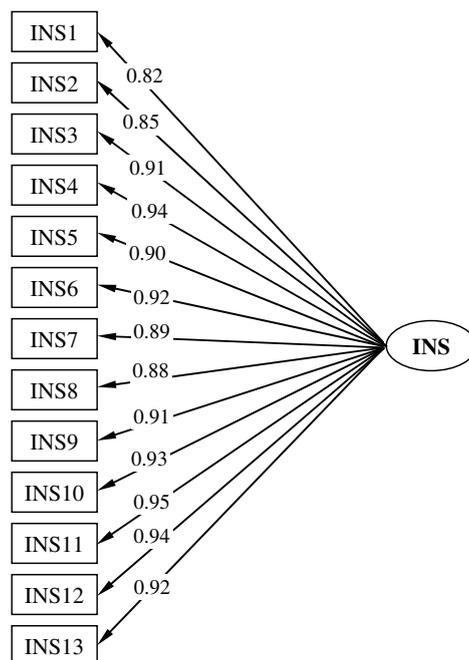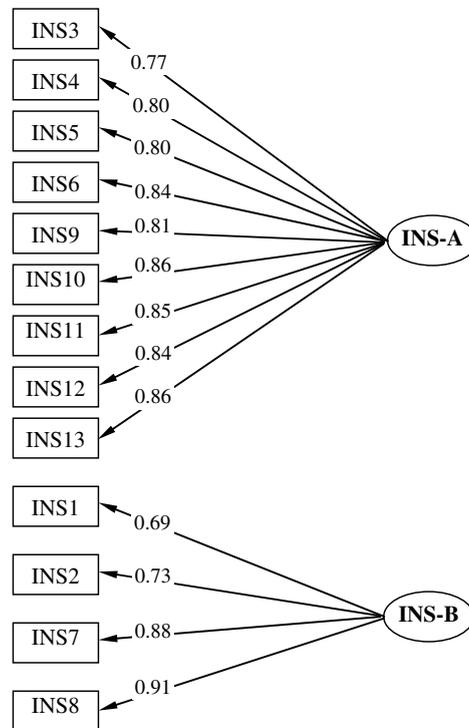

Fig. 1. Instructor confirmatory factor model.

Fig. 2. Confirmatory factor model of INS-A and INS-B.

4.2. Student confirmatory factor model

An attempt was made to test all of the student indicators (STD1–STD22) using one confirmatory factor model. The model's fit measures indicated poor fit and LISREL output suggested that the STD construct be split into 3 categories. The first, STD-COMP, consisted of STD1 to STD10 which measured student motivation to use e-learning technology, student computing competency, and student mindset about e-learning. The second, ST-COLL, comprised 5 items (STD11–STD15) that measured student interactive collaboration capabilities. The third, ST-CONT, comprised the last 7 indicators (STD16–STD22). All the 7 indicators were related to e-learning course content and design. This factor captured students' perception about interactivity, efficiency and effectiveness of Blackboard as a course management system used by the university as an e-learning resources management tool. The availability and timeliness of course materials and e-learning course components were tested by this CSF category.

Fig. 3 shows the ST-COMP confirmatory factor model. This category included student's motive to use e-learning and the approach that best suits him/her such as learning by construction or absorption. All the fit measures of ST-COMP model surpassed the acceptance levels indicating the adequacy of validity of the model, $\chi^2 = 52.69$, p-value $= 0.06$ which indicate good model fit. All the t values of the validity coefficients shown in Fig. 3 are significant indicating a non-zero correlation between the student computing ability indicators and the e-learning CSF category. STD6
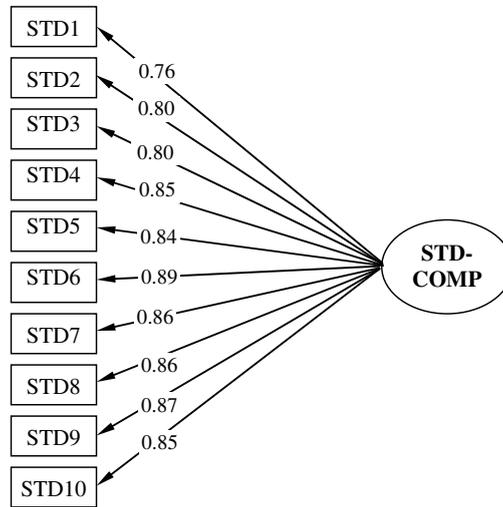
Fig. 3. Student computing confirmatory factor model.

indicator had the maximum validity coefficient of 0.89 indicating that this indicator is the most critical success factor among the 10 indicators. It can be concluded that the student previous knowledge in using computers is the most critical success factor that can be used to measure student computing capabilities to absorb and accept e-learning. This factor was followed by STD9 with validity coefficient of 0.87. STD9 measured the student ability to learn using a construction approach that is by participation and contribution. All included indicators exhibited a level of criticality to the acceptance of e-learning (all validity coefficients were more than 0.75).

Fig. 4 shows the confirmatory factor model for STD-COLL that represented the student interactive collaboration abilities. All the fit measures were within the acceptable levels, $\chi^2 = 4.29$, p-value $= 0.12$ which indicate good model fit. This e-learning CSF category indicated that the more interactions the students get exposed to, the more opportunities they have to learn. The e-learning resources such as on-line discussion forums can play a mediating role for collaboration among students. All validity coefficients were significant with t values of more than 2.00. As shown in Fig. 4, STD14 has the maximum validity coefficient indicating that the ability of the students to initialize discussions is the most critical factor in measuring the student collaboration abilities.

Examining ST-CONT confirmatory factor model revealed good fit ($\chi^2 = 15.15$, p-value $= 0.30$) indicating high validity of the model. Fig. 5 shows the model with validity coefficients of values
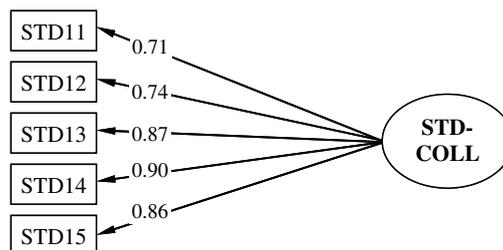

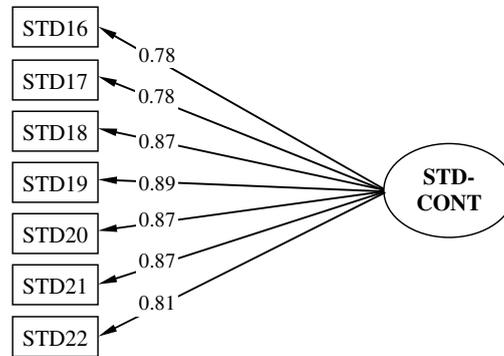Fig. 4. Student collaboration confirmatory factor model.

Fig. 5. Student content confirmatory factor model.

more than 0.75 and significant. Navigating course webs (STD19) showed the maximum validity coefficient indicating high level of criticality. The validity coefficients showed that all the 7 indicators are considered CSFs and crucial to the acceptance of e-learning technologies and tools.

4.3. Technology confirmatory factor model

The technology CSF category of e-learning acceptance was measured by 13 indicators. The indicators used in the technology factor were related to the ease of technology access and navigation, visual technology interface, and the information technology infrastructure reliability and effectiveness. The technology (TEC) confirmatory factor model was evaluated for its validity. The measures suggested a moderate fit of the measurement model. The LISREL output was examined and accordingly the TEC factor category was split into two factors, TEC-A and TEC-B. The TEC-A factor, shown in Fig. 6, comprised indicators related to technology access, navigation, and interface. TEC-B factor, shown in Fig. 6, included the indicators related to information technology infrastructure reliability and effectiveness. Both measurement models were examined and yielded good fit measures and achieved the recommended levels. As shown in Fig. 6, TEC4 yielded the maximum validity coefficient indicating the most critical factor to measure TEC-A CSF category is the ease of use of web facilities. Both TEC3, TEC5, and TEC6 showed very high validity coefficients in support to TEC4 criticality. They indicated to the criticality of screen designs, browsing speed, and well structured content. TEC-B CSF category had TEC10 as the most valid indicator with coefficient value of 0.89 and this indicated to the criticality of computer labs availability to students. All validity coefficients were significant as indicated by the *t* value of each one. The students were mostly satisfied with the on-campus Internet access, course websites available via Blackboard, and online course registration.

4.4. Support confirmatory factor model

The university support factor is the second wing of the technology factor and was measured using 5 indicators. All the items were related to university support to e-learning initiatives available. The support included library services, help desk, computer labs and facilities. Students were mostly satisfied with university support. The SUP confirmatory factor model is given in Fig. 7.
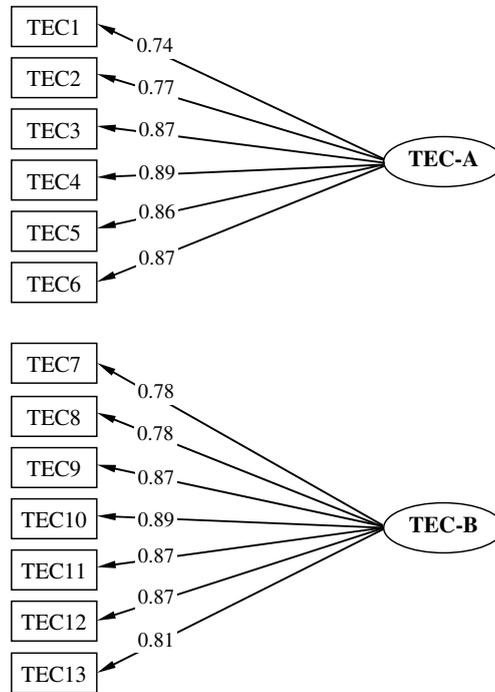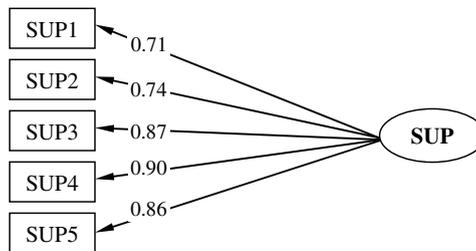
Fig. 6. Technology confirmatory factor model.

Fig. 7. Support confirmatory factor model.

Examining the model revealed good fit measures indicating high level of validity. SUP4 was the most critical factor in measuring the university support. SUP4 measured the availability of computers to practice. Two more critical factors of the university support were the availability of printing facilities and the student over all satisfaction with the university support to e-learning initiatives.

E-learning CSFs were specified within each CSF category. The proposition of grouping e-learning CSFs into 4 categories was not supported by the research results. The confirmatory factor models test results proposed 8 categories for e-learning CSFs as follows: (1) instructor's attitude towards and control of the technology, (2) instructor's teaching style, (3) student motivation and technical competency, (4) student interactive collaboration, (5) e-learning course content and structure, (6) ease of on-campus internet access, (7) effectiveness of information technology infrastructure, and (8)

university support of e-learning activities. Each category of the 8 categories included several critical measures. The level of criticality of each indicator is represented by its validity coefficient.

5. Conclusions and future work

E-learning has been and will be adopted by many higher education institutions. Consequently, several adoption-related critical factors must be carefully evaluated before, during, and after any adoption. The adoption of e-learning technology is a complicated process of establishing and developing an integrated information technology system. This paper, in line with the literature, specified eight e-learning critical success factor (CSF) categories that can assist universities and instructors to efficiently and effectively adopt e-learning technologies. The criticality level of each CSF was evaluated. The specified e-learning CSF categories were based on students perceptions and included: instructor characteristics (attitude towards and control of the technology, and teaching style), student characteristics (computer competency, interactive collaboration, and e-learning course content and design), technology (ease of access and infrastructure), and support. The eight CSF categories impact the decision to adopt e-learning technology in higher education institutions. A sample of 37 class sections with 900 enrolled students was used to identify and measure the proposed e-learning CSFs. The students perceived the eight CSF categories as critical determinants of e-learning acceptance.

All indicators of the instructor's attitude towards and control of technology indicated high levels of criticality to measure the posited category. The validity coefficient values were above 0.75 indicating high level of validity. The most critical indicators were instructor's attitude towards interactive learning and teaching via e-learning technologies. All indicators of the instructor's teaching style yielded validity coefficients of 0.69 or more indicating reasonable to high criticality of all the 4 measures of this category.

Student motivation and technical competency measures indicated high levels of validity with values of 0.76 or more. Previous student experience with personal computers came as the most critical factor in this category with a validity coefficient of 0.89. The class discussion was perceived as the most critical factor in the student interactive collaboration category. Course content as an e-learning CSF category contained 7 critical factors. All validity coefficients had values of 0.78 or more. Course management system was the most critical factor in this category with 0.89 validity coefficient.

In the technological dimension, the ease of on-campus Internet access category included 6 factors. The ease of use of the course web was the most critical factor followed by browser efficiency and screen design. Reliability of the information technology infrastructure as a CSF category comprised 7 factors. The most critical factor among them was the availability of computer labs for practice. Computer network reliability and student information system came in the second place of criticality with 0.87 validity coefficient. University support was not limited to technical assistance and troubleshooting but included library and information availability. Students indicated that they would register in future e-learning based courses assuring their positive attitude and support to e-learning technology and tools.

For future work, there is a need to expand on this research to develop a causal structural equation model that includes all the 8 constructs (INS-A, INS-B, ST-COMP, ST-COLL, ST-CONT,

TEC-A, TEC-B, and SUP). The objective of the causal research model would be to study the effects of the first 8 CSFs on e-learning acceptance which can be represented as a 9th construct in the research model. The proposed research model can generate causal relationships among the 9 factors. Another future expansion is to check the validity of the causal research model in different countries. In conclusion, this study specified the critical factors affecting e-learning technology adoption by universities from students' perspective.

Acknowledgments

Appendix. E-learning CSF instrument

Instructor characteristics (INS)	
INS1	The instructor is enthusiastic about teaching the class
INS2	The instructor's style of presentation holds me interest
INS3	The instructor is friendly towards individual students
INS4	The instructor has a genuine interest in students
INS5	Students felt welcome in seeking advice/help
INS6	The instructor encourages student interaction
INS7	The instructor handles the e-learning units effectively
INS8	The instructor explains how to use the e-learning components
INS9	I feel the instructor is keen that we use the e-learning based units
INS10	We were invited to ask questions/receive answers
INS11	We were encouraged to participate in class
INS12	The instructor encourages and motivates me to use e-learning
INS13	The instructor is active in teaching me the course subjects via e-learning
Student characteristics (STD)	
STD1	The e-learning encourages me to search for more facts than the traditional methods
STD2	The e-learning encourages me to participate more actively in the discussion than the traditional methods
STD3	I enjoy using personal computers
STD4	I use the personal computers for work and play
STD5	I was comfortable with using the PC and software applications before I took up the e-learning based courses

Appendix (*continued*)

STD6	My previous experience in using the PC and software applications helped me in the e-learning based courses
STD7	I am not intimidated by using the e-learning based courses
STD8	I learn best by absorption (sit still and absorb)
STD9	I learn best by construction (by participation and contribution)
STD10	I learn better by construction than absorption
STD11	I only read messages in the discussion group
STD12	I do read as well as participate in the discussion group
STD13	The instructor initiated most of the discussion
STD14	The students initiated most of the discussion
STD15	The instructor participated actively in the discussion
STD16	I found the instructions on using the e-learning components to be sufficiently clear
STD17	I found the course content to be sufficient and related to the subject
STD18	It was easy to understand the structure of the e-learning components
STD19	It was easy to navigate through the Blackboard/course web
STD20	The e-learning components was available all the time
STD21	The course materials were placed on-line in a timely manner
STD22	I perceive the design of the e-learning components to be good
Technology (TEC)	
TEC1	Easy on-campus access to the Internet
TEC2	Did not experience problems while browsing
TEC3	Browsing speed was satisfactory
TEC4	Overall, the website was easy to use
TEC5	Information was well structured/presented
TEC6	I found the screen design pleasant
TEC7	I could interact with classmates through the web
TEC8	I could easily contact the instructor
TEC9	I can use any PC at the university using the same account and password
TEC10	I can use the computer labs for practicing
TEC11	I can rely on the computer network
TEC12	I can register courses on-line using Banner
TEC13	Overall, the information technology infrastructure is efficient
Support (SUP)	
SUP1	I can access the central library website and search for materials
SUP2	I can get technical support from technicians
SUP3	I think that the UAEU e-learning support is good
SUP4	There are enough computers to use and practice
SUP5	I can print my assignments and materials easily

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