Assessment of the Psychometric Properties of E-learning Instructional Design Quality

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Abstract

With the ever-growing adoption of E-learning as an alternative mode for instructional delivery, and indeed as part of the strategic plan by higher learning institutions to foster open and distance learning, the development of empirically tested guidelines to evaluate E-learning instructional quality is timely. The purpose of the study was three-fold, that is to, explore the underlying structure of the E-learning instructional design quality construct, test the adequacy of its psychometric properties in terms of common method bias, reliability, convergent and discriminant validity, and cross validate the consistency of the measurement model across samples. The quantitative data was collected from a stratified random sample of 837 students undertaking CISCO E-learning courses at ten different institutions of higher learning in Uganda. A 38-item self-reported questionnaire to measure E-learners' perceptions on E-learning instructional design quality served as the research instrument. The collected data were analysed using Exploratory Factor Analysis and Confirmatory Factor Analysis, with SPSS version 20.0 and AMOS version 22.0 softwares. The study results revealed that E-learning instructional design quality is a multidimensional construct with the sub dimensions of content quality, interface design quality, instructional strategies, content interactivity and E-learning feedback. Moreover, the measurement model was found to be free from common method bias and demonstrated adequacy in its validity and reliability. However, the results of cross validation indicated that the measurement model was not consistent across the three samples as shown by the variations in the model fit indices. The results are valuable to enable E-learning stakeholders to take strategic and evidence-based decisions regarding the integration of E-learning interventions for quality learning outcomes and enhanced future research in the domain of E-learning instructional design quality. Specifically, this study has successfully validated an E-learning instructional design quality questionnaire that educationists can use in evaluating E-learning courses regarding instructional design soundness.

Keywords: Instructional design quality, content format, interface design quality, embedded support devices, content sequencing, E-learning feedback, content interactivity, CISCO courses

INTRODUCTION

E-learning Instructional Design Quality

The concept of E-learning instructional design quality is multidimensional in nature that is applied to define a set of desirable instructional design attributes for E-learning. Besides, quality seems to have no universally agreed definition, since each prospective stakeholder considers numerous features of a service or product which they refer to as constituting quality, hence multidimensional (Vlachopoulos, 2016). Important to note though, is that, the concept of quality does not imply perfection, but rather a means of measuring satisfaction of a given criteria/standards to ensure it (Vlachopoulos, 2016).

Skills development and lifelong learning have been underscored as post-2015 educational priorities that could be fostered via E-learning in the form of E-learning/digital content. Such digital content is useful for enabling the: (i) expansion of learner access to both formal and informal learning, (ii) diversification of learning pathways to cater for diverse pedagogical interests, and (iii) blended learning in dynamic contexts (UNESCO, 2015). Thus, in realization of such potential benefits afforded by digital technologies and content, quality assurance is central to stakeholders' validation and improvement of E-learning interventions. Also, worth noting is that, as learners and instructors tend to be physically separated in the E-learning environments, the design of the E-learning course environments based on established instructional theory is vital to instructional quality and learning effectiveness rather than merely focusing on E-learning as an delivery medium (Ally, 2004).

A Review of Existing E-Learning Quality Standards

The very nature of E-learning necessitates carefully crafted and developed guidelines to ensure quality learning outcomes (Marciniak, 2018). In response to the need for E-learning/Online learning quality assurance, there has been an evolving trend of guidelines in relation to E-learning among researchers and institutions. At individual researcher level, efforts have been noted. For example, Mhlanga, Krull, and Mallinson (2013) based on the synthesis of selected existing quality guidelines have created a set of Online quality indicators. They have identified four areas of course design, course activities, assessment, and technology as essential to improving the quality of online courses. In a quite similar manner, Barnard and Echolas (2015) have suggested that an Online programme should include the elements of learning strategies, thematically developed content, learner profiles, attributes of educational technology, and techniques for assessing the learning process. Meanwhile, Marciniak (2018) has suggested a set of quality components for Online education. That is, it should include and clarify among others on the elements of: programme objectives, thematic nature of content, learning activities, learning assessment methods, and nature of the virtual classroom environment. Clawson (2007) in a related trend developed a taxonomy of Online course quality standards which covers course content and materials, alignment, instructional strategies, feedback, information design, and accessibility. Lastly, Masoumi (2010) created an e-Quality framework for Virtual learning institutions with seven dimensions of pedagogical, instructional design, technological, evaluation, student support, institutional and faculty support factors (Masoumi, 2010; Masoumi & Lindstrom, 2012).

At institutional level, numerous efforts towards E-learning quality are evident. A case in point, the Quality Matters Program (2013) has indicated overview and introduction, objectives, accessibility, assessment, instructional materials, learner interaction and engagement, course technology and learner support as constituting quality in E-learning. Meanwhile, the INACOL National Standards for Quality Online Courses has evolved the quality components of instructional design, content, assessment, technology and course evaluation and support (INACOL, 2011). The Quality Online Course Initiative of the University of Illinois (2015) has suggested six item criteria for E-learning assessment. The criteria include the aspects of instructional design, web design, student evaluation, course evaluation, communication interaction and communication, and lastly learner support resources.

THEORETICAL FRAMEWORK

The current study was grounded on the synthesis of Khan's (2005) E-learning framework and the three-way model for computer-initiated interaction by Evans and Sabry (2003) as elaborated in the next sections.

Khan's (2005) E-learning Framework

Khan's E-learning framework can be considered one of the comprehensive theoretical models available for assessing the degree of success with E-learning interventions. The E-learning Octagonal framework by Khan covers the eight areas of, interface design, pedagogical, technological, resource support, evaluation, management, institutional and ethical dimensions. The eight dimensions have generally been clustered into broad areas which are technological, educational and organisational (Khan, 2005). As per the current study, the framework components of interface design and pedagogy have been adapted for purposes of elaborating on the hypothesized E-learning instructional design quality aspects of interface design quality, content quality and instructional strategies. The pedagogical domain of the E-learning Octagonal framework describes issues related to design approach, media analysis, content analysis, instructional strategies and methods used in E-learning. The interface design dimension on the other hand, elaborates on the overall look and feel of E-learning course environment, with special focus on design of the E-learning site, navigation and content design (Khan, 2005).

Evans and Sabry's Three-way Model for Computer Initiated Interaction

The three-way model for computer-initiated interaction as forwarded by Evans and Sabry (2003) postulates that interactivity in a Computer-Mediated Environment includes a sequence of three actions, which are, initiation, response and feedback. Moreover, each of the three actions involves a one-way movement of information between two agents (User and the Computer-based environment). According to Evans and Sabry (2003), the initiation action takes place when the first agent requires input from the second agent. Then, the response action involves the second agent providing the input as required. The third action of feedback entails the first agent returning information regarding the initial response. To that end, there is a kind of dependant relationship between the three interactivity actions, given that response is a direct result of initiation, and feedback has to be in agreement with the response. A classical illustration of the three-way model for computer-initiated interactivity is when: (a) the E-learning environment presents the learner with a quiz (initiation), (b) the learner answers the quiz by supplying the answer (response), and (c) the E-learning environment informs the learner about the extent and correctness of the answer provided (feedback), and the interaction goes on and on to form a loop. In the interest of the current study, the hypothesized components of E-learning Feedback and E-learning Content interactivity have been derived based on the three-way model for computer-initiated interaction. The hypothesized E-learning instructional design quality subconstructs in the study are briefly elaborated in the following section.

Content Quality

Content quality may be defined as the inherent characteristics of the information, concepts, principles used by learners as reflected in format of presentation, extent of usefulness, timeliness, accuracy, structure and sequence (Dick *et al.,* 2009; Wixom & Watson, 2001). The format of information presentation is a feature that examines the mode of content presentation, for example, as text, video, audio, graphics and animations. The attribute of relevance of information gauges the extent of congruence between what the student requires and what is availed by the E-learning content. The concept of timeliness denotes the accessibility to learning content at the time suitable for its use, and when it is up-to-date. The attribute of accuracy of the information gauges the degree of correctness regarding the E-learning materials, in as much as they are free from errors. Lastly, structure and sequence pays attention to the way learning content is ordered and choice of topics, alignment with learning objectives, instructional activities and assessment. Structure and sequence of content sequencing can take the form of known to unknown, simple to complex, according to cause-effect relationships. Thus, in order to meet or even exceed learners' needs and expectations, E-learning content should be properly sequenced and structured, presented in a friendly format, accurate, and with relevant learning activities. It becomes critical therefore, that E-learning content is presented in a consistent manner, with learning materials in multiple modes of text, graphics, video, audio and animations (Alessi & Trollip, 2001; Koslow, 2015; Sahin & Shelley, 2008; Simonson *et al.*, 2008).

Interface Design Quality

Interface design quality can be defined as an aggregate of the desirable features of an information system that allow user engagement and navigation in terms of system flexibility, intuitiveness, ease of use, reliability, and response time (Faghih et al. 2013; Petter, DeLone, & McLean, 2008). As underscored by Guralnick (2006), interface design for E-learning is of essence because the degree of learning success and user interface design are intertwined; moreover, the effectiveness of user interface quality fosters learners' accomplishment of learning tasks. Additionally, E-learning interface design plays the fundamental roles of affording learners ease of orientation to instructional content, providing essential navigational tools for access to pedagogical support, instructional content and facilitating learners-course feedback (Lohr, 1998).The nature of the E-learning interface design quality is influenced by the attributes of text, graphics and interactive tools employed to give elaborate instructional guidance (Centers for Disease Control and Prevention, 2013; Faghih *et al.*, 2013). It is crucial therefore, that user interfaces for E-learning courses are designed to enhance user-friendliness, with clear navigational tools to guide learners in the course environment and the ability to proceed through it with ease (Center for Disease Control and Prevention, 2013). The benefit is that, the ability of the learners to understand the architecture of the user interface will enhance their E-learning course experience. On the contrary though, if E-learners have difficulty in accessing the instructional materials due to a poorly designed user interface design, the likelihood of frustration with the learning process is high (Koslow, 2015).

Instructional Strategies

Instructional strategies are intended to foster learning proficiency and mitigate obstacles that tend to arise during the process of learning and assimilation of new knowledge in digital learning environments (Clawson, 2007; Ekwue, 2013). Given the critical role of instructional strategies as intermediaries that help to activate learner-to-learner, learner-to-interface, instructor-learner, learner-to-content interactivity for meaningful learning, E-learning courses should be designed to integrate several instructional approaches as a way to cater for varied student learning styles (Lorenzo, 2012; Gaytan & Mcewen, 2007;. Hathaway, 2009). Instructional strategies in E-learning courses can be generally classified as teaching strategies and embedded support devices. Teaching strategies, on the one hand, enable the instructor to efficiently deliver learning content and experiences to the learners. For example, student collaborative method, inquiry method, project-based method, demonstration and drill and practice are among the most useful teaching strategies (Khan, 2005). Embedded support devices on the other hand are related formal and content related add-ons that serve to elaborate on the learning content (Martens, 1993). Simply stated, embedded support devices act as learner support tools included in E-learning materials to facilitate self-study. The commonly applied support devices are, tests of prior knowledge, advanced organisers, learning objectives, lesson summaries, question feedback and use of examples (Martens, 1998).

E-learning Feedback

The role of E-learning feedback in fostering meaningful learning cannot be under estimated as it is essential to enable learners make reflections on what they are learning and necessary adjustments to the learning process. Thus, as Hyland (2000) cited in Hatziapostolou and Paraskakis (2010) has pointed out, feedback is useful in the process of evaluating learner confidence, motivation and achievement, particularly with E-learning. For E-learning feedback to be effective, it should demonstrate the attributes of being prompt and thorough, constructive and supportive, and above all, ongoing, objective and consistent. There is need as Martinez-Arguelles et al. (2015) have noted to design and provide E-learning feedback in a variety of formats (text, video, graphic) to meet diverse learner interests. Moreover, Webb and Moallem (2016) have emphasised that motivating, timely and informative feedback helps learners to improve their E-learning process. Effective feedback should not be limited to mere comments from the E-learning course environment or instructors; but rather, should extend to strategies like peer and automated feedback hat are important to enhance student learning (Bonnel *et al.*, 2007 as cited in Bonnel (2008). The foregoing assertion by Bonnel **et al.** (2007) has equally been underscored by Byers (2010) who reports that interactive and personal feedback influences learners' satisfaction with the online learning experience.

E-learning Content interactivity

The degree of interactivity that occurs between the learner and the E-learning course content is an indicator that E-learning was well designed and implemented. Thus, a clear understanding of learner-to-E-learning content interactivity is important for the appropriate use of delivery methods that influence the quality of student learning and course completion rates in E-learning (Murray *et al.*, 2013; Zimmerman, 2012). E-Learning content interactivity can be conceptualised in terms of the opportunities that help E-learners to spend time with and work on course content in terms of reading and reviewing text, audio, video material, web pages, e-books, PowerPoint slides, attending discussion forums, and completing quizzes (Su *et al.*, 2005). The above trends in the empirical findings clearly align with Murray et al. (2013) who have postulated, the more time learners spend interacting with content, the higher the possibility of earning better grades on a learning unit, and eventually in the overall module.

Statement of the Problem

With the rapid development and popularity of E-learning as a trending mode of facilitating conventional learning, adult learning, and corporate training given its benefits like flexibility and cost-effectiveness, the urgency to evaluate E-learning quality is raising concerns among stakeholders (Zhang & Cheng, 2012). And as Casey (2008) and Jung and Latchem (2007) have noted, E-learning continues to face issues related to suspicion and quality. To that end, concerted efforts have been stepped up at individual and institutional levels intended to consider matters related to E-learning quality assurance (Jung *et al.*, 2011; Endean, Bai, & Du, 2010). For example, at the institutional level, E-learning frameworks like Quality Matters Program, The Online Consortium, iNACOL National Standards for Quality Online Course quality, Latin American and Caribbean Institute for the Quality of Online Higher Education, The African Council for Distance Education, and The African Virtual University

Frameworks have been established. At individual level, Mhlanga *et al.* (2013), Barnard and Echols (2015, Clawson (2007), Masoumi (2010) among others have looked at concerns regarding E-learning quality.

However, review of literature reveals that a very limited number of the existing E-learning guidelines have in a specific and comprehensive manner focused on the instructional design quality in light of empirical data. Such existing E-learning quality guidelines have rather focused more on general issues at E-learning/Online programme level, ranging from implementation, institutional support and student support systems, and less concentration has been paid to the aspect of instructional design quality. Thus, the inadequacy of empirically tested and established guidelines for evaluating the instructional design quality of E-learning courses acted as the precursor for the current this study. Therefore, the purpose of this study was to validate psychometric properties of the instructional design quality construct in relation to E-learning courses.

Research Objectives

In order to contribute to the existing efforts in addressing the concerns related to E-learning instructional design quality, the current study was guided by three key objectives that acted as a point of referral. Thus, the study specifically sought to:

1) Explore the underlying factor structure of the E-learning instructional design quality construct,
2) Validate the psychometric properties of E-learning instructional design quality in terms of common method bias, reliability, convergent and discriminant validity, and
3) Establish if the measurement model of E-learning instructional design quality is consistent across samples.

Research Hypotheses

Based on Khan's E-learning Octagonal Framework, Evans and Sabry's Three-way Model for Computer Initiated Interaction and the foregoing assertions on E-learning instructional design quality in empirical studies, it was hypothesized that:

1) E-learning instructional design quality is a multidimensional construct with interrelated sub-dimensions
2) The E-learning instructional design quality construct is psychometrically sound in terms of reliability, common method bias, convergent and discriminant validity
3) The E-learning instructional design quality measurement model is consistent across samples

METHODOLOGY

Sample

The quantitative data for this study were collected from 837 students undertaking CISCO E-learning courses at ten different institutions of higher learning in Uganda. Most of the respondents were males, constituting 61% while the females trailed at 39%. In terms of their ICT knowledge, almost 56% of the students rated themselves as being at intermediate level. While about 22% rated their level of ICT knowledge as being at beginner and a similar number at advanced level. Meanwhile, over 77% of the students reported to be taking the

CCNA E-learning course. And 23% of the students were taking other CISCO E-learning courses of CCNP, IT Essentials and Cyber Security.

Instrument

A self-Administered questionnaire with 38 items was used in the process of data collection to measure students' perceptions on E-learning instructional design quality. The measurement items were derived from the literature review of related studies on the subject, and some of the items had been used by some previous researches studies. The items were mainly drawn from the work of Clawson (2007), Debattista (2018), Khan (2005), Masoumi and Lindstrom, (2012), Martens (1993) and Martens (1998). The items were first subjected to content-validation by the experts, as well as a pilot study before being applied in the current study. Thus, the hypothesised sub-dimensions were content quality (11 items), interface design quality (7 items), instructional strategies (8 items), E-learning content interactivity (7 items) and E-learning feedback (5 items).

Data Analysis Procedures

In pursuit of the research objectives, the current study applied two Multivariate Analysis tools of Principal Component Analysis (PCA) and Confirmatory Factor Analysis (CFA) under SPSS version 20.0 and AMOS 22.0 softwares respectively. First, Principal Component Analysis was employed to explore the underlying structure of E-learning instructional design quality from the data. Moreover, the Promax rotation method was chosen, based on the assumption that the expected dimensions of content quality, interface design quality, instructional strategies, E-learning content interactivity and E-learning feedback were theoretically correlated. Second, Confirmatory Factor Analysis was applied as a means of assessing the psychometric properties of the constructs regarding common method bias, composite reliability, convergent and discriminant validity. Cross validation of the measurement model across samples was also done using CFA. Furthermore, the Cronbach alpha index was used to establish the internal consistency of the constructs, while Total Variance Explained (TVE) was applied to verify the construct validity.

RESULTS

Dimensionality of E-learning Instructional Design Quality

Table 1 presents the descriptive analysis of the observed variables for the E-learning instructional design quality construct. The overall mean scores for each of the subconstructs ranged between 3.94 and 4.14, implying that respondents to a large extent expressed their agreement with the observed variables for the construct under study. In terms of reliability, the Cronbach indices (which indicate the internal consistency of the items to the construct) were satisfactory as they exceeded the threshold of 0.7 (Pallant, 2007). For example, they ranged between .845 and .891. Preliminary analysis further revealed adequate construct validity with all components indicating TVE above the threshold of 40%. For example, on the lower end, content quality yielded 47.8% of the variance, while E-learning feedback had 62.3% of the variance on the higher side.

Table 1: E-learning instructional design quality dimensions and item statistics

Code	Dimension/items	Factor Loading
Content Quality (Alpha=.887, TVE=47.8%, Overall Mean=3.98)		
cq1	Video learning content	.531
cq3	Text learning content	.752
cq4	Lessons notes that are clear	.857
cq5	Pictures to illustrate the learning content	.796
Cq6	Animated learning content	.643
cq7	Learning content that uses vocabulary suitable to my learning level	.629
cq8	Provides me with learning activities to support the course objectives	.540
cq9	Clearly states the grading method to be used	.661
cq10	Provides me with content that is well-organized	.681
cq11	Breaks down practice activities appropriately for ease of my understanding	.682
cq12	Provides me with learning activities that follow each other	.541
Instructional Strategies (Alpha=.891, TVE=60%, Overall Mean=3.94)		
Instr6	Seek my own answers while learning	.500
instr10	Elements for gaining attention during learning	.815
Instr11	Lesson activities that increase my learning success	.736
Instr12	Strategies for stimulating recall of my prior information	.859
Instr13	Strategies for maintaining attention on content being learnt	.806
Instr14	Strategies for enhancing learning retention	.774
Instr15	Elements that maintain my motivation during learning.	.777
Instr16	Opportunities for practice of difficult concepts I learn	.680
Interface Design Quality (Alpha=.885, TVE=56.4%, Overall Mean=4.00)		
intf1	Has navigational tools on all pages	.706
inf2	Enables me to control my learning progress.	.711
intf3	Has well organized pages	.688
intf4	Has predictable screen changes	.797
intf5	Presents me with a logical sequence on how to complete tasks	.735
intf6	Gives me clear page directions.	.740
intf7	Allows a new page to open in a new browser window	.759
E-learning Content interactivity (Alpha=.891, TVE=60.5%, Overall Mean=4.08)		
lc2	Multiple menus	.625
lc3	Links to previously visited sites and pages	.730
lc4	Uses a variety of quizzes	.697
lc5	Uses a variety of drag and drop activities in the learning content	.697
lc6	Allows me to access extra learning content outside the course	.809
lc7	Allows me to easily save learning content in a familiar format	.822
lc8	Gives me hints on how to complete learning activities like quizzes	.834
E-learning feedback (Alpha=.845, TVE=62.3%, Overall Mean=4.14)		
fb1	Provides feedback immediately after making an action	.736
fb2	Provides me with feedback to verify the correctness of my responses	.826
fb3	Provides me with feedback on my performance	.831
fb4	Gives me feedback in a short time whenever I make I request	.729
fb5	Records my learning progress and performance.	.725

Note: Extraction Method: Principal Component Analysis; Rotation Method: Promax with Kaiser Normalization

In exploring the underlying factor structure of E-learning instructional design quality, Principal Components Analysis (PCA) was employed as the data analysis technique. The preliminary checks indicated that the extent of intercorrelations among the measurement items justified the applicability of PCA (Kaiser-Meyer-Olkin Measure of sampling adequacy index=.959, and Bartlett's Test of Sphericity was significant $\chi^2(780) = 17814.8$, p=.000). As depicted in the scree plot (Figure 1), PCA based on Promax rotation for the 38 items extracted five components, with the solution accounting for 56% of the total variance. From Table 1, the results of Principal Component Analysis further revealed that the factor loadings (which are used as a measure of correlation between the observed variable and the factor) were all satisfactory (>0.5). Moreover, the extracted components reveal that E-learning instructional design quality is indeed a multidimensional construct. The resulting sub constructs were labelled as content quality, interface design quality, instructional strategies, E-learning content interactivity and E-learning feedback. In conclusion therefore, objective one has been attained and hypothesis one of this study has been supported.

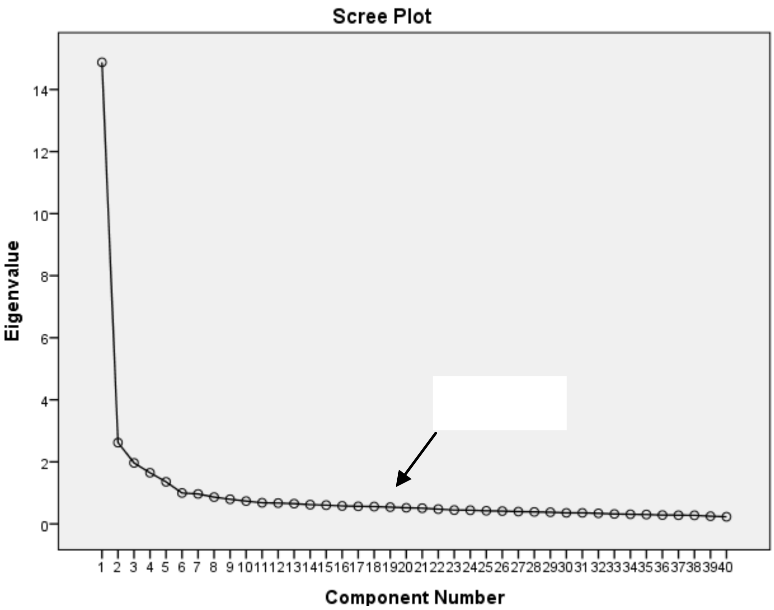

Figure 1: Scree plot

Validity of E-learning Instructional Design Quality

In order to establish the common method bias, construct reliability and validity, Confirmatory Factor Analysis (CFA) was employed on the data set from the sample. The results of the first CFA model in Figure 2 revealed that the one-factor structure of E-learning instructional design quality was indeed not adequate to represent the data. That is, the goodness of fit statistics was below the acceptable levels. Specifically, the χ^2/df =8.236 (greater than the recommended 5); CFI=.704 (smaller than the recommended .90), and RMSEA=.093 (greater than the recommended .08) (Kline, 2016; Matsunaga, 2011).

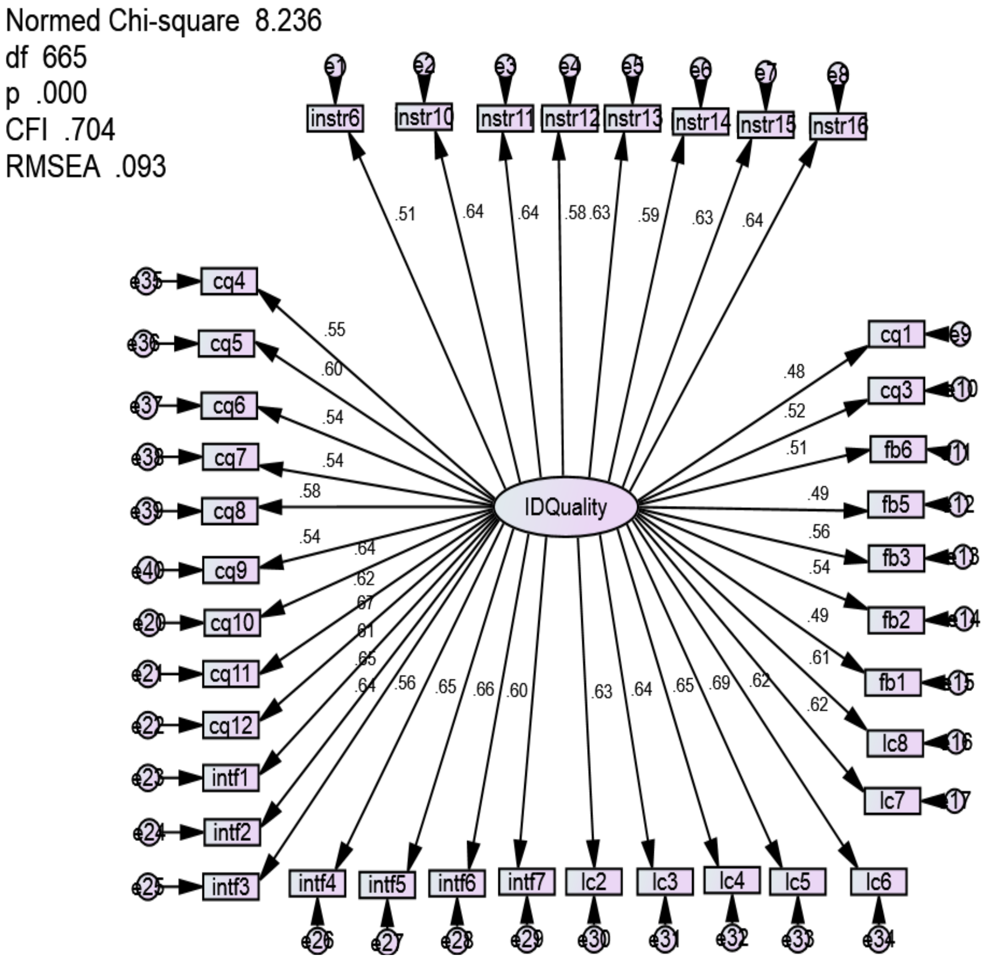

Figure 2: One-Factor CFA model for E-learning instructional design quality

The implication therefore, is that the fit statistics have shown inconsistency with the data at hand. The absence of fit for the one-factor model means that common method bias did not pose a threat to the E-learning instructional design quality instrument. Meanwhile, the five-factor CFA model in Figure 2 produced the hypothesised results, meaning that the measurement model of instructional design quality represented the data. That is, the goodness-of fit for the model was satisfactory (χ^2/df =2.939<5; CFI=.922>.90; RMSEA=.048<.08). Moreover, the parameter estimates demonstrated statistical and practical significance, given that the magnitude and direction of the standardised factor loadings yielded as earlier hypothesised.

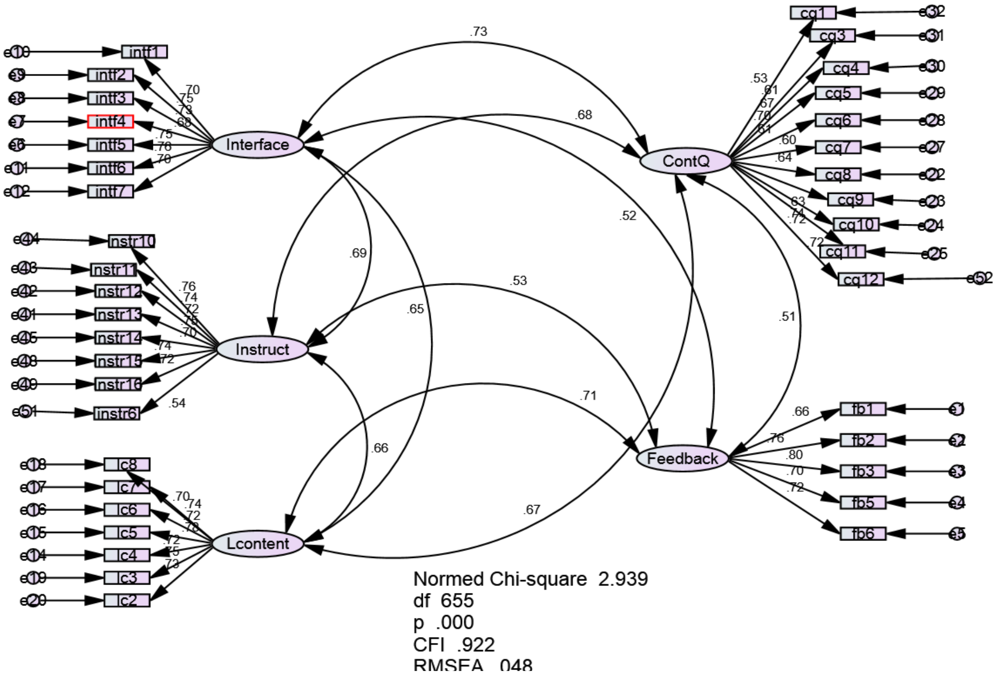

Figure 3: Five-factor model for E-learning instructional design quality

As presented in Table 2, further evidence about the adequacy of the measurement model has been established in terms of reliability, convergent and discriminant validity. The Average Variance Explained (AVE) as indicated by the values along the diagonal show that each of the sub-constructs attained the threshold of 0.5 for convergent validity. It is implied therefore that the measurement items adequately represented the respective sub-constructs in the five-factor model.

Table 2: Inter-factor correlations, shared variance, average variance extracted, and construct reliability among constructs

Dimension	1	2	3	4	5
Content Quality	0.694	0.424	0.527	0.27	0.508
Interface Design Quality	0.726	0.611	0.471	0.442	0.462
Instructional Strategies	0.68	0.686	0.649	0.282	0.456
E-learning content Interactivity	0.675	0.651	0.665	0.681	0.264
E-learning Feedback	0.514	0.52	0.531	0.713	0.664
Composite Reliability	0.911	0.916	0.918	0.922	0.884

Note: (a) Average Variance Explained for each sub-construct along the diagonal; (c) Correlation matrix below the diagonal; (c) Shared variance matrix above the diagonal; (d) All AVEs>shared variance.

Additionally, the measurement of instructional design quality demonstrated satisfactory discriminant validity. This was true as all the AVE values were greater than the corresponding shared variance values (above the diagonal). Lastly, the inter-factor correlations as presented in Figure 2 offered evidence that instructional design quality was indeed a multidimensional construct made up of distinct but inter-related sub-constructs of content quality, interface design quality, instructional strategies, E-learning content interactivity and E-learning feedback. Thus, objective two of the study has been achieved, and hypothesis two accepted.

Measurement Model Cross Validation

To further confirm the goodness of fit (GOF) of the measurement model, cross-validation was conducted. This decision was guided by the recommendations by Hair et al. (2010) and Byrne (2010) that sample data can be split to estimate a model. The sample data in the current study was divided into two folds of training set (n=419) and test set (n=418) which was later compared with the validation set (n=837). Results indicate that although the model fit for the training dataset (Figure 3) is satisfactory (χ^2/df=2.452, CFI=.909 and RMSEA=.059), model fit for the test set (Figure 4) is not adequate (χ^2/df=2.118, CFI=.786 and RMSEA=.052). That is, whereas the relative chi-square and RMSEA have been achieved for the test set in Figure 4, the CFI of 0.786 is far below the recommended ≥ 0.90. Furthermore, a comparison of the results for the validation set (n=837), training set (n=419) and test set (N=418) was made. Figure 2 and Figure 3 show that the measurement models for validation and training sets demonstrated a better fit to the samples. This contrasted with the test set (Figure 4) that yielded poor model fit to the sample data of 418. Table 3 presents the summary of results regarding the fit indices from the three sample data sets that were cross validated. Thus, whereas objective three of the study has been achieved, hypothesis three of the study has not been supported.

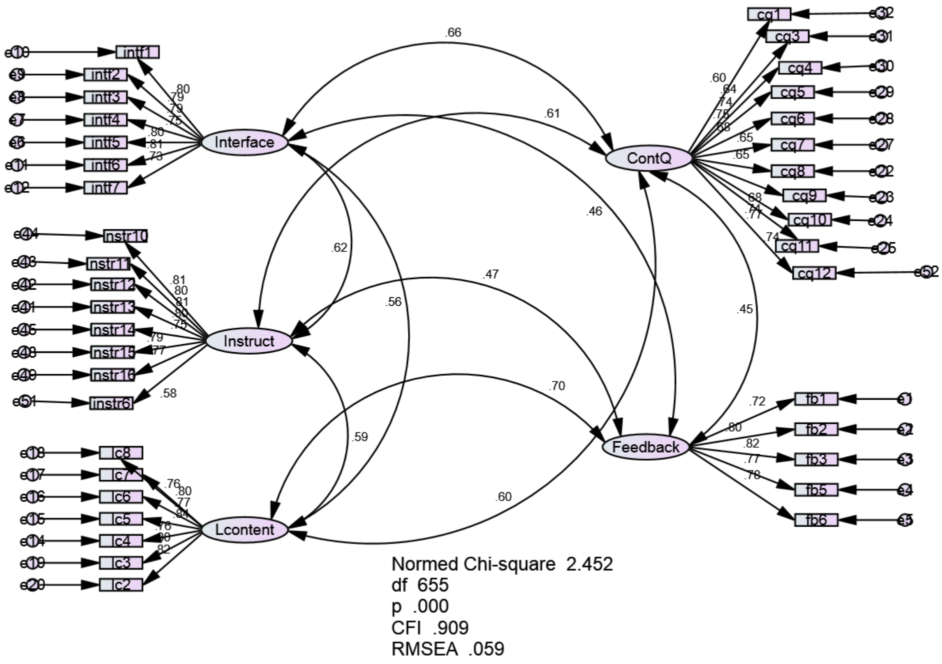

Figure 4: Measurement model for training set (N=419)

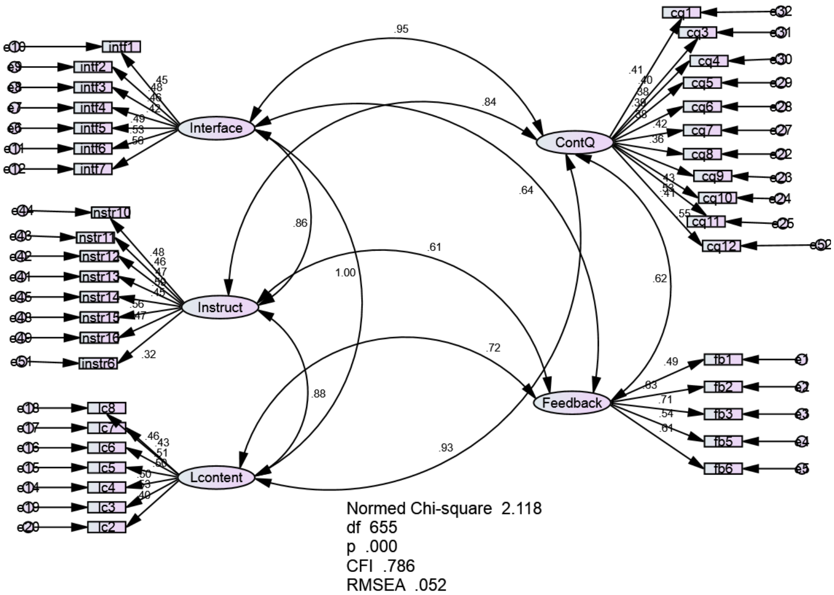

Figure 5: Measurement model for test set (N=418)

Table 3: Comparison of cross validation results

Fit statistics	Model 1 (validation set=837)	Model 2 (training set =419)	Model 3 (test set=418)
χ^2/df	2.939	2.452	2.118
CFI	.922	.909	.786
RMSEA	.048	.059	.052

To conclude, the current study employed PCA to explore the underlying structure of E-learning instructional design quality. Secondly, CFA was useful in validating the psychometric properties for the construct. A summary of the results is presented in Table 4, including the decisions taken on the respective hypotheses considering the results of data analysis.

Table 4: Summary of CFA hypotheses test results

	Hypothesis statement	Decision
H_1	E-learning instructional design quality is a multidimensional construct with interrelated dimensions	Supported
H_2	The E-learning instructional design quality construct is psychometrically sound in terms of common method bias, reliability, convergent validity, and discriminant validity	Supported
H_3	The E-learning instructional design quality measurement model is consistent across samples	Not Supported

DISCUSSION

In line with its objectives, the current study enriched existing studies on instructional design quality and hence broadened the knowledge base regarding the construct in three ways. First, the study has offered empirical evidence that the instructional design quality construct is multidimensional nature. The results have revealed that five sub-dimensions of content quality, interface design quality, instructional strategies, E-learning content interactivity and E-learning feedback constitute instructional design quality. Thus, the results of PCA are in agreement with the classifications of E-learning quality dimensions by (Masoumi & Lindstrom, 2012) and Khan (2005). The second objective of this study was to examine psychometric properties of the instructional design quality questionnaire in terms of common method bias, reliability and validity. The results of the one-factor solution did not achieve the data fit, which was an indicator of absence of threat to common method bias in the data (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Nordin et al., 2016). Additionally, the analysis of results indicated evidence of satisfactory convergent and discriminant validity for instructional design quality. That is, the Average Variance Extracted values and composite reliability of quality sub-constructs met and even exceeded the acceptable threshold, with adequate inter-correlations among the sub-dimensions. To that end, the study was also able to demonstrate that the 38-item questionnaire is indeed an adequate measure of E-learning instructional design quality.

Thirdly, the study addressed concerns regarding cross validation of the data cross three samples as a means of verifying the consistency of the measurement model fit to the data. As already underscored by Hair, Black, Babin,& Anderson (2010), conducting cross validation is an essential step towards estimating and predicting a model being assessed, accomplished by splitting the study sample into two folds, of training set and test set, and then comparing the result against the full sample. The results of cross validation procedure have given firm support to the recommendations of Jackson (2003), Comrey and Lee (1992) and Kline (2016) with regard to the issues of sample size requirements for multivariate analysis techniques like CFA. For example, Comrey and Lee (1992) argues that a study with a sample size of 50 very poor, 100 is poor, 200 is fair, 300 is good, 500 is very good and 1000 is excellent. In addition, Jackson (2003) based on the N:q rule has suggested the ratio of 20 respondents for every measurement item for better results. In a like manner, results revealed that whereas the validation set (n=837) and training set (n=419) models demonstrated fit to the data, the model based on the validation set with full sample of 837 demonstrated much better fit to the data. To the contrary though, the measurement model based on the test set (n=418) did not show satisfactory fit to the data.

CONCLUSION AND RECOMMENDATIONS

The current study has advanced both practical and methodological contributions to the domain of E-learning instructional design quality evaluation and research. Among the methodological contributions of this study is the cross validation of the instructional design quality using several samples to verify model worthiness. Future researches can replicate this approach to verify models using CFA or even full-fledge SEM. In terms of the practical contribution, is the importance of well validated 38-item E-learning instructional design quality questionnaire useful for evaluating E-learning courses in terms of their instructional design attributes. Thus, E-learning instructors, coordinators, instructional designers and subject matter experts can utilise this questionnaire to evaluate how well E-learning programs can succeed as a means of improve learning performance and institutional competitiveness. Specifically, the assessment of E-learning instructional design quality in terms of content quality, interface design quality, instructional strategies, E-learning content interactivity and E-learning feedback will enable the stakeholders take strategic and evidence-based decisions regarding E-learning interventions for quality learning outcomes.

The importance of the results notwithstanding, this study has two key limitations. First, is that, the study did not address the aspect of E-learning personalisation, which could equally be an important aspect while gauging E-learning instructional design quality. As a recommendation therefore, future studies should focus on the E-learning personalisation dimension in terms of the customised content and learning objects, E-learning environment, navigation and learning sequence. The second limitation pertains to methodology. That is to say, the current study focused on the exploratory and confirmatory approach and did not make an attempt to examine any causal relationships among constructs. Further research is thus recommended to try and link the E-learning instructional design quality to outcome variables like student achievement, learning satisfaction and continued learning intention with E-learning courses. To recap, the study has enlightened our understanding with regard to E-learning instructional design quality which is deemed an essential predictor of E-learning success. The study results are therefore important for guiding pedagogical interventions related to E-learning

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