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Modeling e-learning interactivity, learner satisfaction and continuance learning Intention in Ugandan higher learning institutions

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ABSTRACT

This study based on a cross-sectional survey approach, examined E-learning interactivity which was hypothesised to be a multidimensional construct, and its association with learner satisfaction continuing learning intentions. The Transactional Distance theory by Moore (1989) and the three-way model for computer-initiated interaction by Evans & Sabry (2003) formed the study's theoretical framework. The quantitative data were collected using a 28-item questionnaire from 232 learners who had enrolled in various CISCO E-learning courses. Principle Components Analysis revealed a three-factor structure of E-learning interactivity comprised of learner-content, learner-interface, and learner-E-learning system feedback interactivity. Additionally, Confirmatory Factor Analysis confirmed the reliability and validity of the three-factor measurement model; while the SEM fit indices revealed that the structural model has achieved goodness-of-fit. Lastly, the results have confirmed that with the exception of learner-content, the other interactivity sub dimensions demonstrated a significant relationship with learner satisfaction, and in turn, learner satisfaction had a positive influence on continuance learning intention. The results have supported and extended previous works on E-learning interactivity. This study is important for making evidence-based decisions by E-learning instructional designers, interface designers, subject matter experts and instructors, while designing, implementing and evaluating E-learning interventions for open and distance learning.

Keywords: *E-learning interactivity; learner satisfaction; continuance learning intention; CISCO courses; Ugandan higher learning institutions*

INTRODUCTION

One of the key essential attributes of modern instructional technologies is the capability to offer learner interactivity in real time (Ramessur & Santally, 2007). To that end, interactivity in today's digital learning spaces is akin to quality E-learning, which underscores student engagement in the entire learning process to guarantee the effectiveness of any E-learning intervention (Chen, 2008). E-learning interactivity focuses on the dialogue that takes place between users/students and the E-learning system, encompassing a level of cognitive and deliberate commitment to learning activities by students in pursuit of an instructional objective (Pappas, 2016). Thus, if well designed and applied, E-learning interactivity can ably motivate learners, enhance their critical thinking, so that they analyse, and reflect on learning activities and process. That is why Edwards (2015) has argued that effective E-learning design should begin with what the learner needs to do, rather than focus on what the learner needs to know (content).

Interactivity has been found to be central to the E-learning process. For example, it provides opportunities for learner exploration of content, application of knowledge acquired, and assessment of their level of understanding based on the learning activities. This is made possible by the interactive dialogue between entities, where the learner responds to the course environment and feedback so that the entire learning process is engaging and thought provoking. Thus, as learners interact with instructional content and make decisions on the learning activities being presented, they become actively engaged, which in turn triggers subject matter recall, retention and eventually learning transfer (Center for Disease Control and Prevention, 2013). Thus, E-learning interactivity

helps to actively engage the learners' mind to carry out learning activities that improve their ability and readiness to learn effectively.

Interactivity and interaction are two concepts that continue to be used interchangeably in much of the E-learning/Online learning literature, which to some degree causes conceptual confusion. Wagner (1997) however has endeavoured to clearly distinguish between the two terms, stressing that interaction entails reciprocal events that call for at-least two actions and two entities, with dialogue happening when the concerned objects and events have a mutual influence. Interactivity on the other hand, seems to emanate from the technological affordances that are used to establish links from one point to another or several points on a real time basis. Sims (2000) has defined interactivity in terms of the operations and functions presented that enable users work with instructional content presented in the E-learning course environment. Ramessur and Santally (2007) have used the term instructional interactivity, which they define as active participation that affords the learner a level of user control over the sequence and pace during the process of instruction. To highlight further, Harper and Hedberg (1997) have cautioned that by simply enabling learners to select given navigation options or even move from page to page does not amount to interactivity. From the foregoing viewpoints, it can be deduced that interaction is apparently more process-based with an emphasis on mutual relationships between human actors, while interactivity is feature-centric as it focuses more on the technological capability of the instructional system that trigger responses to users' actions (Su, 2006). In the current study, Wagner (1997)'s and Sims (2000)'s definitions of interactivity were adopted and synthesised. In this study therefore, interactivity is conceptualised as the cognitive engagement and connection between the user and the E-learning applications and systems to facilitate effective acquisition of knowledge towards achieving a learning objective.

E-learning interactivity design is based on the premise that Technology-Based Instruction (TBI) does not merely focus on page-turning. In other words, opportunities for practice and engagement with instructional content should be embedded in the design, which should go beyond mere recall of facts, implying that active mental processes are required from the learner. The interactivity of an E-learning system should foster proaction rather than reaction, by empowering the learner with a sense of anticipation rather than just response. That is why Roschelle, Pea, Hoadley, Gordin and Means (2001) believe that effective learning is driven by learners being actively engaged, participating in group activities, being provided with frequent interaction and feedback, and making connections to real world contexts while learning. Hong, Clinton, and Rieber (2014), while drawing on the earlier works of Rhodes and Azbell, 1985, Jonassen and Reeves (1996), Aldrich, Rogers and Scaife (1988) has identified reactive and proactive interaction as the two key levels of interaction. Reactive interaction has been described as the lowest level of interaction, providing users with limited control over the content and its structure, characterized by turning pages and clicking buttons. On the other hand, proactive interaction optimizes learner control over the instructional environment.

Whereas interactivity in E-learning is a recurrent theme in the literature, much focus has been paid to learner-learner and learner-instructor interactions particularly in the Ugandan higher learning context. Unfortunately, limited research has been directed towards learner-to-content, learner-to-interface, and learner-to-system feedback interactivity despite their critical role in self-paced E-learning courses. In an attempt to address the existing gap in literature therefore, the current study examined the three facets of interactivity in light of Hillman, Willis and Gunawardena (1994), Moore (1989) and Evans and Sabry (2003)'s taxonomy of interactions. These are learner-content, learner-interface, and learner-system feedback which are deemed crucial in E-learning environments, where in most cases quick instructor support may not be accessible.

PURPOSE

The purpose of this study was two-folded: First, to examine the validity and reliability of the underlying structure of E-learning interactivity; and second, to assess the causal relationship between E-learning interactivity dimensions, learner satisfaction and continuance learning intention.

RESEARCH OBJECTIVES

In order to achieve the purpose of the study, five specific research objectives were stated; and these were to:

i. Explore the underlying structure of E-learning interactivity as reported by learners in Ugandan higher learning institutions;
ii. Validate the relationship between the observed variables and latent E-learning interactivity constructs;
iii. Ascertain the validity of hypothesised E-learning interactivity structural model;
iv. Assess the causal relationship between interactivity and learner satisfaction with E-learning;
v. Examine the causal relationship between learner satisfaction and continuance learning intention with E-learning.

THEORETICAL BACKGROUND AND RESEARCH MODEL

Theory of Transactional Distance

The Transactional Distance Theory as introduced by Michael G. Moore (1989) considers the distance between the learner and the instructor in the course as based on psychological rather than physical separation. According to Giossos, Koutsouba, Lionarakis, and Skavantzos (2009), Moore suggested that dialogue, structure and autonomy play an influential role in distance education. Dialogue and structure of the course present opportunities that reduce miscommunication as a result of transactional distance, while learner autonomy impacts on motivation towards the course. Moore's treatise on Transactional Distance Theory (1989) classifies interaction into three major types and these are: i) Learner-Learner, ii) Learner-Instructor, and iii) Learner-content interactions (Sharifah, Hasina & Mohammad, 2014). Learner-learner interaction includes student contact with peers either face-to-face or through computer-mediated communication tools like social networks, email, blogs, discussion forums and wikis. Learner-instructor interaction includes contact between learners and the instructor using several communication tools. Learner-content interaction includes learner use of learning content objects and resources like text material, videos, audio, graphics, hypermedia, and simulations to achieve a learning objective. These three forms generally address two-way interaction which may be either synchronous or asynchronous.

Extended Theory of Transactional Distance

Hillman, Willis and Gunawardena (1994) pointed out that Moore's three classifications of interaction (1989), failed to account for all elements of interaction in technology-enhanced distance learning. Hence the trio added learner-interface interaction as the fourth type, arguing that learners and instructors have to interact and manipulate interfaces so as to communicate with one another and engage with learning activities. The interface acts as a mediating component in all the three interactions that were earlier proposed by Moore (1989) in his Transactional Distance Theory (Abulibdeh & Hassan, 2011).

Three-way Model for Computer Initiated Interaction

The three-way model for computer-initiated interaction was proposed by Evans and Sabry (2003). The model theorises that interaction in a Computer-Mediated Environment involves a sequence of three actions, namely initiation, response and feedback, with each of the actions involving a one-way movement of information between two agents. According to Evans and Sabry (2003), initiation happens when the first agent invites input from the second party. Then, response entails the second party providing the needed input. Last is feedback, which involves the first agent sending back information regarding the response. Thus, it can be seen that there is a correlation between the three actions, in as much as response must be a direct result of initiation, yet feedback must be in tandem with the response. A typical example of the three-way model for computer-initiated interaction is where: (i) the Computer-based learning environment presents the learner with a hypertext (initiation), (ii) the learner clicks on the hypertext (response), and (iii) the Computer-based learning environment presents the learner with the details related to the hypertext (feedback), and the interaction becomes a loop. Figure 1 gives a visual illustration of the four elements of interactivity as described in the theoretical framework.

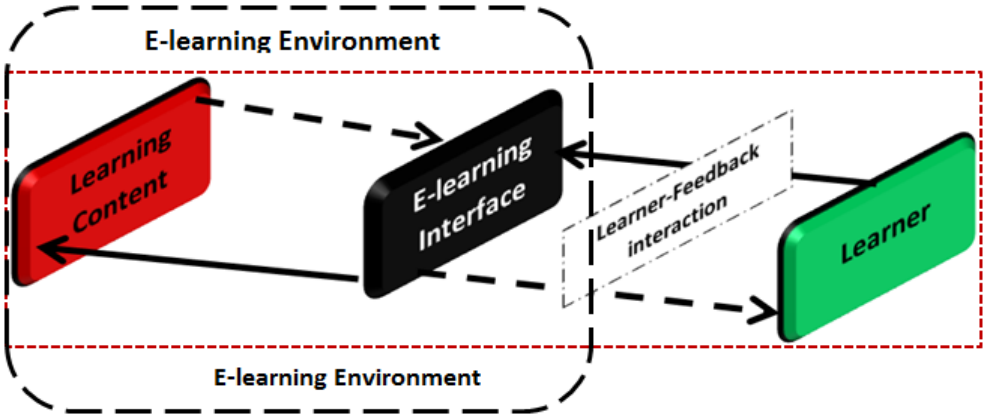

Figure 1*: Illustration of the types of interaction proposed by Moore (1989); Hilman, Willis and Guwardena (1994); Evans and Sabry (2003)*

Thus, based on the foregoing analysis of the theoretical framework, this study hypothesises that:

H_1: E-learning interactivity is a multidimensional construct with interrelated dimensions.

H_2: The relationships between the observed variables and latent constructs of E-learning interactivity, learner satisfaction and continuance learning intention are valid and reliable.

H_3: The hypothesised E-learning interactivity structural model fits the data.

REVIEW OF LITERATURE ON E-LEARNING INTERACTIVITY AND STUDENT LEARNING

Interactivity is a hall mark and salient feature of technology-enhanced learning environments that have been well-designed. Literature pertaining to learner interactivity has indicated that user interactivity has a significant influence on satisfaction, retention and persistence with E-learning (Alhih, Ossiannilsson, & Berigel, 2017; Koslow, 2015; Sharifah, Hasina, Shirin, & Mohammad,

2014; Evans & Sabry, 2003). For example, studies like that of Alsam (2015) have revealed that interactive digital learning environments foster effective student learning. Moreover, recent studies on the effectiveness of interactivity in online learning environments have come to a conclusion that cognitive load during learning decreases as the level of interactivity in the learning materials increases. To illustrate, Chang and Yang (2010) examined cognitive load in Web-based learning materials, and found that gender differences were statistically significant in terms of learner cognitive load. In contrast however, Clawson (2007)'s assessment of online quality standards reports that the interactivity dimension was not statistically significant in predicting satisfaction in online learning.

Existing studies have further revealed learners' preference for E-learning activities that foster their interactivity. For example, Porter (2010)'s assessment of electronic textbooks designed with embedded activities has revealed that users showed preference for electronic textbooks and the embedded problem-based activities as compared to hardcopy textbooks. Similarly, Kok Boon et al. (2008) in their evaluation of interactive multimedia courseware, reported learners' preference for learning with interactive multimedia courseware unlike the traditional learning approach. In a related study, Yerasimou (2010) has reported that interactivity and flow elements in a blended course are of essence in promoting learners' motivation and active participation.

In order to enhance learner satisfaction in E-learning, learning content should contain interactive elements that provide learning engagement. For example, Croxton (2014) has reported that interactivity is a significant predictor of learner satisfaction and persistence in online learning environments. In another study by Lim, Lee, and Richards (2006), results indicate that the level of interactivity and learner control fostered learning. Similarly, Al-kabi and Sharadgah (2015) in their evaluation of interactive multimedia for learning arithmetic skills, found that application of interactive multimedia instructional methods are effective for gaining learner attention especially when animated characters are embedded. In another instance, Tsang (2010)'s study that assessed learning effectiveness with learner-content interactions revealed that combining several formats while presenting content, is an effective way to enhance learning interaction. Tsang (2010) further found that single-media and text-based presentations of content ranked lowest when it came to motivating and engaging student learning. In contrast to the above findings, Helfrich's experimental study (2011) that applied instructional materials with two variants of interactivity, reported non-significant differences between the two learning groups regarding their average post-test scores and individual learning capabilities.

Lastly, E-learning interaction has been reported to play a key role in learner control and persistence, which eventually translates into positive learning outcomes. For example, Croxton (2014) in a study on the role of interactivity in student satisfaction and persistence in online learning has reported two key findings. First, that interactivity is an important predictor of satisfaction and persistence for online learners, and secondly, that preferences for types of online interactivity correlate with student learning styles. Similarly, Bernice (2014) has reported that learner-to-content and learner-to-technology interaction had the most significant influence on learner satisfaction, yet learner-to-instructor and learner-to-learner interactions were not significant in predicting student satisfaction. Moreover, Walker and Kelly (2007) and Dow (2008) have further reported that learners who do not interact actively in E-learning course environments tend to exhibit unsatisfactory learning experiences with the course as compared to their active counterparts. From the review of the relevant theories, models and empirical literature, Figure 3 presents the hypothesised conceptual model for the current study that highlights the interrelationships among the exogenous and endogenous variables.

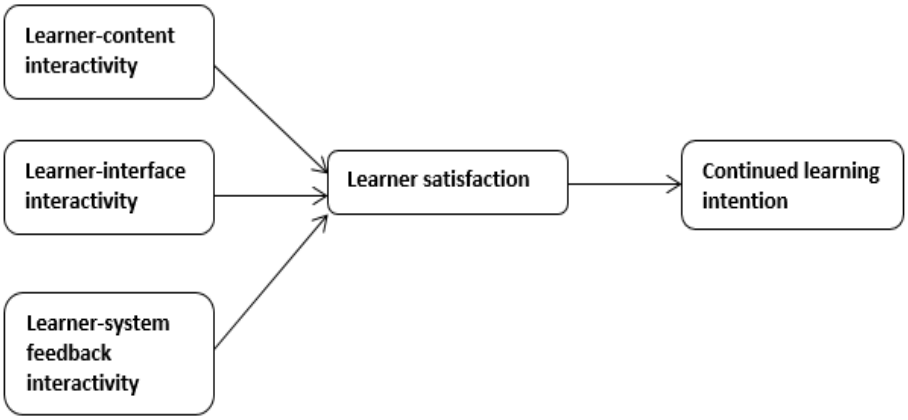

Figure 2: *Hypothesised conceptual model for the study*

RELATIONSHIP BETWEEN E-LEARNING INTERACTIVITY, LEARNER SATISFACTION, AND CONTINUANCE LEARNING INTENTION

Learner-content interactivity and learner satisfaction with E-learning

The level and nature of interactivity between the online learner and course content cannot be underestimated. As Murray, Perez, Geist, and Hedrick (2013) and Zimmerman (2012) have pointed out, a clear understanding of learner-content interaction is a guide to the appropriate delivery methods that later impact on the quality of learning outcomes and course completion rates. Learner-content interaction or interactivity for that matter, can be defined as the amount and quality of time the learner spends with course content, to read and review text, audio, video material, books, PowerPoint slides, web pages, discussion forums, and complete quizzes (Su, Bonk, Magjuka, Liu, & Lee, 2005). Existing empirical studies have affirmed the link between learner-content interactivity and satisfaction with E-learning use. For example, Zimmerman (2012) has reported a statistically significant positive correlation between the amount of time online learners dedicate to interact with learning materials and their grades in quizzes. Closely related to Zimmerman (2012), Fatma and Mustafa (2016) have reported a positive and statistically significant relationship between learner-content interaction and their levels of achievement. While Byers (2010) found that learner-content interaction techniques of simulations, interactive reference, hands-on, personal feedback contribute to learner satisfaction in online learning. The above trends in the findings of the previous empirical studies clearly align with the postulation of Murray et al. (2013), that the more learning content learners view, the higher the likelihood of having better grades on a particular unit, and thus in the overall course. Whereas the Moore (1989) dimension of learner-to-content interaction has been discussed widely in the literature, specific empirical studies on the causal influence of learner-to-content interaction on learning satisfaction in the Ugandan E-learning context are very limited. Hence, guided by the foregoing analysis of the literature and empirical studies this study hypothesises that:

H_4: Learner-content interactivity has a significant and positive influence on learner satisfaction with E-learning**.**

Learner-interface interactivity and learner satisfaction with E-learning

Learner-interface interactivity entails actions and reactions that take place between the learner and the E-learning system support tools like buttons, hyperlinks, and menus that allow the learner to make better use of the learning content. The interface of an E-learning course environment generally includes course navigation tools, the aesthetics design, page design and accessibility (Khan, 2005). For successful learner-interface interactivity, the interface should have features of simplicity, user-friendliness, and provide clear and unambiguous orientation cues, Alhih et al. (2017). It is worth noting though that the ease and quality of learner-interface interaction is influenced by the technological attributes of the interface and the individual characteristics of the user. Thus as Ramessur and Santally (2007) have pointed out, satisfactory learner-interface interactivity will require the learner to understand the in-working procedures of the user interface.

The quality of learner-interface in E-learning is crucial to the success of other forms of interaction. For example, it will influence how learners access and interact with learning materials and quizzes, engage in discussion forums, interaction with peers and instructors. Alhih et al. (2017) for example in their assessment of levels of interaction in a distance education course, reveal that learners expressed satisfaction regarding their interaction with the course interface. Additionally, Chou, Peng, and Chang (2010) have reported a positive relationship between students' perceptions of Computer-Mediated Communication interactivity functions and their usefulness for learning. Yet Alomari (2009) found that learners were dissatisfied with the Web-based Math course because the course interface elements were poorly designed, which made learner comprehension difficult as they got lost in the process of looking for content. The above empirical findings align closely with Gooch (2014) who found statistically significant differences in learner-interaction preferences between the Millennials and Baby Boomers in an Augmented Reality learning environment. Thus, based on the review of the foregoing empirical literature, the current study hypothesises that:

H_5: Learner-interface interactivity has a significant and positive influence on learner satisfaction with E-learning

Learner-system feedback interactivity and learner satisfaction with E-learning

Meaningful feedback is essential in enabling learners to reflect and make adjustments in the learning process. Hyland (2000) as cited in Hatziapostolou and Paraskakis (2010) has noted that feedback serves to evaluate learner motivation, confidence and achievement. Different classifications and taxonomies of feedback have been identified. For example, Martinez-Arguelles et al. (2015) have highlighted the semantic and structural dimensions of feedback. The semantic dimension focuses on error recognition and correction, strategies for task improvement, and depth of feedback information; while the structural dimension pays attention to the agents in the feedback process, timing of feedback, and forms of feedback. Thus, for E-learning feedback to be effective, it should have the inherent qualities of being: (i) prompt and thorough; (ii) constructive and supportive; (iii) ongoing, objective and consistent.

The role of E-learning system feedback interactivity in fostering learning satisfaction has support in several empirical studies. For example, Martinez-Arguelles et al. (2015) in their study reported that learners were less satisfied with text-based feedback, and indicated preference for other feedback formats like video. This implies that there is need to design and provide feedback in a variety of ways so as to meet varied learner interests. In a related study, Webb and Moallem (2016) revealed that timely, motivating and informative feedback allows learners to improve their learning process in online learning. According to Bonnel et. al (2007) as cited in Bonnel (2008), effective feedback is far more than just comments from the E-learning system or instructors; and that techniques like group, automated and peer feedback are important in enhance learning. The assertion of Bonnel et al. (2007) has been reinforced by Byers (2010) who found that interactive and personal feedback

contributed to learner satisfaction in online learning. Thus, a positive learning environment is a vital ingredient for effective feedback. On the basis of the review of related literature, this study thus hypothesises that:

H_6: Learner-system Feedback interactivity in E-learning has a significant and positive influence on learner satisfaction***.***

Learner satisfaction and continuance learning intention with E-learning

Learner satisfaction is defined as the perception of pleasure, state of contentment and feeling of accomplishment that a learner relates to an instructional environment (Chen, 2014). To that end, learner satisfaction has been widely acknowledged in literature as an outcome related to the use of technology-enhanced learning environments, and therefore an essential yardstick to gauge the success of E-learning systems (Ramayah & Lee, 2012). From the perspective of Bloom (1956), domains of learning, satisfaction with E-learning can be gauged from the level of cognitive skills learners acquire, the skills they are able to demonstrate and execute, and the attitude and feelings they will attach to the E-learning environment. Learner satisfaction has been found to exert a significant impact on learner continued engagement, persistence and use intentions with information systems in general and E-learning environments in particular (Bhattacherjee, 2001; Costley, Lange, Costley, & Lange, 2017; Kintu, Zhu, & Kagambe, 2017). For example, Tri-Agif, Noorhidawati and Ghalebandi (2016) in their assessment of E-book utilization among learners revealed a significant causal relationship between learner satisfaction and continued use intentions. Additionally, Alraimi, Zo and Ciganek (2015) in their assessment of MOOCs continued use intention revealed satisfaction as a significant predictor of learner continued intentions with MOOCs. In light of the existing literature, this study hypothesises that:

H_7: Learner satisfaction has a significant and positive influence on continuance learning intention with E-learning***.***

METHODOLOGY

Sampling strategy and Sample profile

This study employed the stratified random sampling method to obtain the participants. That is, nineteen higher learning institutions running CISCO E-learning courses were stratified into public and private, and then as universities and colleges. Simple random sampling was thereafter applied on each stratum to select the sample. The quantitative data for this study were collected from 232 learners enrolled at two Universities in Uganda for various CISCO E-learning courses. Results of the descriptive analysis reveal that the majority of the learners who participated in the study were males, constituting 65% (151/232), trailed by females who made up 35% (81/232). In terms of E-learning courses being studied, 85% of the respondents were taking CISCO Certified Networking Associate, 15% were taking other E-learning courses like CISCO Certified Networking Professional (7.3%), Information Technology Essentials (4.3%) and Cyber Security (3.4%). Learners' ICT experience was also assessed. Data revealed that the majority of the learners - over 50% reported their level of ICT experience to be at intermediate level. This was followed by learners whose ICT experience was rated to be at beginner (34%), and those at advanced level of ICT experience trailed with 16%. In light of the guidelines offered by Jackson (2003) and Comrey and Lee (1992) regarding the adequacy of the sample size for Structural Equation Modeling, the sample size of 232 was considered satisfactory for the current study.

Measures

To successfully collect the quantitative data, the study applied a 28-item self-administered questionnaire to measure learners' perceptions regarding interactivity, satisfaction and continuance learning intention with E-learning. The measurement items were adapted from a thorough review of relevant literature, and had been used in previous studies on the subject under discussion. By implication therefore, the measurement items have been empirically applied prior to being used in the current study.

E-learning interactivity. Fifteen items were used to examine the three interactivity dimensions of learner-content, learner-interface, and learner-E-learning system feedback interactivity. E-learners rated their level of interactivity on 5 response categories of "Never", "Rarely", "Sometimes", "Often", "Always". The measurement items for the E-learning interactivity construct were mainly draw from the works of Abulibdeh & Hassan (2011), Centers for Disease Control and Prevention (2013); Elissavat and Economides (2013), Heidi and Mei (2015), Evans and Sabry (2003), Strachota (2015), Chao (2013), and Lwoga (2014).

Learner satisfaction and continuing learning intention. The constructs of learner satisfaction and continuance learning intention were measured using eight and five items respectively. E-learners rated their perception on satisfaction and intentions to continue learning with E-learning based on a 5-response category of "Strongly Disagree", "Disagree", "Undecided", "Agree", "Strongly Agree". Items on learner satisfaction were drawn from the works of Mei Li (2007), Ming-Chi (2010), Limayen and Cheung (2011), Lin (2012), Wang et. al (2007), Jung et al (2014), Lwoga (2014), Roca (2006), Bollinger (2012), Elena (2013), and Eom (2006). On the other hand, the measurement items used to assess continuance learning intention were adapted from Wen-Lung (2013), Ming Chi Lee (2010), Cheng (2010), Kan (2011), Chao (2013), Bing (2014), Fang (2011), Lin (2012), Bhattacherjee (2001), Chiu (2007), Lwoga (2014), Ginn Hwang (2011), Khaled (2014), Bhattacherjee, Perols and Clive (2007), Tao (2013).

Data analysis procedures. With the help of SPSS version 20.0 and AMOS 22.O, the current study applied three Multivariate Analysis tools of Principal Component Analysis (PCA), Confirmatory Factor Analysis (CFA), and full-fledge Structural Equation Modeling (SEM). First, Principal Component Analysis was applied to understand the underlying structure of E-learning interactivity from the data. Next, Confirmatory Factor Analysis was employed to validate the relationship between the observed variables and latent E-learning interactivity constructs in terms of composite reliability, convergent and discriminant validity. The internal consistency of the constructs was further established using Cronbach alpha. Lastly, full-fledge Structural Equation Modeling was used to assess the causal influence of E-learning interactivity constructs on learner satisfaction and continuance learning intention.

RESULTS

Underlying structure of E-learning interactivity

Table 1 below, gives the descriptive analysis of the measurement items used during the process of dimension reduction.

***Table 1**: E-learning interactivity, learner satisfaction and continuance learning intention dimensions and item statistics*

Code	Dimensions/Sub construct	Mean	SD	Factor Loading
	Learner-content interactivity (Alpha=.779)			
lc2	Uses a variety of quizzes	3.44	1.388	.63
lc3	Uses a variety of drag and drop activities in the learning content	3.29	1.379	.56
lc4	Allows me to access extra learning content outside the course	3.74	1.336	.73
lc5	Allows me to easily save learning content in a familiar format	3.69	1.351	.79
lc7	Gives me hints on how to complete learning activities like quizzes	3.74	1.365	.65
	Learner-interface interactivity (Alpha=.868)			
li8	Animated learning objects	3.23	1.502	.70
li9	Multiple menus	3.48	1.370	.78
li10	Pop-up windows	3.36	1.398	.79
li11	Help tools like glossaries, dictionaries, FAQs, etc.	3.55	1.379	.80
li12	Links to previously visited sites and pages	3.61	1.407	.71
	Learner-system Feedback interactivity (Alpha=.849)			
fb1	Provides feedback immediately after making an action	3.87	1.363	.66
fb2	Provides me with feedback to verify the correctness of my responses	3.81	1.340	.57
fb3	Provides me with feedback on my performance	3.88	1.348	.78
fb5	Gives me feedback in a short time whenever I make, I request	3.97	1.216	.83
fb6	Records my learning progress and performance.	4.02	1.171	.79
	Learner Satisfaction (Alpha=.895)			
Sat 1	usefulness	4.06	1.207	.78
Sat2	relevance	4.03	1.010	.76
Sat3	knowledge gained	4.03	1.023	.75
Sat4	E-learning course functions	4.00	1.083	.65
Sat5	learning content quality	4.05	1.047	.75
Sat6	meeting my learning expectations	3.95	1.058	.70
Sat7	my learning interest in the course	4.10	1.042	.71
Sat8	overall learning experience with this E-learning course	4.10	.991	.69
	Continuance Learning Intention (Alpha=.812)			
Cui1	i would like to take another E-learning course after this	3.97	1.180	.63
Cui2	i will recommend this E-learning course to my friends	4.21	.946	.64
Cui3	i intend to continue using the E-learning course for sharing knowledge	4.21	.917	.69
Cui4	i will use the E-learning system on a regular basis in the future	4.08	.984	.64
Cui5	i intend to continue using a related E-learning course for life-long learning	4.20	.951	.62

Note: Extraction done with Principal Component Analysis

Given that the maximum score for each measurement item is 5, the mean score for the respective items were well above the hypothetical mean of 2.5. Specifically, the highest mean score was 4.21 for the items "*i will recommend this E-learning course to my friends*", and "*i intend to continue using the E-learning course for sharing knowledge*". The lowest mean score levelled at 3.23 for the item "*Animated learning objects*". The implication here is that learners reported high levels of E-learning interactivity. In addition, the Cronbach Alpha indices for internal consistency of the items were satisfactory, and indeed exceeded the threshold of 0.7 (Pallant, 2007; Matsunaga, 2011). For example, the learner-content interaction dimension had a Cronbach Alpha value of .799, learner-interface interaction scored .868, learner-system feedback interaction scored .849, learner satisfaction .895 and continuance learning intention .812.

Before the actual assessment of the underlying factor structure, data were checked to ensure that it met the assumptions necessary for Principal Component Analysis. Indeed, the Kaiser-Meyer-Olkin Measure of sampling adequacy index was at .908, and Bartlett's Test of Sphericity was significant $\chi^2(435)=3953.956$, $p=.000$. The results of Principal Component Analysis and Promax rotation based on the 28 items revealed that the construct of E-learning interactivity was a multidimensional construct. According to the data in Table 1, the sub constructs were labelled as learner-content interaction, learner-interface interaction, learner-system feedback interaction, learner satisfaction and continuance learning intention. To that end, objective one has been achieved and hypothesis one of this study has been accepted.

Relationship between the observed variables and latent e-learning interactivity, learner satisfaction and continuance learning intention constructs

In order to test the validity of the relationship between the manifest variables and latent constructs on interactivity, learner satisfaction and continuance learning intention, Confirmatory Factor Analysis (CFA) was conducted on the data. The results reveal that the five-factor measurement model was satisfactory to represent the data. For example, the observed variables significantly loaded on to each of the constructs as evidenced by the satisfactory factor loadings.

Table 2*: Average variance extracted, Inter-factor correlations and shared variance and among the latent constructs*

Construct/Dimension	**1**	**2**	**3**	**4**	**5**
Learner-content	**.668**	.43	.40	.27	.33
Learner-interface	.66	**.742**	.52	.22	.20
System Feedback	.72	.63	**.720**	.32	.34
Learner satisfaction	.47	.45	.72	**.724**	.57
Continuance learning intention	.58	.57	.58	.76	**.58**
Composite Reliability	.803	.860	.850	.875	.745

Note: (a) Along the diagonal are the Average Variance Explained (AVE) for the sub-constructs; (c) below the diagonal are the correlations; (c) above the diagonal is the shared variance matrix.

The results in Table 2 above, further confirm the validity of the relationship between the observed variables and latent constructs in terms of convergent and discriminant validity. For example, the Average Variance Extracted (AVE) for each of the latent sub-constructs along the diagonal exceeded the threshold of 0.5, which confirms the convergent validity of the measurement items. Additionally, the measurement model demonstrated adequate evidence of discriminant validity given that the AVEs exceeded the respective shared variances (see values above the diagonal in Table 2).

Additionally, as shown in Figure 3 below, the goodness-of-fit of the measurement model was adequate, given the normed Chi-square=1.956; CFI=.903; RMSEA=.064.

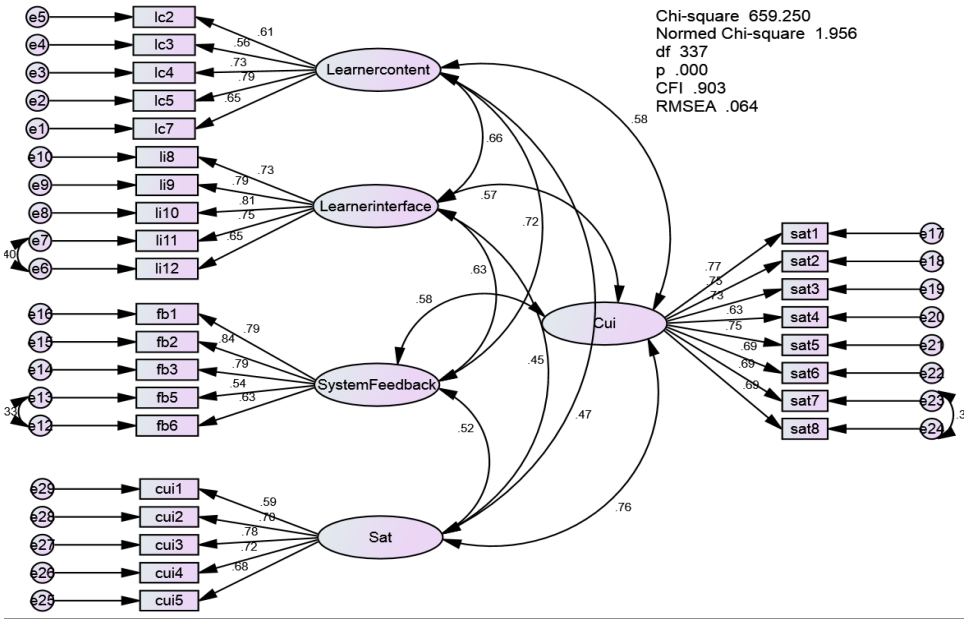

***Figure 3**: CFA Measurement model for E-learning interactivity*

The inter-factor correlations for the measurement model demonstrated that indeed E-learning interactivity is a multidimensional construct as it is comprised of different but inter-related sub constructs of learner-content, learner-interface, and learner-system feedback interactivity. Meanwhile, the AVEs for learner satisfaction and continuance learning intention were also established. Lastly, the results show that the composite reliability for each of the sub constructs were learner-content interactivity (.668), learner-interface interactivity (.742), learner-system feedback interactivity (.720), learner satisfaction (.724) and continuance learning intention (.58). Thus, hypothesis two of the study has been accepted.

Adequacy of the e-learning interactivity structural model

In Figure 4, the results of the full-fledge SEM for E-learning interactivity are illustrated to address hypothesis three of the study. The results have demonstrated evidence of adequate structural model goodness-of-fit to the data. For example normed Chi-square=1.963; CFI=.901; RMSEA=.065, are all within the recommended threshold (Kline, 2016; Matsunaga, 2011). Hence, the fit indices have demonstrated a fitting model of the causal relationship between E-learning

interactivity, learner satisfaction and continued learning intention. Moreover, the SEM analysis demonstrated that the three E-learning interactivity sub-constructs were able to explain 43% of the variability of the perceived learner satisfaction, and learner satisfaction explained 61% of the variance in continuance learning intention with E-learning.

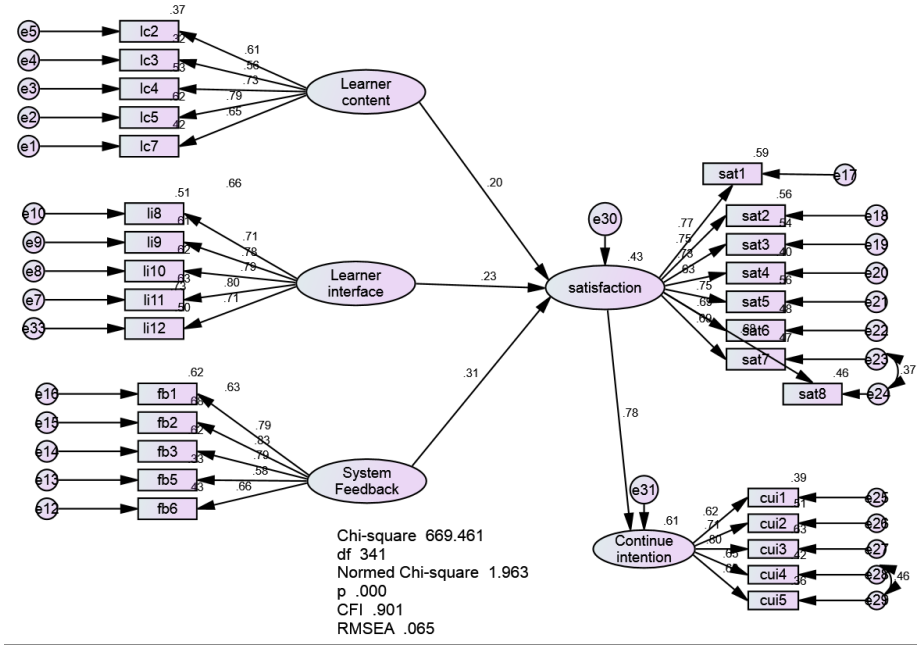

Figure 4: *E-learning interactivity structural model*

Note**:** Lcontent (Learner-content interactivity), Linterface (Learner-interface interactivity), Feedback (Learner-system feedback interactivity), Sat (Learner satisfaction), Cui (Continuance learning intention)

Causal influence of e-learning interactivity on learner satisfaction and continuing learning intention

In order to test hypotheses four to seven on the causal relationships, the path coefficients of the structural model were examined. As seen in Figure 4 above and Table 3 below, with the exception of satisfaction←learner-content, the regression weights for the rest of the causal paths were found to be statistically significant, and practically important for that matter.

Specifically, satisfaction←learner-content with β=.203, p>.05 was non-significant. But the cause paths of satisfaction←learner-interface (β=.228, p<.05), satisfaction←learner-system feedback (β=.310, p<.05), and continuance learning intention←satisfaction (β=.778, p<.001) were all positive, significant and practically important.

Thus, whereas hypothesis four has been rejected, hypotheses five to seven have been accepted.

***Table 3**: Regression Weights (Group number 1 - Default model)*

Structural paths			Estimate	S.E.	C.R.	P	Result
satisfaction	←	Learner_content	.203	.121	1.761	.078	Non-Significant
satisfaction	←	Learner_interface	.228	.081	2.459	.014	Significant
satisfaction	←	System_Feedback	.310	.146	2.816	.005	Significant
Continue_intention	←	satisfaction	.778	.077	7.980	.000	Significant

In conclusion, the results of the study are summarised in Table 4 as per the respective hypotheses and the corresponding decisions taken.

***Table 4**: Summary of results as per hypotheses*

	Hypothesis statement	Decision
H_1	E-learning interactivity is a multidimensional construct with interrelated dimensions	Supported
H_2	The relationships between the observed variables and latent constructs of E-learning interactivity, learner satisfaction and continuance learning intention are valid and reliable	Supported
H_3	The hypothesised E-learning interactivity structural model fits the data.	Supported
H_4	Learner-content interaction has a significant and positive influence on learner satisfaction with E-learning	Not Supported
H_5	Learner-interface interaction has a significant and positive influence on learner satisfaction in E-learning	Supported
H_6	Learner-system Feedback interaction has a significant and positive influence on learner satisfaction in E-learning	Supported
H_7	Learner satisfaction has a significant and positive influence on continuance learning intention with E-learning	Supported

DISCUSSION

The results of the current study have strengthened previous literature on E-learning interactivity and therefore extended our understanding of the construct which is critical to successful learning experiences. First, the study has offered satisfactory evidence that E-learning interactivity is actually a valid and reliable multidimensional construct. For example, the result suggests that the E-learning interactivity measurement model indeed generated a covariance matrix that is consistent with the data. Besides, the E-learning interactivity construct comprised of three sub-constructs, namely learner-content, learner-interface, and learner-system feedback interactivity. The sub-constructs demonstrated sufficient patterns of internal consistency with reliability indices ranging between 0.803 and 0.860. Furthermore, the data demonstrated evidence of convergent and discriminant validity of the relationship between the observed items and the latent interactivity constructs. This was seen when the Average Variance Extracted (AVE) for each sub-construct surpassed the threshold, and with moderate inter-factor correlations. Thus, this study has a firm ground to argue that the measurement items of the three-dimensions can be systematically applied for further investigations regarding learner interactivity in technology-enhanced learning environments. The validity and reliability of the E-learning interactivity dimensions has further

strengthened the theory of Transactional Distance by Moore (1989), Hillman, Willis and Gunawardena (1994), and the Three-way Model for Computer Initiated Interaction by Evans and Sabry (2003).

Next, the study sought to assess the causal influence of the E-learning interactivity dimensions on learner satisfaction, and then learner satisfaction on continuance learning intention with E-learning. Results of full-fledge SEM reveal that with the exception of learner-content interactivity, the other E-learning interactivity dimensions of learner-interface and learner-system feedback demonstrated a significant causal influence on learner satisfaction. Moreover, learner satisfaction was found to have a statistically significant influence on continuance learning intention with E-learning. The causal influence of learner-content interactivity on learner satisfaction yielded $\beta=.211$, $p>.05$, and was practically significant at 21%, which implied that despite the positive correlation and practical significance between the two variables, the influence was not statistically significant. The result sharply contradicted several related empirical studies. A case in point, Ng (2011)'s study on learner retention and completion rates found that learner-content interaction positively correlated with commitment to the online course in the context of Open University Malaysia. In a study by Tsang (2010), learners expressed better satisfaction when they interacted with content that utilize hyperlinks, interactive activities with feedback, video and audio clips, unlike with the content that was in only text format. The result however was in agreement with Jia, Ding, Chen, and Cui (2012) who found that whereas there exists a positive and significant relationship between learner-to-content interaction and learner performance, there was no relationship between learner-to-content interaction and satisfaction. Despite a statistically non-significant result, the elements of learner-content interaction as per the previous empirical studies are essential for E-learning satisfaction.

The structural relationship between learner-interface interactivity was statistically significant ($\beta=.217$, $p<.05$), and practically important at 22%. The interface components of animated learning objects, multiple menus, pop-up windows, help tools and user-friendly hyperlinks were important in enhancing learner-interface interactivity. The findings of the study are in agreement with several existing empirical studies. For example, Alhih et al. (2017) in their assessment of levels of interaction in a distance education course reveal that learners expressed satisfaction regarding their interaction with the course interface. The finding by Alhih et. al (2017) is in tandem with Chou et al (2010) who found a positive relationship between students' perceptions of interactivity functions and their usefulness of learning. In addition, Kokoc and Altun (2016) found that online learner interaction with learning dashboards impacted significantly on their learning process; yet DeLaus (2016) revealed a statistically significant relationship between learner-interface interaction and perceived satisfaction with an online course.

The relationship between learner-system feedback interactivity and satisfaction was equally examined. The structural relationship revealed $\beta=.388$, $p<.05$, which implied that the causal influence between the variables was statistically significant and moreover with practical importance of 39%. The result is supported by Webb and Moallem (2016) who reveals that timely, motivating and informative feedback allows learners to improve their learning process in online learning. Additionally, Cheng (2014) found that the interactivity dimensions of personalization, two-way communication, and responsiveness had a significant influence on learner perceived enjoyment with an E-learning system in the Taiwan context. A similar trend in the result is reflected in Erhel and Jamet (2013) and Martinez-Arguelles et al. (2015). For example Erhel and Jamet (2013)'s study on feedback and instructions in game-based learning revealed that regular feedback to learners is likely to result in deeper learning. While Martinez-Arguelles et al. (2015) in their assessment of usefulness of feedback in E-learning revealed that learners in the experimental group demonstrated higher perceived satisfaction with personalised feedback as compared to the control group.

Lastly, the study hypothesised that the level of learner satisfaction with E-learning interactivity positively correlated with their continued learning intentions in E-learning. Indeed, the regression coefficients for the structural paths revealed that the relationship between learner satisfaction and continuance learning intention with E-learning was statistically significant (β=.617, $p<.05$), and above all with practical importance of 62%. The above result is consistent with several empirical studies on user satisfaction and continuance use behavior. For example, Ramayah and Lee (2012) in their assessment of satisfaction and E-learning adoption found satisfaction as a correlate of continuance use intention in the Malaysian context. In addition, Chen, Lee, and Hsiao (2018) report learner satisfaction as a influencer of continued use with MOOCs. This was further supported by Pereira, Ramos, Gouvêa, and Da Costa (2015) who found that user satisfaction was critical in predicting continuance use intention with E-learning in public organizations. The implication of this result is that in order to ensure learning persistence and continued engagement with E-learning, learning satisfaction is of essence.

CONCLUSION AND RECOMMENDATIONS

This study has made significant contributions to the domain of instructional technology and E-learning success. For example, the study has left behind a valid and reliable 28-item questionnaire and integrated model on Interactivity design for E-learning success. This will serve as an adequate tool to evaluate interactivity in E-learning courses and the extent of end-user post adoption behavior in terms of satisfaction and continued use intention. Specifically, the assessment of the three E-learning interactivity dimensions (learner-content, learner-interface, and learner-system feedback interactivity) would enable interface designers and subject matter experts to develop interactive E-learning environments suitable for open and distance learning. Secondly, the study has further expanded existing theory and enlightened our understanding regarding the role of interactivity in shaping learner satisfaction behavior and continuance use intention with E-learning. The research data generated by the study is crucial to informing ongoing efforts in designing, developing and evaluating instructional environments to foster rich learning experiences. Despite overwhelming support for the hypotheses, the study has one key inherent limitation. First, the sample was drawn from learners who were taking homogenous E-learning courses developed by the same instructional team. Further investigations are needed that involve E-learners taking various E-learning courses so as to offer varied insights for purpose of comparability of interactivity experiences.

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