Assessing the Impact of Interactivity on E-learning Quality: A Quantitative Investigation in Higher Education Institutes of Pakistan

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ABSTRACT

In recent times, integration of internet technologies has been taking place at a rapidpacein educational institutions to reinforce their learning processes and enrollment in online learning courses; however, attrition rates are persistently high. This paper reviews three dimensions of quality, i.e. service, information, and system, where quantitative research was conducted to test the effect of interactivity on the student's perception of e-learning quality using E-Learning Quality (ELQ) model (Uppal et al., 2017). The purpose of this study is to explore key aspects of interactivity in an e-learning environment, and to do so, empirical literature was reviewed through the lens of social cognitive theory. The findings of this research, conducted by collecting data from 384 university students, revealed that student perception concerning e-learning quality would be higher, if provided material would be more interactive and engaging. Furthermore, several implications have been suggested in this study pertaining improving particular aspects of interactivity to enhance quality in an online learning setting.

KEYWORDS: E-Learning, Social Cognitive Theory, Interactivity, E-Learning Quality (ELQ) Model, Higher Education Institutes

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1. INTRODUCTION: INTERACTIVITY IN LEARNING

Interaction is extensively discussed in the literature due to its association with pedagogy(Nurdin & Aratusa, 2020; Alzahrani, 2015; Schmid, Yeung, George, & King, 2009). Rochester and Pradel (2008)explain that learner's perception of quality and the ultimate satisfaction is highly correlated with interactivity. Interaction is also mentioned as the student level of engagement (Smart & Marshall, 2013; Rhode, 2009). The Oxford English Dictionary defines "interaction" as "the reciprocal action, or influence of a person or thing on each other". At an operational level, interactivity has been defined as the function of input required by the user; whilst responding to the computer and the nature of the system's response to the input action (Sims, 1995). Another author regards interactivity as the degree to which users of a medium can influence the form or content of the mediated environment(Rahmi et al., 2017; Steuer, 1992). Barker considers interactivity in learning as "a necessary and fundamental mechanism for knowledge acquisition and the development of both cognitive and physical skills" (Sims, 1995; Barker, 1994).

Bannan-Ritland (2002) classified the definitions of interactivity into five categories: 1) interactivity can be defined as active involvement of learners; 2) interactivity has been defined based on the patterns of communication among learners/instructors; 3) interactivity is defined as instructor–learner communication; 4) interactivity is considered as social, cooperative, or collaborative exchanges; and 5) interactivity can be viewed as a range of instructional activities and technologies.

2. Literature Review: Role of Interactivity in emerging technologies

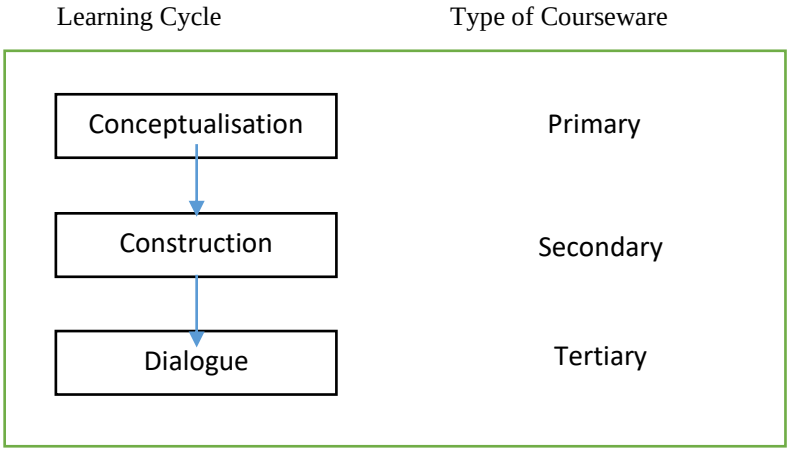
Online learning in higher education has become a major instructional modality in today's technology-focused world. At the same time, attrition rates in online courses remain high(Mubarak et al., 2020; Rochester & Pradel, 2008). Findings highlighted in this online learning literature review suggest that interactivity in online courses, particularly between student–instructor, can play an important role both in student satisfaction (Ha & Im, 2020; Mahle, 2011; Espasa & Meneses, 2010;Park & Choi, 2009; Liu, Magjuka, Bonk & Lee, 2007; Thurmond, Wambach, Connors & Frey, 2002) and user persistence (Tello, 2007; Morris, Finnegan, & Wu, 2005; Rovai, 2003). Further, research data suggest that preferences for types of online interactivity vary according to level and type of learner(Hollenbeck, Mason, & Song, 2011; Offir, Belazel &Barth, 2007; Tello, 2007; Tu & McIsaac, 2002). Accordingly, colleges and universities should take great care to create satisfying learning environments that provide opportunities for rich and meaningful interactions with students, instructors, and content.

A crucial factor that affects the student learning and satisfaction is related to interactivity (Ha & Im, 2020; Anderson, 2003). Online course interactivity can occur either as a formal interaction that is built into the overall course design or informal interaction that exists outside of the online course (Rhode, 2007). Primary forms of formal interactivity include student–student, student–instructor, and student–content (Moore, 1989). Research data suggest that online courses with high levels of interactivity lead to higher levels of student motivation, improved learning outcomes, and satisfaction over less interactive learning environments (Wang et al., 2019; Mahle, 2011; Espasa & Meneses, 2010; Park & Choi, 2009; Liu et al., 2007; Thurmond et al., 2002). Park and Choi (2009) assessed 147 adult learners who either completed or dropped out of online courses offered at a large university. Park and Choi (2009) found that online learners easily lose motivation and feel less satisfaction if courses do not stimulate their active participation and/or interaction. In support of these findings, the results from three separate studies (Mahle, 2011; Offir et al., 2008; Liu et al., 2007) noted significant, positive relationships between interactivity and perceived engagement, learning, confidence, relevance, and student satisfaction. In a separate study, Espasa and Meneses (2010) electronically surveyed 186 online graduate students in their last week of online learning courses. The results of their study showed a statistically significant relationship between instructor feedback received and learning as measured by student satisfaction and final grades. Building the right blend of student-student and student–instructor interactivity into online course design has been suggested to not only improve student satisfaction and achievement but motivation as well (Sun & Hsieh, 2018; Mahle, 2011; Park & Choi, 2009; Offir et al., 2008; Liu et al., 2007).

From a social cognitive perspective, knowledge is constructed when individuals are engaged in activities, receive feedback, and participate in other forms of human interaction in public, social contexts (Bandura, 2001). Because cognition is not considered an individual process, learning and knowledge are shaped by the kinds of interactions a student has with others and the context within which these interactions occur (Bandura, 2001). In the online learning context, some students anticipate a lack of interaction and perceive that this is an expected trade-off of online learning experiences (Mahlangu, 2018; Liu et al., 2007). According to the tenets of social cognitive theory, however, a well-designed online course should not sacrifice interaction, but instead provide an active-learning environment, where students are highly engaged in the learning process through interactions with peers, instructors, and content. Active learning involves students in doing things and thinking about things they are doing, and include activities such as discussions, cooperative learning, debates, role playing, problem-based learning, and simulations (Waluyo, 2020; Schunk, 2012; Braxton, Milem & Shaw Sullivan, 2000).

According to Mayes and Fowler (1999), there are three stages of learning, and they can be supported by three kinds of courseware, involving conceptualisation, construction, and dialogue (see Figure 1). At the conceptualisation phase, learner views resources online, e.g. like lecture slides or

notes. In the construction phase, learners apply the knowledge to the tasks being performed on the computer-based assignments and tests. Finally, on the dialogue stage, actual active learning takes place.



'Mayer's learning style' implies that different types of interactivity are required at different stages of learning. At the conceptualisation stage, interactivity with learning material is useful. At the knowledge construction stage, interactivity with the system may be beneficial and at the dialogue level, interactivity with the teacherand/or peers may be beneficial. Since interactivity has been defined from different perspectives, therefore different types of interactivity considering the e-learning experience have been discussed below.

3. Types of Interactivity

Moore and Kearsley (1989) define the three levels of interaction as being 'student-content, 'student-teacher', and 'student-student'. "Student-content" interaction refers to how interactively the student can access the content presented, "student-teacher" interaction refers to how interactively the teacher delivers the content, and the skills required for the student to access the content independently. "Student-student" interaction refers to the extent to which the students interact with peers; in order to exchange information and knowledge through social communication.

3.1. Content Interactivity

In traditional distance education models, student content is the only and only content is the source of learning and/or interaction in the education. This passive unidirectional interaction model is still being followed in many developing countries. The content is transferred to the students in the form of hard copies or digital disks, this completely ignores the concept of interaction with a teacher, and students have no sources to rely on other than the course material. In contrast to distance learning, e-learning, however,emphasises more on the potential for interaction. Moore (1989) explains the importance of the course in e-learning by giving an example of a movie. In order for a movie to convey its meaning to the viewer every one of the actors' actions, reactions and words should be prewritten, and thoroughly analysed according to the script. Similarly, with distance course content, in order to convey a consistent message through content (in spite of the difference in the perspectives of learners), it needs to be carefully developed and structured; in part explaining the increased cost of developing distance learning teaching resources.

Students can interact with teaching materials via text, images, sound, video or combination of these media. Also, streams with the advent of instant messaging and video calling, distance interaction with teachers and peers are much easier. They can also engage in self-paced learning, taking control over both the process and the content of their learning (Wang et al., 2020; Zhang, 2003;Trombley & Lee, 2002). Numerous empirical studies have also indicated that information quality is important in determining users' level of satisfaction with the system, which in turn leads to system utilisation (Ha & Im, 2020; Katerattanakul & Siau, 1999).

With the advances in multimedia technology, more multimedia-based e-learning systems are becoming

available. These systems facilitate the presentation and integration of learning materials in a range of diverse media; such as text, image, sound, and video. However, some of the multimedia-based systems suffer from insufficient learner-content interactivity and flexibility because of their passive and, unstructured way of presenting instructional content. Under such a system, learners have relatively little control over the knowledge structure and the learning process to meet individual needs. For example, it may be ineffective and time-consuming to locate a particular segment or to skip a portion of a three-hour instructional video delivered via the Internet, making interactive learning difficult (Zhang, Zhao, Zhou & Nunamaker, 2004).

If the information (learning content) is carefully developed, keeping in mind the aspects of interactivity, students not only engage with the material more but also find the learning experience more satisfying as well. If students do not get enough opportunities to interact formally and informally in online courses, their learning and satisfaction may be compromised. Of the three types of interactivity that can occur online, student–content interaction has been found to be the strongest predictor of student satisfaction in online courses (Kuo, Walker, Schroder & Belland, 2014; Keeler, 2006; Chejlyk, 2006).

Boud, Cohen, and Walker (1993) mention that interaction of students with information (course content) is important; however, information alone is not enough to achieve learning success. Bond et al. state interaction as equally necessary as interaction with information (course content). If students like the subject, they are more likely to engage. If they engage, they do better.

3.2. System Interactivity

Technology has an important role in delivering learning outcomes because learners interact more in e-learning environments than with traditional face to face instruction (Hayashi et al., 2020; Li et al., 2014; Webster & Hackley, 1997). System design facilitates formative interactions, controls organisational activities, and provides correct and sufficient information to reduce uncertainty (Daft & Lengel, 1986). System quality relates to a learner's belief about e-learning performance characteristics (Chiu et al., 2007) and is measured by functionality, ease of use, reliability, flexibility, data quality, portability, integration, and importance (Delone & McLean, 2003). System quality has a strong positive effect on learners' satisfaction (Ozkan & Koseler, 2009) and directly affects user beliefs. Results from Hara & Kling (2001), measuring the quality assessment of an e-learning experience, showed that students faced technical issues in the e-learning system while the instructor was competent. Factors that are relevant for infrastructure and system quality include internet quality, facilitating conditions, reliability, ease of use, system functionality, system interactivity, system response, and equipment accessibility (Wu, Tennyson & Hsia, 2010; Sun, Tsai, Finger, Chen & Yeh, 2008).

A study by Pituch and Lee (2006) concerning student use of e-learning system stated in their findings that interactivity in distance education has the strongest direct effect on student's use of the e-learning system. Pituch and Lee(2006)concluded that systems that allow more interaction amongst teachers and students are more helpful in the learning process. Accordingly, a major issue in the pedagogy in an e-learning environment is the absence of interactive system.

3.3. Interactivity with Service Provider

In an e-Learning system, the service is provided by the developer of the learning course, which is the teacher; with system support provided by administrators. The interaction between the service provider and support provider is very important as the learners expect quick and reliable service and support.

According to Moore et al. . (2011) interaction of teacher with students in the classroom is a crucial component of learning. This interaction with teacher and student is defined as the interpersonal communication, which can be in and outside the context of learning, e.g. counsellingadvice, and career guidance. Although e-learning is largely independently driven, independence does not mean leaving the student in complete isolation as this can lead to problems (Moore & Thompson, 1990). Morris, Mitchell, and Bell (1999)mention that in spite of the highest degree of structured content, the role of the teacher as a contact point cannot be replaced by any means. Accordingly, student-teacher interaction is one of the most significant types of interaction in e-learning (Blaine, 2019; Zhao, Lei, Yan, Lai & Tan, 2005). The success of e-learning is directly dependent on the interaction with peers and most

importantly with teachers (Magjuka, Shi & Bonk, 2005).

Shih, Martinez-Molina, and Muñoz (2008) provided more in-depth study on the role played by teachers in e-learning and concluded that teachers can improve the effectiveness of e-learning by providing constructive and prompt feedback to the students. Teachers can also support the students in learning how to use the system because different individuals can have different perceived IT self- efficacy. In this manner, the teachers can lift the level of performance of the students and help reduce the rate of withdrawal, which is, unfortunately, quite high in e-learning courses. In addition, by considering the design of the interaction during course, teachers can promote learner to learner interaction, which considering the role of social interaction in human performance, is likely to help the students both personally and professionally (Abulibdeh and Hassan, 2011).

Student-teacher interaction is different from student-content interaction in that student-content interaction is more about how the course is structured, whilst student-teacher interaction is more about how the two interact. Interactivity among students and teachers in the classroom may of the critical success factor of learning (Chou, 2003; Fulford & Zhang, 1993), also Ozkan and Koseler(2009), however, mentions that interactivity also plays a vital role in achieving e-learning objectives of making student, independent and lifelong learners. More interactive classroom environment will lead to more effectiveness and ultimate success of learner (Doe et al., 2018; Evans & Sabry, 2003). Online course interactivity, particularly between student and instructor, plays an important role in a student's choice to persist in an online course. Consequently, in university-wide efforts to retain students, online instructors must take care to design courses that provide students the opportunity to interact both with each other and with the instructor in both meaningful and supportive ways.

Taught content is largely independent of the teacher, i.e. a teacher can teach content developed by someone else. Student-teacher interaction includes the direct and verbal communication and/or engagement between the two stakeholders. This is interpersonal communication that occurs between the teacher and learner in, and outside, the context of the study. For example, teachers often act as mentors for students helping them learn beyond the limits of the subjects. Teachers also feel empathy for students if they are struggling with the learning, and/or have other issues which affect student success. Students also develop a sense of dependency on teachers, allowing them to ask teachers for help and advice, not only about the courses, yet about other personal issues; as students see teachers as a reliable source from where they can get authentic and valuable advice.

Moore and Thompson (1990) argue that teacher's feedback is critical to the learning of the student. While some researchers have argued in support for more interaction between the students and the teachers. However, critics argue that more is not always better when it comes to student-teacher interaction in e-learning, e.g. Mazzolini and Madison (2003) observed that increased efforts of interaction by the teacher, through an increased number of messages, does not result in increased interaction from the students.

Zhao et al. (2005) concluded that, of all the available forms of interaction in e-learning, the most significant one is the student-teacher interaction. This was supported by Magjuka, et al. (2005) who concluded that e-learning success depends most significantly on the interaction between human participants, i.e. either learner to learner interaction and learner to teacher interaction. Therefore, present study draws attention towards interactivity, as an important factor in successful implementation of e-learning system.

4.Hypothesis of the study

By looking at the literature, there appears to be a number of benefits associated with appropriate use of interactivity for learning. Since there are three dominant aspects, or dimensions, of interactivity with respect to e-Learning, which are content interactivity, system interactivity, and service interactivity. Interactivity is vital in the case of e-Learning as face to face interaction with the content provider is not always possible. Interactivity is not only important for the learning content but also is equally important for the system through which the e-learning is being provided. This includes the website or software through which the e-learning is being delivered. Similarly, the interaction with the service and support providers is also key to the success of e-learning systems. In this study, the effect of interactivity has

been tested from the point of 'service', 'information' and 'system' dimensions, using ELQ model (Uppal et al., 2017).

Our research hypotheses state; when moderated by interactivity,

H1: "Reliability" is positively associated with students' perception of e-learning quality.

H2: "Assurance" is positively associated with students' perception of e-learning quality.

H3: "Tangibility" is positively associated with students' perception of e-learning quality.

H4: "Empathy" is positively associated with students' perception of e-learning quality.

H5: "Responsiveness" is positively associated with students' perception of e-learning quality.

H6: "Learning Content" is positively associated with students' perception of e-learning quality.

H7: "Course Website" is positively associated with students' perception of e-learning quality.

To test these hypotheses, e-Learning Quality (ELQ) model has been used (see Figure 2).

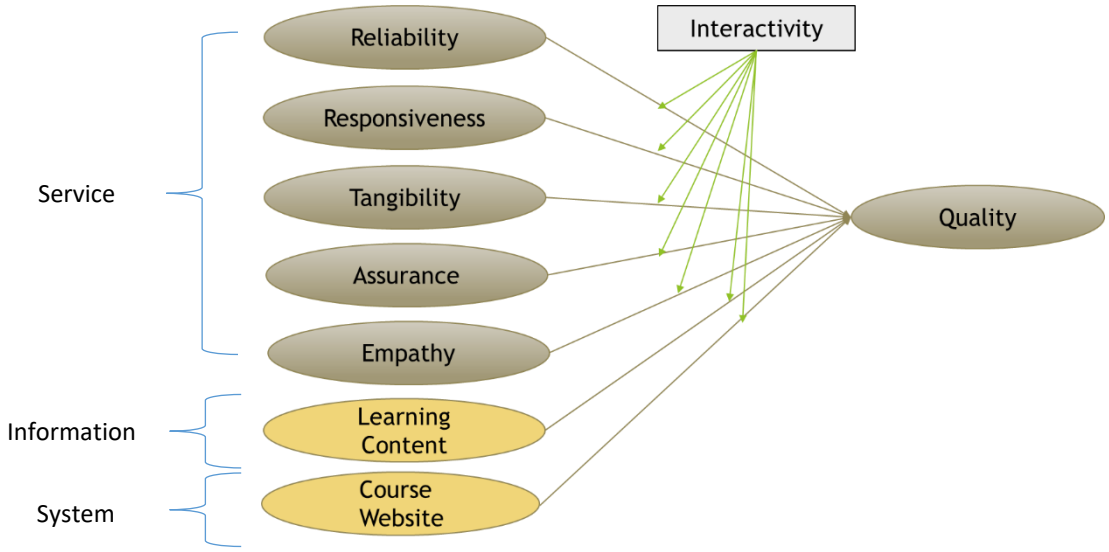


Figure 2: Research model to test interactivity moderation

5. Methodology

In present research, data has been collected from 384 students from two universities in Lahore, Pakistan. The students were asked about their perception regarding quality of their e-learning experience if the material was presented in an interactive manner, as compared to the learning material that is not interactive. Similarly, we asked their perception regarding interactivity of the course website and interactivity of the e-learning services provided.

5.1. Respondents Profile

A questionnaire was used to collect participant data, which consisted of two sections. The first part included the questions related to demographic data. A five-point Likert scale was used for all questions in section two. The questionnaire was distributed to students in different classes at two leading public universities in Lahore, Pakistan. University student (undergraduates, postgraduates, and executives) were used to collect data.These students were enrolled in BSc Applied Management, BBA honours, MBA, EMBA, BSc Sciences and BSc Engineering programs. Data were collected from a total of 430 students, most of whom had previouslyexposure to e-learning content. After careful screening, 384 responses were found to be valid. Details of the demographics of respondents are shown in the Tables 1, 2 and 3.

Table 1: Demographics data - Gender

		Frequency	Percentage
Valid	Male	186	48.4
	Female	198	51.6
	Total	384	100.0

Table 2: Demographics data – Education level

		Frequency	Percentage
Valid	BSc Honors	113	29.4
	MBA	235	61.2
	Engineering	6	1.6
	BSc Sciences	30	7.8
	Total	384	100.0

Table 3: Demographics data – Household income

		Frequency	Percentage
Valid	Below Rs. 20,000	27	7.0
	Rs. 21,000 to Rs. 50,000	80	20.8
	Rs. 51,000 to Rs. 100,000	112	29.2
	Above Rs. 100,000	165	43.0
	Total	384	100.0

5.2. Reliability and Validity

To check the reliability of scale, we conducted Cronbach Alpha (Cronbach, 1951; Nunnully, 1978) to measure internal consistency. The extracted Cronbach alpha values for our quality factors are shown in Table 4. All alpha (α) values are greater than (>) 0.70, which implies factors are highly correlated and interchangeable (Jarvis et al., 2003).

Table 4: Scale Reliability values

Factor Label	**Number of Items**	**Cronbach's alpha (α)**
Assurance	6	0.949
Reliability	7	0.964
Responsiveness	5	0.951
Empathy	4	0.903
Tangibility	4	0.884
Learning Content	8	0.964
Learning Quality	4	0.943

Course Website	8	0.968

5.3. Exploratory Factor Analysis (EFA)

To see if the observed variables adequately correlated, i.e. met reliability and validity criteria, we conducted an EFA using Principal Component Analysis, with Varimax rotation (see Table 5). The cumulative variance of the eight factors was 75.64%, and all extracted factors had eigenvalues above 1.0. All the commonalities for each variable were significantly high; i.e. all were above 0.300, with most being above 0.700.

Two questions of 'Learning Content' needed to be dropped. One question was cross loading and one had a loading value below 0.5 (Hair, Black, Babin & Anderson, 2010). The seven factors that were extracted in the pattern matrix (see Table 5) were, however, used for further analysis. Terms measuring the same construct exhibited high construct loadings, i.e. suggesting adequate convergent validity. According to Hair et al. (2010), the minimum threshold value recommended for a sample size of 384 is 0.350. Since all loaded values were above 0.50, it confirms that the

Table 5: Rotated Pattern Matrix[a]

Extraction Method: Maximum Likelihood.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

	Factor							
	1	2	3	4	5	6	7	8
CW_4	.920							
CW_1	.899							
CW_3	.891							
CW_2	.889							
CW_5	.888							
CW_6	.867							
CW_7	.822							
CW_8	.817							
LC_1		.895						
LC_2		.892						
LC_3		.889						
LC_4		.887						
LC_6		.878						
LC_5		.868						
LC_7		.832						

LC_8		.814						
RA_1			.925					
RA_3			.908					
RA_2			.901					
RA_4			.874					
RA_6			.870					
RA_7			.865					
RA_5			.855					
AS_1				.911				
AS_4				.861				
AS_5				.855				
AS_3				.853				
AS_2				.842				
AS_6				.839				
RS_1					.918			
RS_3					.896			
RS_4					.878			
RS_2					.848			
RS_5					.842			
LQ_2						.927		
LQ_4						.893		
LQ_3						.868		
LQ_1						.803		
EM_3							.852	
EM_4							.841	
EM_2							.797	
EM_1							.764	
TA_3								.833
TA_1								.816
TA_2								.786
TA_4								.712

factors had sufficient discriminant validity, and no unexpected cross-loading occurred (see Table 5).

The Kaiser-Meyer-Olkin and Bartlett's test for sampling adequacy was significant, showing that the chosen variables were sufficiently correlated (see Table 6).

Table 6: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.859
Bartlett's Test of Sphericity	Approx. Chi-Square	19598.090
	Df	1035
	Sig.	.000

After exploratory factor analysis we used SEM to prove the convergent and discriminant validity of extracted construct; accordingly, Confirmatory factor analysis was performed using AMOS.

5.4. Confirmatory Factor Analysis (CFA)

After testing the scale reliability, convergent and divergent validity was tested. Convergent validity can be established if two indicators correspond to each other. Divergent validity is the degree to which two dissimilar constructs can be easily differentiated. Construct reliability is the measure used to check the reliability of the extracted constructs, the threshold value is 0.7 in our case, composite reliability (CR) for all eight extracted factors is above 0.90 (see Table 7).

Table 7: Discriminant and convergent validity

	CR	AVE	MSV	ASV	CW	AS	EM	RS	RA	TA	LQ	LC
Course Website(CW)	0.967	0.784	0.052	0.029	**0.886**							
Assurance (AS)	0.949	0.758	0.052	0.018	0.150	**0.870**						
Empathy(EM)	0.904	0.702	0.122	0.035	0.022	0.118	**0.838**					
Responsiveness (RS)	0.952	0.798	0.077	0.027	0.161	0.228	0.277	**0.893**				
Reliability (RA)	0.959	0.795	0.031	0.008	0.177	0.064	-0.052	0.053	**0.892**			
Tangibility (TA)	0.890	0.670	0.122	0.042	0.157	0.165	0.349	0.042	0.082	**0.818**		
Learning Quality (LQ)	0.944	0.807	0.080	0.033	0.217	0.089	0.167	0.132	0.011	0.282	**0.899**	
Learning Content (LC)	0.965	0.773	0.052	0.023	0.229	0.030	0.062	0.099	0.103	0.180	0.222	**0.879**

All fitness values are within acceptable criteria limits, depending on the test, hence implying a good model fit (see Table 8). The Chi-square/df value equalled 2.83; where a value between 2.0 and 5.0 is considered acceptable (Hau, 2010). Our RMSEA value is 0.069, and our CFI and NFI values are 0.91 and 0.868 respectively; demonstrating a good model of fit, thus supporting the results and validating the proposed model.

Table 8: Goodness of Fit Statistics

Index	Value	Criterion
Chi – Square /Df	2.83	2.0 – 5.0
RMSEA	0.069	0 – 0.1
CFI	0.91	0 ~ 1
NFI	0.868	0 ~ 1

5.5. Results

The ELQ model has been used to measure the perception of e-learning quality, ensuring consideration of 'service', 'information' and 'system' dimensions. Seven hypotheses were tested as independent variables, i.e. the original five SERVQUAL dimensions, plus the proposed dimensions - 'Learning Content' and 'Course Website' (see Table 9).

Table 9: Regression Weights

			Estimate	S.E.	C.R.	P
E-Learning Quality	←	Learning Content	0.153	0.053	3.008	.003***
E-Learning Quality	←	Tangibility	0.216	0.071	4.017	.001***
E-Learning Quality	←	Reliability	-0.046	0.051	-0.895	0.371
E-Learning Quality	←	Responsiveness	0.072	0.053	1.41	0.158
E-Learning Quality	←	Assurance	0.013	0.059	0.247	0.805
E-Learning Quality	←	Empathy	0.070	0.065	1.334	0.182
E-Learning Quality	←	Course Website	0.144	0.043	2.825	.005***
* P≤ 0.05, ** P ≤ 0.01, *** P ≤ 0.001, **** P ≤ 0.0001						

6. CONCLUSION

The present study aimed to determine the impact of interactivity in context of e-learning quality particularly in higher education institutes of Pakistan since to create a satisfying learning environment, a crucial factor that affects the student learning and satisfactionis related to interactivity. From Table 9 we can see that "Learning Content", "Tangibility" and "Course Website" are significant. This means that students perceive the e-learning material to be of higher quality, if that material is more interactive, as compared to if there is little or no interactivity. This is in line with the literature which states that the interactivity improves the perception of quality of the learning material. Research data suggest that online courses with high levels of interactivity lead to higher levels of student motivation, improved learning outcomes, and satisfaction over less interactive learning environments (Ha & Im, 2020; Mahle, 2011; Espa sa & Meneses, 2010; Park & Choi, 2009; Thurmond et al., 2002).

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