E-learning: substitutability of learner–learner, and learner–facilitator interactions to enhance learner satisfaction in higher education

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Abstract

Purpose – The purpose of this study is to evaluate the effect of learner–learner and learner–facilitator interactions on learner satisfaction and their substitutability.

Design/methodology/approach – A quantitative survey research focusing on 130 students was used to collect data. Stratified sampling was preferred for the study, with a Likert type research instrument being administered online.

Findings – Learner–learner and learner–facilitator interactions mediate the effect of e-learning on learner satisfaction. These sets of interactions act as independent mediators, each playing a pivotal role in enhancing learner satisfaction. The interactions are however not substitutable.

Practical implications – The findings of the study will provide insights to academic administrators, to ensure that the two sets of interactions contribute to an effective and conducive e-learning environment and ultimately learner satisfaction. Deliberate efforts should be made to design increased e-learning interactivity into the cyber learning environment for effective learning.

Originality/value – The findings result in a ranking of learner–learner and learner–facilitator interactions for increased learner satisfaction. The interactions cannot be substituted without affecting the level of learner satisfaction. The interactions play a complementarity role, and collectively, enrich the quality of e-learning. A collective deployment is recommended.

Keywords Social presence, e-learning, Learner–learner interaction, Learner–facilitator interaction, Learner satisfaction, Developing countries

Paper type Research paper

Background

The concept of e-learning has been adopted world-over, as a revolution in the educational field, to better the traditional modes of learning and build capacity in education and training (Alfraih and Alanezi, 2016; Tarhini *et al.*, 2017). The phenomenon has been implemented either haphazardly or in a calculated move, in order to enhance the knowledge and skills of students as demanded in the 21st century (Dubey and Sahu, 2021). A smooth e-learning environment is a prerequisite to effective learning and learner satisfaction. Three sets of

interactions are key relationships to this ideal virtual learning environment: learner–learner interaction (LLI), learner–facilitator interaction (LFI) and the learner-content interaction (LCI). The three relationships create a smooth e-learning environment which ultimately leads to learning effectiveness and learner satisfaction (Luo *et al.*, 2017; Kurucay and Inan, 2017), by supporting higher-order thinking. They also make it possible for learners to have fulfilling learning experiences. This study focuses on two of these interactions capable of being substituted: learner–learner and learner–facilitator interactions.

In developed economies, the implementation of e-learning followed years of careful and steady planning. The understanding behind this planning was that e-learning is likely to increase its presence and influence with time. The electronic platforms were however sparingly utilized, as the phenomenon was perceived to be inferior to face-to-face learning in terms of academic rigor (Monash, 2020). The suspension of face-to-face learning as a result of the COVID-19 pandemic, therefore, saw educational institutions in most developed economies, seamlessly transition to e-learning. This was made possible by the already existing e-learning platforms that had been well developed at the time (Amanor *et al.*, 2020; Monash, 2020). As a result, the COVID-19 protocols had minimal disruptions in the programming of lessons in the higher education sector. This planning was glaringly lacking in developing economies. The adoption of e-learning was forced on universities by crisis circumstances in most African countries, including Zimbabwe (Kotoua *et al.*, 2015; Queiros and de Villiers, 2016). The implementation was done hurriedly without preparations (Bates, 2020). When fast tracked and unplanned, e-learning is detested by both facilitators and learners (Pete and Soko, 2020).

The objective of e-learning is to develop an effective knowledge economy and enhance lifelong education (Barteit *et al.*, 2020; Pete and Soko, 2020). It is a transformative tool meant to extend the traditional modes of learning and build capacity in education (Alfraih and Alanezi, 2016). To achieve this objective, institutions have focused on critical success factors for e-learning effectiveness (Dubey and Sahu, 2021) and learner satisfaction (Asoodar *et al.*, 2016; Tawfik *et al.*, 2018). These studies have categorized success factors into internal and social presence factors. The internal or learner factors include self-motivation and determination (Alhabeeb and Rowley, 2018). The social presence (virtual environment) factors consist of experiences encountered during the creation and transmission of knowledge (Ng, 2017; Alhabeeb and Rowley, 2018; Nasir, 2020).

The effect of internal factors on e-learning has been extensively researched. There is however limited research on the effect of social presence factors. A number of studies indicate that social presence factors have a greater impact on learner satisfaction than internal factors (Asoodar *et al.*, 2016; Luo *et al.*, 2017; Kurucay and Inan, 2017; Baharudin *et al.*, 2018; Quadir *et al.*, 2022). The things that happen in the course of learning, not what the student started with, contribute more to learner satisfaction with e-learning.

As technology presents more opportunities for interactions, there is increased need to rank these interactions, in importance, to learners. No comparative study has been done on the substitutability of learner–learner and learner–facilitator interactions. Do these two types of interactions yield the same or different levels of effect on learner satisfaction? Is it possible to substitute LLI for LFI without affecting the effectiveness of learning and learner satisfaction? This study seeks to examine the effect of substituting one type of interaction for the other on learner satisfaction levels.

Literature review and hypothesis development

Global education has over many years exploited advances in information and communication technology to plan for a staged transition from traditional models to e-learning. In developed economies, e-learning has become an alternative but key channel of instructional delivery in

higher education institutions (Amanor *et al.*, 2020; Mohan *et al.*, 2022). Several studies indicate the effectiveness of e-learning that culminate in learner satisfaction. The promotion of interactivity between and among learners (Gunesekera *et al.*, 2019; Nasir, 2020) increased flexibility of e-learning (Sun and Chen, 2016), availability of competencies required to use technology (Queiros and de Villiers, 2016), presence of a more enriching learning environment (Nasir, 2020), and the presence of better prepared facilitators (Queiros and de Villiers, 2016) were identified as some of the key strengths of e-learning. These strengths have positive effects on learner satisfaction (Nasir, 2020).

Online education also offers learners the opportunity to study at their own pace and convenient time. As such, social presence, especially LLI leads to course satisfaction (Shin and Kang, 2015). Flexibility and convenience are major drivers behind the demand for online education amongst the working learners (Nasir, 2020). E-learning is however not without weaknesses. The feelings of isolation by students (Alhumaid, 2019; Nasir, 2020), delayed feedback from facilitators (Alhumaid, 2019), technical challenges (Nasir, 2020), higher student attrition rates (De Paepe *et al.*, 2018; Choi and Kim, 2018; Nasir, 2020) and the need for greater discipline on the part of learners (Nasir, 2020) were identified as weaknesses of e-learning. Notwithstanding these weaknesses, the consensus is that e-learning offers value for money (Heflin *et al.*, 2017; Dubey and Sahu, 2021). The first hypothesis is therefore:

H1. Electronic learning has a positive effect on learner satisfaction.

The bulk of studies on e-learning effect on learner satisfaction, have not incorporated the mediating effect of the virtual learning environment. A number of studies have acknowledged the effect of the social presence factors in explaining learner satisfaction. Some form of interaction, is advantageous to e-learning (Ng, 2017). Three theories lend credence to the importance of the virtual learning environment to learner satisfaction. They focus on the importance of LLI and LFI: the major constituent elements of the virtual learning environment. The *social integration theory, social constructivist theory* and *interaction equivalency theorem* both focus on LLI and LFI. The *social integration theory* emphasizes the importance of a sense of belonging in students to their learning environments through active participation in virtual learning groups (Ng, 2017).

Learning satisfaction is not only a function of learner characteristics but the outcome of a process of interactions between individuals and their peers and facilitators (Asoodar *et al.*, 2016; Queiros and de Villiers, 2016; Mohan *et al.*, 2022). Empirical findings show that involvement in these interactions enhances learners' sense of belonging through communication and interaction with others in the same environment (Tawfik *et al.*, 2018; Quadir *et al.*, 2022). When learners feel a sense of integration with other learners, the likelihood of satisfaction increases (Ng, 2017; Tawfik *et al.*, 2018; Quadir *et al.*, 2022). The quality of e-learning is also influenced by LLIs (Goh *et al.*, 2017; Ng, 2017; Tawfik *et al.*, 2018).

The *social constructivist theory* looks at deeper learning as taking place when learners' perspectives and experiences are brought into collaborative work to actively construct knowledge (Scardamalia and Bereiter, 1999). It exclusively examines the LLIs' effect on learner satisfaction. Learning is not simply the assimilation and accommodation of new knowledge by learners, but is the process by which learners are integrated into a knowledge community. According to Kurucay and Inan (2017), for knowledge to be constructed, individuals need to converse and interact with one another. The learner-to-learner interactions increase the sense of community and encourage learners to work in teams (Luo *et al.*, 2017). The interactions encourage positive attitudes toward online learning and enhance learner satisfaction (van Nuland and Rogers, 2016; Luo *et al.*, 2017; Tawfik *et al.*, 2018). Highly interactive settings are required to facilitate supportive and corrective feedback.

The collaboration between students allows for investigation and development of multiple perspectives on an issue, which helps students to learn better. When there is collaboration between learners, their self-esteem increases. They learn to accommodate diverse views, enhance their listening and communication skills (Gunesekera *et al.*, 2019). Group discussions, disagreements or conflict help group members' cognitive development (Tawfikk *et al.*, 2018; Quadir *et al.*, 2022). Collaboration is ideal for mutual support and an exchange of ideas (Queiros and de Villiers, 2016). Course quality is therefore influenced by cooperation and reciprocity between learners. When learners relate to peers they experience deeper learning and satisfaction (Baharudin *et al.*, 2018). Collaboration allows learners to form and belong to a knowledge community that actively constructs new ideas Kurucay and Inan (2017). Interactions are said to increase openness, communication as well as contributing to a sense of togetherness amongst learners (Tawfik *et al.*, 2018; Quadir *et al.*, 2022) and support e-learning goals. They encourage positive attitudes toward e-learning. Although there exists a number of constraints in developing countries, management of LLIs present great potential for accessing quality higher education. The second hypothesis is therefore:

H2. LLI mediates the effect of e-learning on learner satisfaction.

Learner–facilitator interaction enriches the virtual learning environment too, in several ways. There is a feeling of better assessment and increased participation in e-learning discussion forums when learner–facilitator interaction is high (Taib *et al.*, 2021). These findings support the social integration theory's argument on the importance of having a sense of community in virtual learning groups. This category of interaction is said to be the most important of the three interactions (Rhode, 2009; Queiros and de Villiers, 2016). The findings however did not specify the depth and frequencies of these interactions. Notwithstanding this limitation, learner–facilitator interactions enhance learning (Ng, 2017).

There is a statistically significant relationship between learner–facilitator interaction on one hand and the results of learners' grades (Luo *et al.*, 2017). Facilitators motivate learners to interact actively in discussion forums, as well as determine the quality and quantity of e-learning discussions. This leads to improved higher order thinking (Hewett *et al.*, 2019; Hesrcu-Kluska, 2019). Research findings also note that learner–facilitator interactions contribute to the process of collaborative inquiry, leading to a deeper understanding of concepts under discussion (Mohan *et al.*, 2022). Facilitators create a community of learning and thereby help students increase their cognitive engagement with peers. A study by Mohan *et al.* (2022) on the effect of interactions showed that learner–facilitator interactions are vital for learner satisfaction with e-learning. Facilitators are the drivers of the learning experience (Mohan *et al.*, 2022; Quadir *et al.*, 2022), source of technical skills and motivation. They have a strong influence over learners' experience and through that their efforts do provide opportunities to connect learners with other learners.

The implications of the research findings suggest that learner–facilitator interactions represent an important tool in increasing students' learning, satisfaction and retention. Literature reviews suggest that learner–facilitator interactions are critical to better student grades, higher student satisfaction and students' higher-order cognition (Elfeky, 2018). Electronic learning is still in its infancy in developing economies which experience challenges unique to third world countries (Kotouaa *et al.*, 2015; Amanor *et al.*, 2020). Studies need to be conducted to find out if the learner–facilitator interactions have a positive effect on learner satisfaction and are substitutable. The third hypothesis is therefore:

H3. Learner–facilitator interaction mediates the effect of e-learning on learner satisfaction.

In terms of the social constructivist theory and social integration theory, LLI and LFI combined, help learners create meaningful learning, by constructing a smooth virtual learning environment (Quadir *et al.*, 2022). The fourth hypothesis is therefore:

H4. Learner–learner and learner–facilitator interactions have a positive effect on learner satisfaction.

The *interaction equivalency theorem* suggests that meaningful learning can occur when at least one of the forms of interaction is present at a high level: learner–learner, learner–content, and learner–facilitator (Rhode, 2009; Ng, 2017). Course designers can even substitute one type of interaction for another with little loss in educational effectiveness. Rhode (2009, p. 4) states that "deep and meaningful formal learning is supported as long as one of the three forms of interaction (student–teacher; student–student; student-content) is at a high level. The other two may be offered at minimal levels, or even eliminated, without degrading the educational experience. High levels of more than one of these three modes will likely provide a more satisfying educational experience, though these experiences may not be as cost or time effective as less interactive learning sequences." The proposition put forward in this theory is that each student is different and requires a specific mix of interactions to fit specific preferences and needs. This assumption has however not been tested. The fifth hypothesis is therefore:

H5. All forms of interaction in an e-learning environment are substitutable.

Operational definitions
Social presence
Social presence represents the "individual perception that his/her presence with a group of people is recognized, valued and respected, which boost the feeling of connected to other group members" (Tasir and Al-Dheleai, 2019, p. 14). It reflects one's ability to interact with others virtually (Quadir *et al.*, 2022). It serves as a predictor, and has been linked with course satisfaction (Shin and Kang, 2015; Baharudin *et al.*, 2018). Social presence involves three key interactions, namely, LFI, learner–content interaction and LLI (Queiros and de Villiers, 2016; Gunesekera *et al.*, 2019).

Learner–facilitator interaction
It refers to the ability for learners (students) and facilitators (lecturers) to interact, either via synchronous or asynchronous communication platforms using text, audio and/or video (Anderson, 2008; Ng, 2017). This interaction includes emails, forums, discussions or feedback from facilitators to learners with regards to their work or progress in a course.

Learner to learner interaction
This refers to interactions between peers or course participants (Hesrcu-Kluska, 2019) with a view to allowing for the investigation and development of multiple perspectives on an issue, which help students to learn better. The interactions include comments that a student gets from peers on assignments, sharing of work and feedback (Goh *et al.*, 2017).

Learner satisfaction
It is defined as the pleasure and success which learners receive from the learning environment (Assodar *et al.*, 2016; Tawfik *et al.*, 2018). Learner satisfaction is thus a result of learner outcomes of the learning process and a requirement for successful learning. It covers the

entire learner experience cycle from information retrieval through assignment submission, assignment feedback, getting notices, reminders and service.

e-learning
Electronic learning (also known as online learning, virtual learning and web-based learning), is defined as the use of "digitally permitted and technology-facilitated learning devices that use a digital camera, personal computers, digital videos, tablets, projector; OHP, software, operating systems which aid in the interaction of students and teachers" (Eze *et al.*, 2018, p. 34). It is a system that permits the distribution of information through videos and other techniques. It is a modern educational approach where students and teachers follow a structured curriculum program using advanced information technology that is mediated via the Internet (Monash, 2020). The phenomenon is about virtual classrooms/lecture rooms enabled by information technology via Internet.

Study design
This study made use of Astin's input-environment-output model (1993) as its conceptual framework. The premise of this model is that educational assessments are not complete unless the evaluation includes information on learner inputs, the educational environment and learner outcomes. This study focuses on the effect of the educational environment on learner outcomes. The majority of studies have focused at the direct effect of e-learning on learner satisfaction, at the exclusion of the learning environment (Queiros and de Villiers, 2016; Ng, 2017; Tarhini *et al.*, 2017; Dubey and Sahu, 2021). In addition, none of them have been conducted on the substitutability of the types of interactions under scrutiny (see Figure 1).

The study focused on one public university in Zimbabwe. A cross-sectional quantitative survey research was used to collect data. All undergraduate students in the Faculty of Commerce, numbering 489 in total, made up the population of interest ($N = 489$). For sampling purposes, an inclusion criterion was that, the persons of interest should have been subject to e-learning for at least two academic semesters. A total of 200 students, (from Part II, III and IV) made up the sample of interest ($n = 200$). The undergraduate register was utilized as a sampling frame. Israel (1992) formula for determining sample size, where attributes being measured are assumed to be distributed normally, was used. The stratified sampling method was used to select the 200 respondents, with "academic stages" that the students were in, being treated as strata. Data were collected through a structured
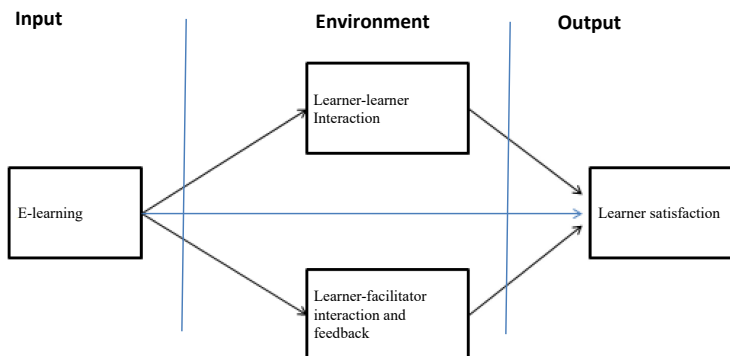
Figure 1.
Conceptual framework
of the study

questionnaire between November 1, 2021 and 15 March, 2022 inclusive. Likert type scales with strongly agree and strongly disagree anchors were chosen. The instrument was piloted on 20 respondents. The instrument was administered online due to the COVID-19 protocols. A total of 130 responses were recorded, representing a 65% return rate. A research instrument with measures of e-learning, LLI, LFI and learner satisfaction was developed to test the conceptual framework.

Electronic-learning scale
The four-item "e-learning" instrument makes use of the five-point Likert scales anchored with strongly agree and strongly disagree. It was developed from validated research instruments used by Queiros and de Villiers (2016) and Dubey and Sahu (2021). Its internal consistency is $\alpha = 0.83$. The e-learning variable is treated as an independent variable in this study (Queiros and de Villiers, 2016; Tarhini *et al.*, 2017; Dubey and Sahu, 2021), implemented to bring forth learner experiences.

Learner–learner interaction scale
The three-item "learner-learner" instrument makes use of the five-point Likert scales, also anchored with strongly agree and strongly disagree. It was developed from validated research instruments used by Queiros and de Villiers (2016). Its internal consistency is $\alpha = 0.72$. The variable is treated as an intervening variable in this study (Queiros and de Villiers, 2016; Tarhini *et al.*, 2017; Dubey and Sahu, 2021), implemented to bring forth learner satisfaction.

Learner–facilitator scale
The three-item "learner-facilitator" instrument makes use of the five-point Likert scales anchored with strongly agree and strongly disagree. It was developed from validated research instruments used by Queiros and de Villiers (2016) and Alhabeeb and Rowley (2018). Its internal consistency is $\alpha = 0.81$. The variable is treated as an intervening variable in this study (Queiros and de Villiers, 2016; Tarhini *et al.*, 2017; Dubey and Sahu, 2021).

Learner satisfaction scale
A five-item "learner satisfaction" instrument was developed from validated research instruments used by Tarhini *et al.* (2017). It makes use of the five-point Likert scales with strongly agree and strongly disagree anchors. Its internal consistency is $\alpha = 0.81$. The "learner satisfaction" variable is treated as a dependent variable in this study (Queiros and de Villiers, 2016; Tarhini *et al.*, 2017; Dubey and Sahu, 2021), an outcome of implementing e-learning (see Table 1).

Scale validation
Although the scales have been reported in literature, a scale validation process nonetheless was carried out. The purpose was to identify and eliminate poorly performing manifest variables for the respective constructs. Once the exploratory factor analysis and confirmatory factor analysis were performed, the measurement models were assessed. To validate the measurement models, reliability and validity tests were carried out.

Table 2 shows the reliability and validity statistics used. Cronbach's alpha statistic is a measure of the internal consistency of a scale. The statistics for the four constructs were: e-learning (0.83), LLIs (0.72), LFIs (0.81) and learner satisfaction (0.81). The values exceed the recommended value of 0.70 (Hair *et al.*, 2013). The factor loadings of all items exceed the recommended value of 0.50 (Hair *et al.*, 2013). Composite reliability (CR) values, which depict

Construct	Items	Item loading	$\alpha \geq 0.70$	CR ≥ 0.70	AVE ≥ 0.50	DV
E-learning	The e-learning system is reliability	0.85	0.83	0.81	0.56	0.75
	The e-platform is suited to e-learning	0.74				
	I am satisfied with the flexibility of e-learning system	0.71				
	I am satisfied with the speed of e-learning system	0.69				
Learner–learner	I benefit from peer–peer interaction	0.79	0.72	0.76	0.56	0.75
	E-learning gives me autonomy	0.73				
	There is little disturbance in e-learning	0.72				
Learner–facilitator	I benefit from interacting with lecturers	0.92	0.81	0.86	0.68	0.82
	I value prompt feedback from lecturers	0.87				
	E-learning allows lecturers to give different types of assessments	0.65				
Learner satisfaction	I am satisfied with the online learning environment	0.80	0.81	0.87	0.58	0.76
	The e-learning system improves my ability to integrate information	0.79				
	I value the flexibility that comes with e-learning systems	0.76				
	E-learning systems allow me to accomplish learning tasks more quickly	0.75				
	Using e-learning system increases my performance	0.69				

Note(s): DV: Discriminant value

Table 1.
Questionnaire items
and measurements

the degree to which the instrument measures the concept that it is intended to measure, ranged from 0.76 to 0.87; again exceeding the recommended statistic of 0.70. This confirms the reliability of the measures used in the study (Hair *et al.*, 2013).

The convergent validity is the degree to which multiple items to measure the same concept are in agreement. The average variance extracted (AVE) is the determinant of convergent validity of the scale. It signifies the amount of variance captured by a construct from each scale. The value of AVE ≥ 0.5 provides fair evidence for the convergent validity measures for the construct (Hair *et al.*, 2013). The convergent validity values of the four scales range from 0.56 to 0.68. All the scales are convergent valid.

Discriminant validity is a measure that establishes the extent to which scores on a measure are not correlated with measures of variables that are conceptually distinct. According to Hair *et al.* (2013), the square root of AVE values (discriminant values) should be greater than the highest correlations with any other construct for a scale to be discriminant valid. The discriminant validity values range from 0.75 to 0.82, much higher than any correlation among any pair of latent constructs (Hair *et al.*, 2013). In total, the measurement model demonstrated adequate reliability and validity.

Construct	AVE ≥ 0.50	CR ≥ 0.70	α ≥ 0.7	DV	R	Loading
e-HRM use	0.60	0.81	0.8	0.77	0.50	
Minimum						0.53
Maximum						0.93
Employee performance	0.73	0.83	0.8	0.85	0.49	
Minimum						0.75
Maximum						0.98
Job satisfaction	0.79	0.90	0.7	0.89	0.07	
Minimum						0.70
Maximum						0.97
e-HRM macro level consequences	0.69	090	0.9	0.83	0.50	
Minimum						0.70
Maximum						0.96

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Table 2.
Scales' internal
consistencies

Findings and analysis

The majority of respondents (52.5%) were female and 47.5% male. In terms of age, 40.3% of respondents were in the 20–21 years age group, whilst 59.7% of the respondents were 22 years old and above. The majority of these students (57%) were in Part II, 15.2% in Part III and 27.8% in Part IV.

H1. Electronic learning has a positive effect on learner satisfaction.

Table 3 shows the results of linear regression performed to find the effect of e-learning (independent variable) on learner satisfaction (dependent variable). First, the data was checked for its suitability for linear regression analysis. The correlation (R) statistic is 0.569. High correlations ($r > 0.90$) indicate that data could have multicollinearity problems. The residuals are also independent. The Durbin–Watson statistic is 1.97, close to the recommended value of 2 (Hair *et al.*, 2013). The scatter plot showed homoscedasticity of residuals. The Cook's distance statistic of 0.075, (with a value greater than 1 being a cause for concern) and the P-P plot of regression standardized residual showed the normal distribution of residuals (Hair *et al.*, 2013). The effect of e-learning on learner satisfaction is strong, positive and statistically significant ($\beta = 0.569, p \leq 0.01$). The model explains 32.3% of the variance in the dependent variable (R-sq. = 0.323). The implementation of e-learning positively predicts learners' satisfaction.

H2. LLI mediates the effect of e-learning on learner satisfaction.

Table 4 shows a PROCESS macro analysis that was performed to establish the effect of e-learning (independent variable) through LLI, as a mediating variable on learner satisfaction (dependent variable). The coefficient of e-learning on learner satisfaction is positive, statistically significant and of medium effect ($\beta = 0.3151, p < 0.01$). Electronic learning also has a positive effect on learner–learner variable, ($\beta = 0.3245, p < 0.01$). The coefficient of this

Model	R	R square	Adjusted R square	Std. Error of the estimate	R square change	F change	df1	df2	Sig. F change	Durbin–Watson
1	0.569[a]	0.323	0.318	0.60180	0.323	61.154	1	128	0.000	1.968

Note(s): [a]Predictors: (Constant), electronic learning

Table 3.
Model summary

mediator variable on learner satisfaction variable is also positive, statistically significant and of medium effect ($\beta = 0.2855$, $p < 0.01$). The indirect effect of e-learning on learner satisfaction is positive and statistically significant ($\beta = 0.0927$). Zero falls outside of the calculated interval of 0.0402–0.1628. There is evidence of successful mediation involving LLIs. The introduction of LLIs improves the predictive power of e-learning from 32.3% (0.323) to 41.3% (0.413).

H3. Learner–facilitator interaction mediates the effect of e-learning on learner satisfaction.

The coefficient of e-learning on learner satisfaction is positive, statistically significant and of medium effect ($\beta = 0.2186$, $p < 0.01$). Electronic learning has a strong, positive and statistically significant effect on learner–facilitator variable, ($\beta = 0.6772$, $p < 0.01$).The coefficient of this mediator variable on learner satisfaction variable is also positive, significant and of medium effect ($\beta = 0.2793$, $p < 0.01$). The indirect effect of learner–facilitator interaction on learner satisfaction is positive and statistically significant ($\beta = 0.1891$). Zero falls outside of the calculated interval of 0.0987–0.2844. There is evidence of successful mediation involving LFIs. The introduction of LFIs improves the predictive power of e-learning from 32.3% to 38.05%. The improvement in the quality of LFIs enhances learner satisfaction (see Table 5).

H4. Learner–learner and learner–facilitator interactions have a positive effect on learner satisfaction.

Path	Coeff.	se	t	p	LLCI	ULCI
E-L → L-L	0.3245	0.0666	4.8697	0.0000	0.1927	0.4564
E-L → L-S	0.3151	0.0531	5.9386	0.0000	0.2101	0.4201
L-L → L-S	0.2855	0.0646	4.4166	0.0000	0.1576	0.4134

R-sq = 0.4134

Indirect effect of learner–learner interaction on learner satisfaction

Path	Effect	BootSE	BootLLCI	BootULCI
L-L → L-S	0.0927	0.0314	0.0402	0.1628

Note(s): Key: L-L: Learner–learner interactions; E-L: E-learning; L-S: Learner satisfaction

Table 4. Learner–learner interactions mediation

Path	Coeff	se	t	p	LLCI	ULCI
E-L → L-F	0.6772	0.0543	12.4721	0.0000	0.5698	0.7847
E-L → L-S	0.2186	0.0746	2.9328	0.0040	0.0711	0.3662
L-F → L-S	0.2793	0.0815	3.4255	0.0008	0.1180	0.4406

R-sq = 0.3805

Indirect effect of learner–facilitator interaction on learner satisfaction

Path	Effect	BootSE	BootLLCI	BootULCI
L-F → L-S	0.1891	0.0468	0.0987	0.2844

Note(s): Key: L-L: Learner–learner interactions; E-L: E-learning; L-S: Learner satisfaction

Table 5. Learner–facilitator interactions mediation

Table 6 shows the results of multiple regression analysis performed to determine the effect of LLI and LFI on learner satisfaction. Both interactions have a positive and statistically significant effect on learner satisfaction. When introduced together, the two interactions explain 48.4% of variance in the independent variable. The LFI effect ($\beta = 0.557$, $p < 0.01$) is bigger than the LLIs effect ($\beta = 0.213$, $p < 0.01$).

All forms of interaction in an e-learning environment are equally valued by learners
There are no findings showing that the two types of interactions under study causally influence each other. As such mediation in serial was inappropriate. It was deemed interesting to know if any one of the two intervening variables drove the mediation more than the other or if they all equally contribute to the mediation. Parallel mediation was therefore performed to find out the relative importance of the two types of interactions. In this mediation process, mediators are allowed to correlate but not to causally influence each other. The direct effect of e-learning on learner satisfaction is positive, and statistically significant ($\beta = 0.2116$, $p < 0.01$). The introduction of LLI as a mediator is positive and significant. The effect of e-learning on LLI is positive and statistically significant ($\beta = 0.3245$, $p < 0.01$). The effect of LLI on learner satisfaction is also positive and statistically significant, ($\beta = 0.2343$, $p < 0.01$). Zero falls outside of the calculated interval of 0.0250–0.1452. There is evidence of partial mediation linked to LLI.

The introduction of LFI as an intervening variable is positive and significant. The effect of e-learning on LFI is positive and statistically significant ($\beta = 0.6772$, $p < 0.01$). The effect of LFI on learner satisfaction is positive and statistically significant ($\beta = 0.1774$, $p < 0.01$). Zero falls outside of the calculated interval of 0.0284–0.2172. There is evidence of successful partial mediation involving LFI. The indirect effect of LFI is $\beta = 0.1202$, whilst that of LLI is $\beta = 0.0760$. LFI and LFI are two significant independent mediators, each having an explanatory role. However, LFI contributes more than LLI to the mediation observed. The two forms of interaction in an e-learning environment are not equally valued by learners. Substitutability of one type of interaction for the other to effect learner satisfaction is not possible. The fifth hypothesis is thus rejected (see Table 7).

Conclusion
The result of the first hypothesis indicated that e-learning positively and significantly influences learner satisfaction. The effect of e-learning on learner satisfaction has been widely researched. This finding is consistent with findings from previous research (Tarhini *et al.*, 2017; Kurucay and Inan, 2017; Dubey and Sahu, 2021; Quadir *et al.*, 2022). It can be concluded that the adoption of e-learning systems in developing economies will result in improved

Model	Unstandardized coefficients		Standardized coefficients			95.0% confidence interval for B	
	B	Std. Error	Beta	*t*	Sig.	Lower Bound	Upper Bound
1 (Constant)	0.667	0.163		4.094	0.000	0.345	0.989
Learner–facilitator interaction	0.435	0.059	0.557	7.352	0.000	0.318	0.553
Learner–learner interaction	0.192	0.068	0.213	2.814	0.006	0.057	0.328

R-sq = 0.484

Note(s): [a]Dependent Variable: Level of satisfaction

Table 6.
Coefficients

Path	Coeff	se	t	p	LLCI	ULCI
E-L → L-S	0.2116	0.0716	2.9551	0.0037	0.0699	0.3533
L-F → L-S	0.1774	0.0837	2.1201	0.0360	0.0118	0.3431
L-L → L-S	0.2343	0.0682	3.4359	0.0008	0.0993	0.3692
R-sq = 0.4336						

Indirect effect of X on Y

Path	Effect	BootSE	BootLLCI	BootULCI
Total	0.1962	0.0462	0.1089	0.2908
L-F → L-S	0.1202	0.0480	0.0284	0.2172
L-L → L-S	0.0760	0.0307	0.0250	0.1452

Table 7.
Parallel mediation:
learner–facilitator and
learner–learner
interactions

learner satisfaction. Despite the lack of planning with respect to its adoption, and its infancy status, e-learning enhances learner experiences and satisfaction.

The result of the second hypothesis indicated that LLIs mediate the relationship between e-learning and learner satisfaction. The mediating role of this type of interaction has not been studied using a quantitative approach. This is one of the study's contributions to theory development. LLIs enhance the effect of e-learning on learner satisfaction. University administrators and system designers should ensure that e-learning platforms promote LLI, as this complements e-learning effect.

The result of the third hypothesis indicated that LFIs also mediate the relationship between e-learning and learner satisfaction. There is no known study that has looked at the mediating role of this interaction on learner satisfaction using a quantitative survey. LFIs enhance the effect of e-learning on learner satisfaction. System and course designers should ensure that e-learning platforms and virtual learning environments promote more of LFIs for a bigger effect on learning satisfaction.

LLI and LFI jointly, have a positive effect on learner satisfaction. The two interactions are central to predicting students' satisfaction (De Paepe *et al.*, 2018). This finding is consistent with findings from previous research (Asoodar *et al.*, 2016; van Nuland and Rogers, 2016; Sun and Chen, 2016; Goh *et al.*, 2017; Ng, 2017; De Paepe *et al.*, 2018; Gunesekera *et al.*, 2019; Taib *et al.*, 2021; Quadir *et al.*, 2022; Mohan *et al.*, 2022). Learner–facilitator interactions have a bigger effect on learner satisfaction than LLIs. This particular finding is consistent with findings from previous research (Queiros and de Villiers, 2016). Facilitator presence plays a central role in creating a cyber-environment that enables students to learn effectively. "Online instructors can orchestrate the class environment to increase the interaction between learner and-facilitator, and learner and learner through both synchronous and asynchronous interactions" (Gilbert, 2015, p. 9). It can be concluded that the two types of interactions collectively lead to improved learner satisfaction than when adopted individually. College administrators need to improve the quality of interactions in the e-learning environment so as to reinforce the effect of e-learning on learner satisfaction. The two types of interactions enrich the quality of learning environments (Gilbert, 2015; Sun and Chen, 2016; Queiros and de Villiers, 2016).

The presence of both types of interactions in an e-learning environment is a realistic proposition. The system and course designers should work on improving the quality of both interactions for the maximization of learner experiences. The implication of this is that the two types of interactions create a complementary partial mediating effect. LLI and LFI act as independent mediators, each playing a role in explaining learner satisfaction. LFIs, however, play a greater role (β = 0.1202) in explaining the effect of e-learning toward e-learner

satisfaction (65% of the total effect) than LLIs do ($\beta = 0.0760$). The two types of interactions result in different levels of learner satisfaction. Substitutability of one type of interaction for the other, to effect equal learner satisfaction is not possible. This hypothesis is thus rejected.

Contribution to theory and practice

This study contributes to theory development and practice in a number of ways. First, the study provides support to the hypothesized positive relationship between e-learning and learner satisfaction, even as e-learning is still in its infancy in developing economies. Electronic learning has a positive effect on the interactions that are essential for effective learning experiences. Second, the findings also show support to hypothesized positive relationship between both types of interactions and learner satisfaction. An increase in any of these interactions increases the level of learner satisfaction. Some form of interaction is advantageous to learning in an e-learning environment. Educational administrators have to invest in improving the quality of the e-learning environment in order to increase the nature of interactions. The findings are in line with previous studies which found that improving any one type of interactions leads to improved learning experiences. Third, the findings suggest that the two types of interactions mediate the effect of e-learning on learner satisfaction. Any one type of interaction boosts the effect of e-learning on learning experiences. There is no known study that has looked at the mediating effect of learning environment variables on learner satisfaction in Africa, using a quantitative approach. Fourth, the findings suggest the types of interactions are not substitutable. This is the research gap that this study sought to fill. LFIs have a bigger effect on learner satisfaction, when jointly introduced, (therefore more preferable) than LLIs. This study represents a first attempt to explore the substitutability of the interactions. The substitution effect is different for the two sets of interactions. Designers of the e-environment should focus on improving LFIs first, as they represent a bigger effect. Educational practitioners should invest time and resources outside technology and connectivity costs to build a conducive e-learning environment for an effective learning experience. Whilst e-learning platforms have the potential to engineer the desired learner responses, when coupled with different types and forms of interactions, the effect is bigger.

Way forward

The adoption of e-learning in Zimbabwe was forced on universities by COVID-19 crisis circumstances. It is now predicted that conditions around COVID-19 pandemic will be around into the foreseeable future. It is increasingly likely that e-learning will now be formalized into a delivery method of choice. Although e-learning is unlikely to replace traditional higher education delivery methods in the near future, it is nonetheless expected to increase its presence and influence in Zimbabwe. As such, course designers are encouraged to build the level of interactions present in face-to-face learning into e-learning environments. University administrators are encouraged to adopt e-learning tools that impact positively on LLI and LFI for increased learning experiences and satisfaction.

Notwithstanding the successfully attainment of the study's objectives, the findings should be treated with caution for a number of reasons. First, the data on the independent, intervening and dependent variables come from the respondents who participated in the study. A "single source bias" is likely to result. Secondly, the study involved the administration of the same questionnaire to all respondents. This could result in "common method bias". These limitations could be minimized through the use of mixed method research. Thirdly, the study was cross-sectional, and as such, it suffers from the well-documented "Neyman bias". Cross-sectional studies tend to fail to capture processes that take time to manifest. This reduces an in-depth understanding of the relationship between

e-learning and learner experiences. Future research should address the depth to which these interactions should be taken to influence learner satisfaction. There is also need to address the frequency of these interactions for them to have an enhancing effect on learner satisfaction.

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