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Path Modeling of Online Learning Indicators and Learners' Satisfaction During Covid-19 Pandemic

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With upsurge of Covid-19, many educational institutes at basic and post-basic level had shifted paradigm from top-bottom teaching and learning process, and passive to a more interactive, collaborative approach in which learners and instructor co-create the learning process. Thus, the goal of this paper is to explain and predict the endogenous construct of learners' satisfaction in the Partial Least Square (PLS) path model through four exogenous constructs namely; content quality, learners' quality, system quality and service quality respectively. A non-experimental design of correlational research type was used. The sample consisted of 501 drawn senior secondary school students (K-12) of Lagos Central Senatorial District, Lagos State, Nigeria. Two instruments were used, and data obtained were subjected to a two-step technique to composite based structural equation modeling; Measurement and Structural model. Also, the construct validity and reliability were established using average variance extracted (AVE), heterotrait-monotrait ratio of correlations (HTMT) and MacDonald Omega. The significance of the hypothetical constructs' relationship was assessed using a structural model. The findings supported the hypothesised direct constructs relationship except for service quality. The authors concludes that in order to promote learners' satisfaction in online learning during Covid-19, it would be apt for school managers and instructors to direct efforts on the content quality, learners' quality, and system quality because they are essential ingredients in ensuring satisfaction of online teaching. Consequently, it was recommended that both public and private schools should integrate these factors into their virtual teachings.

Key words: *Content Quality; Learners Quality; Service Quality; PLS-SEM; System Quality; Learners Satisfaction; Heterotrait-Monotrait Ratio of Correlations; Average Variance Extracted*

Introduction

The world has faced a myriad of changes caused by various factors ranging from human, biological, climate, and industrial revolutions to technological factors, among others. While some of these changes have improved our world, others are deteriorating. On December 31, 2019, the first cases of a novel coronavirus were identified in Wuhan City, Hubei Province, China, now officially known as Covid-19. The Africa continental disease control and prevention agency noted that the virus has spread into 54 African countries, having over a two hundred thousand infections of more than 7 million infected persons globally. As of June 2020, the Africa CDC reported the death toll from the pandemic at six thousand, four hundred and sixty-four. Amid the rapid spread of Covid-19 across the African continent, the profoundly affected African countries include South Africa, Egypt, Djibouti, Morocco, and Nigeria, with Southern Africa region being the most affected area across the continent (Xinhu, 2020). With the fear of a second surge of Covid-19, the World Health Organization (WHO) has urged countries to press on with efforts to contain the virus (Steward, 2020; Reuters, 2020). Viewed from the international legal perspective, the World Health Organization (WHO) has a heavy burden on solutions to the pandemic and has prescribed policy directions in solving the pandemic. Global legal perspectives outlined frameworks of maintaining high environmental hygiene and the introduction of restrictions like lockdowns and curfew to reduce and contain the spread of the disease. Adhering to the Covid-19 guidelines, sub-Saharan Africa, like other regions of the world, have affected lockdowns resulting in halting all physical contacts while carrying out educational activities of teaching and learning. Virtual learning has gained popularity with recent happenings like never before as a way of mitigating the effect of the lockdowns on educational activities with learners at the receiving end. This study intrinsically modelled virtual learning processes concerning learners' satisfaction.

Review of Literature on Covid-19

COVID-19 is one of the biological factors which have changed our world in unimaginable ways with multiple and global effects on physical, human, social, professional and economic life, among others. These multiple and global effects bring to bear the uniqueness of the changes caused by the disease. The Covid-19 has been described as a zoonotic disease transmitted between animals and humans. Diseases passed from animals to humans have been reported to constitute a significant threat to human health (Warwic & Corning, 2013; United Nations Environment Programme, 2020). Such diseases have severe symptoms that are compounded by its novelty in humans with no existing antibodies to defend themselves against the disease. Some approaches being investigated for tackling Covid-19 are drugs and vaccines. According to Gallagher (2020), more than 150 drugs are being researched around the world as curatives for COVID-19. Most of these drugs are existing drugs that are being trialed against the virus such as the Solidarity trial by the World Health Organization (WHO), the Recovery trial by the UK government with more than 5,000 patients partaking in the study and multiple

research centres around the world are attempting to use survivors' blood as a treatment. With vaccines, the rationale is to protect against the virus rather than treating it. Scientists took many approaches to develop vaccines while always adding novelty to these approaches (Leclerc, 2003; Gomez, et al., 2013; De Groot & Moise, 2007). These approaches are based on information about the infections to be prevented and the immune system response. Considerations include regions of vaccine used, are also important because some virus strains respond to environmental conditions and exposure risks (Federman, 2014). Vaccines work by activating the body's natural ability or immune system to eliminate the virus before having the opportunity to cause havoc to the body. A vaccine can be likened to a germ half-killed and introduced into the body, which cannot now cause illness but still make the body recognise it was to come in the usual way (US Centers for Disease Control and Prevention, 2013).

Medical sciences have recorded remarkable success developing drugs and vaccines over time following rigorous stages to produce them starting from the exploration, pre-clinical, clinical development, regulatory review and approval, manufacturing, and quality control (Elhassa & Alfarouk, 2015; Rolling & Hayney, 2016). However, these processes could span a good number of years. The length of time required becomes an undesirable drawback that strengthens the fact that the COVID-19 pandemics would remain for a while, which could span from one to ten years (Lowe, 2020). This call for urgent measures for coping with the COVID-19 while pandemic last. One of these preventive measures is social distancing. Social distancing is an unprecedented measure for restricting social and even professional activities and travels (De Vos, 2020) that that could bring more than 50 people together. Though these restrictions have been useful for slowing the spread of the virus, the measure is not without its side effects, just like every effective medicine. These restrictions have led to lockdowns globally; some are partial, and others total depending on the severity of Covid-19 hit. Oyeniran et al. (2020) reported that the lockdown has also affected the educational institutions in Nigeria and as a result, caused a discontinuity in education. In a bid to resume educational activities worldwide, teaching and learning had gone virtual.

Concept of Online Learning

Virtual learning synonymous to e-learning or online learning is a medium for facilitating learning with no forms of physical contact between the teacher and the learner while leveraging on a variety of electronic technologies. Online learning is a form of education that takes place over the catalyse a pedagogical shift in how teaching and learning are carried out with a shift away from top-down lecturing and passive students to a more interactive, collaborative approach in which students and instructor co-create the learning process (Stern, n.d.). E-learning employs technology-based instruction delivery method relying on a variety of electronic media including the internet, intranet, extranet, satellite broadcasts and interactive television which makes it virtual (Ozkan & Keseler, cited in Bindhu & Manohar, 2015). According to Aparicio et al. (2016), e-learning unites the main areas of learning and

technology. They explained that while learning is a cognitive process for achieving knowledge, technology is an enabler of the learning process. They further explained that technology underpins other problematic situations because it includes various dimensions such as writing technologies, communication technologies, visualisation, and storage. The forgoing necessitates transforming e-learning systems to guarantee its effectiveness.

Oyeniran et al. (2020) proposed an e-learning framework where teachers will upload the courseware and lecture notes to the e-learning zones consisting of Google Classrooms, Zoom, WhatsApp and Blogs, while the students will also access the e-learning zones to attend their various classes as scheduled by the teachers or as directed by the school management. Thus, the e-learning zone serves as the meeting point or lecture room for the students and the lecturers alike. Also, the e-learning zone allows the students to take and submit assignments; the lecturers can as thoroughly assess the students by the use of various technical functions embedded in the e-learning zones. Aparicio et al. (2016) put forward an e-learning systems' theoretical framework with the three main components of information systems which are people, technologies, and services. People interact with e-learning systems with various technologies as an enable for the direct or indirect interaction of the different groups of users. Technologies provide support to integrate content, enable communication, and provide collaboration tools. They stressed that e-learning services integrate all the activities corresponding to pedagogical models and instructional strategies. The complex interaction combination is the direct or indirect action with e-learning systems. At the same time, systems provide services according to the specified strategies for activities. In other words, service specifications are e-learning activities aligned with the e-learning pedagogical models and the instructional strategies.

Theory of E-learning

While e-learning can no longer be regarded as new, a grand unifying theory of e-learning thus remains elusive and practitioners continue to operate mainly based on trial and error (Teo & Williams, 2005; Lashayo & Johar, 2018). A theoretical dimension of e-learning effectiveness built on the DeLone and McLean model Information Systems Success measurement also known as D&M Model (DeLone and McLean 1992; revised in 2016) and empirically validated with dimensions of content quality, system quality, service quality, learners' quality with regards to (extent of use and intention to use) and learners' satisfaction (Petter & McLean, 2009; Wang & Wang, 2009; Bindhu & Manohar, 2015). The indicators of these dimensions were also explained by (Hassanzadeh et al., 2012). First, content quality refers to the knowledge, skills and behaviour that is being taught during the lesson. The content of an e-learning system is determined by the individual user's needs (relevance) and aims to satisfy the needs of every user (comprehensive). Content should change regularly based on user input, experiences and new practices. Courses with strong writing component and wider online content availability were found to be very successful. The purpose of teaching-learning is to

develop task-related content to satisfy the needs of the learners and hence is vital for learning performance, which must be relevant, adequate, comprehensive and up to date. The indicators of content quality dimension point to requirements, timeliness, usefulness, comprehensiveness, intelligibility, accuracy, preciseness, organisation, related as well as up to date content and information.

Also, system quality is a measure of the technical efficiency of the online teaching-learning process. It is comprised of its structure, functionality and accessibility, user-friendliness, interactivity between system and users, personalised information presentation, attractive features and high-speed information access. The availability of an efficient communication system with internet access, specialised centres with a central reference database and the appropriate software application, all lead to the effectiveness of the system. The indicators of system quality are aesthetic, ease of access, ease of use, user-friendly, interactivity, personalisation, attractiveness, system speed, reliability, security, structured design, usability, maintenance, flexibility, ease of integration, and having the required functions through appropriate menus. Another factor is service quality comprises of the level of service received by the learner and the appropriateness of the pedagogy adopted by the e-learning system. Some of the identified elements of service quality are tracking learners work, course management, instructional authorisation and knowledgeability. Thus, when the instructors are satisfied with the e-learning system, they tend to provide high service quality and content to the learners. The indicators of service quality are potentials of guidance to students, responsiveness, the extent to which user views reflecting in system design and development, courseware management and the speed of provided service. Lastly, learner quality comprises of the individual profile of the learner and includes the learners' attitude, computer self-efficacy, learning style, motivation to learn, learning pace and other individual differences. More so, some authors suggested that gender, age, learning style, fundamental computer skills, interaction with the instructor, interaction with fellow students, course activities, discussion sessions, and time spent on the course as factors affecting learners' satisfaction, thereby indirectly affecting the effectiveness of the e-learning system. The indicators of learner quality are the extent of use and intention to use e-learning system by the learners.

Learners' satisfaction of e-learning is a complex construct to measure, and many scholars have attempted to develop a comprehensive set of factors to measure user satisfaction. Some of the factors are system quality, information quality, service quality, learners' quality, among others jointly affects user satisfaction, which is a direct antecedent of e-learning systems impact on individual performance. Also, learner computer anxiety, instructor attitude toward e-learning, e-Learning course flexibility, course quality, perceived usefulness, perceived ease of use, and diversity in the assessment are the variables proved to have a critical relationship with e-learner satisfaction. The indicators of Learners' Satisfaction of e-learning are perceived usefulness, systemic performance, learners' systemic perception, the extent to which the system meets learners' educational needs and the extent to which learners' confidence are gained. Since the

beginning of the National lockdowns, which necessitated for controlling the spread of the Covid-19, educational institutions in sub-Saharan African countries such as Nigeria have been, striving to engage students virtually. Oyeniran et al. (2020) stressed that many educators are enthusiastic about the use of computer-based technology for teaching and learning and have adapted strategies from small-group and interactive techniques to the online mediums. Students who are the receiving end of the online teaching and learning activities are gauged in terms of satisfaction in determining the effectiveness of virtual learning for achieving behavioural objectives viewed theoretically. Nevertheless, the revised D&M model is one of the most widely used models of Information Systems (IS) success. E-learning systems are a specific type of IS (Lee & Lee, 2008; Lashayo & Johar, 2018) and the revised D&M model has been used for measuring the success of e-learning systems (Wang, et al., 2007; Lin, 2007; Petter & McLean, 2009; Hassanzadeh et al., 2012; Maina & Nzuki, 2015; Lashayo & Johar, 2018). These efforts have been primarily geared towards higher education with adult learners; this study focused on the secondary level education with teenage learners in measuring their satisfaction as the endogenous variable. The exogenous variables considered for the study were learner quality, content quality, service quality and system quality which are sub-components of virtual learning.

In this study, online learning processes were intrinsically modelled concerning learners' satisfaction using Partial least square (PLS); a robust structural equation modelling (SEM) approach. PLS is sometimes referred as component-based SEM or variance-based SEM. PLS-SEM is a causal modelling statistical approach to maximise explained variance of latent dependent variables (Chin, 1998b; Hair, Ringle, & Sarstedt, 2011). Researchers across a wide range of disciplines exploited the capabilities of PLS-SEM technique (Knock, 2013). The upsurge in attractiveness of PLS-SEM is remarkably evident from a few decades ago. Meanwhile, the Social Sciences and humanities discipline hardly utilises the advantages of the PLS-SEM approach. PLS-SEM is useful in identifying relationships between constructs. Thus, in this study, PLS-SEM implemented in SMARTPLS was adopted. The objectives of this study were to examine online learning and learners' satisfaction with implications for COVID-19 pandemic in sub-Sahara Africa. To this end, the following research questions and hypotheses were addressed:

a. What is the construct validity and reliability of the scale?
b. What is the performance of the latent variable in explaining the endogenous construct?

H_{01}: Learners' quality does not positively and significantly explain learners' satisfaction.
H_{02}: Learners' satisfaction is not positively and significantly explained by content quality.
H_{03}: Learners' satisfaction is not positively and significantly explained by service quality.
H_{04}: Learners' satisfaction is not positively and significantly explained by system quality.

Methodology

Design, Population, Sample and Instrument

Correlational research type of non-experimental design was adopted for this study. In this study, students (learners) were the unit of analysis. Therefore, those that had participated in online learning and duly informed during Covid-19 pandemic constituted the target population of the study. In order to test hypotheses raised, the study used a sample of 501 drawn prospective final year secondary school students (K-12) in Lagos Central Senatorial District, Lagos State, Nigeria. Their ages ranged between 16 and 20 years with 176 (35.1%) boys and 325 (64.9%) girls respectively. A researcher-developed questionnaire titled virtual learning scale (VLS) and learners satisfaction scale (LSS) were used to generate data. Items contained in the VLS were 37 items using four-point Likert ranged from 1 = Low extent to 4 =Very large extents while LSS had 14 items using five-point Likert ranged from 1= Not at all satisfied to 5= Extremely satisfied. More importantly, the content validity index of 0.78 and 0.62, and ordinal alpha reliability coefficient of 0.80 and 0.83 respectively were established for the two instruments. Data collected were analysed using PLS-Structural Equation Modelling implemented in SmartPLS version 3.3.3 software.

Composite- SEM Sample Size Determination

Theoretically, concerning PLS path model and the statistical method used, the data of 501 students that were involved in virtual learning was sufficient about the maximum number of indicators (14 indicators) associated with learners' satisfaction construct and the minimum sample size suggested by Barclay et al. (1995), that is 14 × 10 = 140. Thus, this is the expected minimum sample size for the study. Data obtained were analysed using Partial Least Square (PLS) path modelling to test the hypothetical model. PLS path modelling is a non-parametric, multivariate approach based on iterative ordinary least square (OLS) regression to estimate models with latent variables and their direct and indirect relationships (Wold, 1982; Lohmöller, 1989). Latent constructs cannot be directly observed but can be measured indirectly through numerous indicators (for instance: virtual learning and learners' satisfaction were measured by numerous manifest indicators based on responses from the questionnaire). However, the justification for using PLS path modelling was because the goal of this study was to maximise explained variance of dependent latent variable and modelling is regarded as the "most fully developed and general system" (McDonald, 1996) of the component-based structural equation modelling (SEM) techniques. The researchers thus, considered PLS path modelling to be the apt analytical technique (Hair et al., 2011). Consequently, this study used the SmartPLS 3 software version 3.3.3 (Ringle et al., 2015).

Ethical Clearance: This study got the approval and met the requirement to obtain informed consent by the Faculty of Education Research Ethics Committee with Ethical Clearance Number: Sem 2-2021-060 because the data for the study involved human subjects.

Results and Discussion

This study used PLS path modeling for data analysis because the technique had gained popularity in the academic research community (Hair et al., 2012; Lee et al., 2011). The following questions and hypotheses were answered through the PLS path modeling application. Before that, Table 1 presents the descriptive statistics of all the indicators in the study.

Table 1: Descriptive statistics on indicators used in PLS-SEM (N = 501)

Indicators	Missing	Mean	Median	Min	Max	Standard Deviation	Excess Kurtosis	Skewness	Coefficient of Variation
LQ1	0	2.76	3	1	4	1.20	-0.49	-0.73	0.43
LQ2	0	2.87	3	1	4	1.15	-0.13	-0.87	0.40
LQ3	0	2.62	3	1	4	1.20	-1.02	-0.37	0.46
LQ4	0	2.74	3	1	4	1.19	-0.94	-0.51	0.43
LQ5	0	2.37	2	1	4	1.29	-1.36	-0.06	0.54
LQ6	0	2.80	3	1	4	1.17	-0.65	-0.65	0.42
LQ7	0	2.88	3	1	4	1.17	-0.44	-0.80	0.41
LQ8	0	2.84	3	1	4	1.18	-0.71	-0.68	0.42
LQ9	0	2.99	3	1	4	1.05	-0.08	-0.85	0.35
LQ10	0	2.72	3	1	4	1.31	-0.82	-0.67	0.48
LQ11	0	2.72	3	1	4	1.20	-0.87	-0.51	0.44
CQ1	0	2.81	3	1	4	1.16	-0.74	-0.64	0.41
CQ2	0	2.84	3	1	4	1.17	-0.62	-0.70	0.41
CQ3	0	2.88	3	1	4	1.10	-0.39	-0.74	0.38
CQ4	0	2.93	3	1	4	1.14	-0.51	-0.77	0.39
CQ5	0	2.73	3	1	4	1.27	-1.18	-0.50	0.46
CQ6	0	2.88	3	1	4	1.15	-0.66	-0.68	0.40
CQ7	0	2.54	3	1	4	1.23	-1.36	-0.21	0.48
CQ8	0	2.85	3	1	4	1.18	-0.93	-0.60	0.41
CQ9	0	2.87	3	1	4	1.17	-0.80	-0.66	0.41
CQ10	0	2.73	3	1	4	1.20	-0.81	-0.56	0.44
SQ1	0	2.63	3	1	4	1.31	-1.16	-0.48	0.50
SQ2	0	2.86	3	1	4	1.10	-0.91	-0.49	0.39
SQ3	0	2.85	3	1	4	1.09	-0.34	-0.68	0.38
SQ4	0	2.90	3	1	4	1.08	-0.41	-0.74	0.37
SQ5	0	2.88	3	1	4	1.11	-0.39	-0.77	0.39
SQ6	0	3.81	3	1	4	1.19	-0.57	-0.71	0.31
SQ7	0	3.00	3	1	4	0.94	0.22	-0.94	0.31
SQ8	0	3.14	3	2	4	0.81	0.59	-0.90	0.26

SYQ1	0	2.83	3	1	4	1.12	-0.84	-0.59	0.40
SYQ2	0	2.85	3	1	4	1.05	-0.71	-0.59	0.37
SYQ3	0	2.73	3	1	4	1.14	-0.55	-0.61	0.42
SYQ4	0	2.82	3	1	4	1.10	-0.26	-0.70	0.39
SYQ5	0	2.91	3	1	4	1.06	-0.43	-0.67	0.36
SYQ6	0	2.86	3	1	4	1.12	-0.27	-0.77	0.39
SYQ7	0	2.79	3	1	4	1.14	-0.37	-0.71	0.41
SYQ8	0	2.94	3	1	4	0.99	-0.11	-0.90	0.34
LS1	0	3.87	4	1	5	1.12	-0.50	-0.70	0.29
LS2	0	3.83	4	1	5	1.18	-0.51	-0.76	0.31
LS3	0	3.89	4	1	5	1.09	-0.69	-0.65	0.28
LS4	0	3.85	4	1	5	1.10	-0.34	-0.74	0.29
LS5	0	3.80	4	1	5	1.15	-0.93	-0.52	0.30
LS6	0	3.79	4	1	5	1.08	-0.92	-0.50	0.29
LS7	0	3.80	4	1	5	1.21	-0.88	-0.62	0.32
LS8	0	4.01	4	1	5	1.05	-0.23	-0.83	0.26
LS9	0	3.89	4	1	5	1.10	-0.80	-0.59	0.28
LS10	0	3.89	4	1	5	1.06	-0.37	-0.68	0.27
LS11	0	3.88	4	1	5	1.12	-0.51	-0.71	0.29
LS12	0	3.77	4	1	5	1.16	-0.95	-0.51	0.31
LS13	0	3.87	4	1	5	1.12	-0.72	-0.66	0.29
LS14	0	3.91	4	1	5	1.15	-0.51	-0.74	0.29

Coefficient of variation (std. dev./mean)

What is the reliability and construct validity of the scale?

According to Hair et al. (2010, 2014); Henseler et al. (2009), PLS-SEM evaluation can be portrayed in two stages, and these stages were emphasised in this study. These are the measurement model or outer model and structural model or inner model for assessing and reporting PLS-SEM results. Measurement model, which is the first stage, was conducted using partial least square- structural equation modelling (SEM) implemented in SmartPLS version 3.3.2. SmartPLS is one of the prominent software applications for Partial Least Squares Structural Equation Modeling (PLS-SEM). Also, stage one can be assessed using reflective and formative model techniques, which have been shown in literature for evaluating the validity and reliability of any instrument. First, the reflective measures which are represented by arrows pointing from the construct to the indicators are estimated in PLS-SEM by the external loadings while the formative measures, which are presented by arrows pointing from the indicator to the construct, are calculated by their outer weights. However, all manifested variables in this study were reflectively measured. Therefore, the assessment of measurement models in this analysis was examined through indicator reliability, internal consistency reliability and construct validity (convergent and discriminant validity) (Kock, 2013; Urbach & Ahlemann, 2010).

Meanwhile, the structural model establishes the relationship between constructs in the model. More so, the proposed measurement model was presented in Figure 1, which have both exogenous and endogenous constructs. The exogenous construct is virtual learning with four sub-constructs namely; learners' quality (LQ), content quality (CQ), service quality (SQ) and system quality (SYQ) and endogenous construct is learner satisfaction (LS) respectively. They are all measured reflectively.

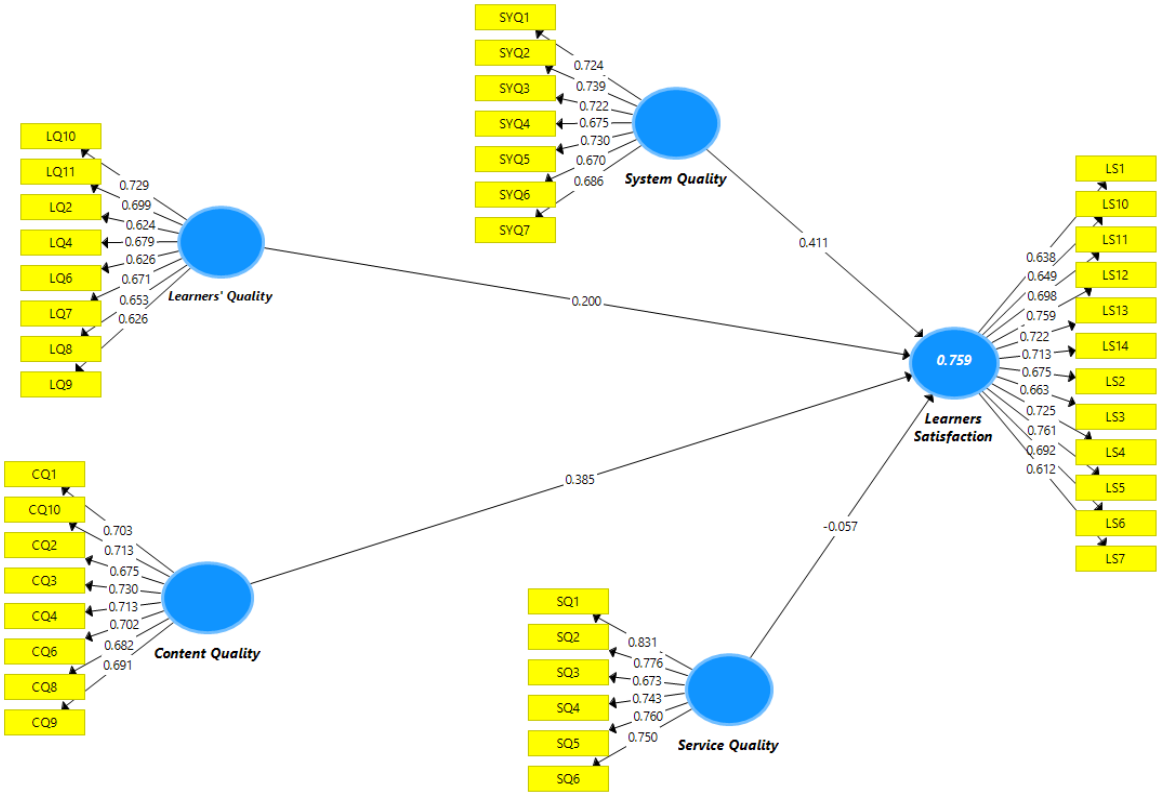

Figure 1: Measurement Model

Indicator Reliability

Hair et al. (2011) indicated that external loadings greater than 0.70 are desirable. Meanwhile, outer loadings less than 0.4, the reflective indicator ought to be expunged. When an outer loading is between 0.4 and 0.7, the choice on whether to keep or delete the item depends on the high outer loadings of the other items (Hair et al. 2017b). Subsequently, outer loadings for each of the construct of the present study were considerably over 0.50, although items (such as LQ1, LQ3, LQ5, CQ5, CQ7, SQ7, SQ8, SYQ8, LS8 and LS9) with loadings less than 0.50 and negative loadings have been removed and not reliable for the measurement of the constructs they are reflecting (see Table 2). Hence, it was concluded that the study sufficiently met the cutoff for individual item reliability.

Internal Consistency

The composite reliability measure allows assessing the construct's internal consistency. The composite reliability ought to have a value of 0.7 and higher (Hair et al. 2016; 2017b; Chin, 2010). It was remarked from Table 2 that the composite reliability coefficients for each of the construct of this study were above 0.70 cutoffs. Also, the reliability coefficient, as observed in Table 2, for each of the construct varied between 0.86 to 0.92; which exhibits sufficient internal consistency reliability of the measures (Hair et al., 2016, 2017b; Chin, 2010).

Convergent Validity

Chin (2010); Fornell and Larcker (1981) recommended a rule of thumb that average variance extracted (AVE) greater than 0.50 is preferred; this proportion infers that greater than 50% of the variance of the reflective indicators have been accounted for by the construct. However, Hair et al. (2017) also recommended minimum value of 0.4 for estimated average variance extracted (AVE) to be considered substantial. As displayed in Table 2, the average variance extracted values explained that all the constructs of this study had achieved the least benchmark of 0.40. Thus, it was remarked that the study achieved the feat of convergent validity, as suggested by (Hair et al., 2017).

Discriminant Validity

In order to examine the model's discriminant validity, Fornell and Larcker (1981) criteria were applied in order to estimate squared root of average variance extracted (AVE) for each latent variable which has got to be higher than its relationships with other factors. However, recently, HeteroTrait-MonoTrait ratio of correlations (HTMT) which has become the primary criterion for assessing discriminant validity since it offers superior performance compared with the Fornell-Larcker criterion and the assessment of cross-loadings (Henseler et al. 2015; Voorhees et al. 2016). In this study, HeteroTrait-MonoTrait (HTMT) ratio of relationships (Henseler et al., 2014) was evaluated as well. This was computed for reflective measurement models against the threshold value of 0.90 (that is, for discriminant validity to be established, the HTMT values should not exceed 0.90 (Gold et al., 2001; Teo et al., 2008; Henseler et al., 2016). The present analysis found an HTMT ratio below these values, as shown in Table 3, so the model’s discriminant validity was confirmed.

Table 2: Reliability and convergent validity of the measurement instrument

Constructs	Indicators	Indicator Reliability	Communality	Composite Reliability (CR)	Average Variance Extracted (AVE)
Content Quality	CQ1	0.70	0.49	0.89	0.49
	CQ2	0.68	0.46		
	CQ3	0.73	0.53		
	CQ4	0.71	0.51		
	CQ6	0.70	0.49		
	CQ8	0.68	0.47		
	CQ9	0.69	0.48		
	CQ10	0.71	0.51		
Learners' Quality	LQ2	0.62	0.39	0.86	0.44
	LQ4	0.68	0.46		
	LQ6	0.63	0.39		
	LQ7	0.67	0.45		
	LQ8	0.65	0.43		
	LQ9	0.63	0.39		
	LQ10	0.73	0.53		
	LQ11	0.70	0.49		
Learners' Satisfaction	LS1	0.64	0.41	0.92	0.48
	LS2	0.68	0.46		
	LS3	0.66	0.44		
	LS4	0.73	0.53		
	LS5	0.76	0.58		
	LS6	0.69	0.48		
	LS7	0.61	0.37		
	LS10	0.65	0.42		
	LS11	0.70	0.49		
	LS12	0.76	0.58		
	LS13	0.72	0.52		
	LS14	0.71	0.51		
Service Quality	SQ1	0.83	0.69	0.89	0.57
	SQ2	0.78	0.60		
	SQ3	0.67	0.45		
	SQ4	0.74	0.55		
	SQ5	0.76	0.58		
	SQ6	0.75	0.56		
System Quality	SYQ1	0.72	0.52	0.88	0.50
	SYQ2	0.74	0.55		
	SYQ3	0.72	0.52		
	SYQ4	0.68	0.46		
	SYQ5	0.73	0.53		
	SYQ6	0.67	0.45		
	SYQ7	0.69	0.47		

Table 3: HeteroTrait-MonoTrait ratio (HTMT) of the constructs in the model

Constructs	Content Quality	Learners Satisfaction	Learners' Quality	Service Quality	System Quality
Content Quality					
Learners Satisfaction	0.53				
Learners' Quality	0.54	0.25			
Service Quality	0.46	0.24	0.76		
System Quality	0.32	0.22	0.75	0.67	

***What is the performance of the latent variable in explaining the endogenous construct*?**

To answer this question, Important-Performance Map Analysis (IPMA) Ringle and Sarstedt (2016) were conducted. Table 4 and Figure 2 depict the results of the construct level IPMA on the parsimonious model for the endogenous construct learners' satisfaction. Total effects on the horizontal axis represent the importance, and the vertical axis represents the percentage of the performance of the four exogenous constructs in explaining the endogenous construct. However, the performance of the four exogenous constructs was very related; it is crystal clear that learners' quality construct was not comparably crucial as content quality followed by system quality and service quality, respectively. More importantly, in terms of fostering learners' satisfaction in virtual learning during Covid-19, it would be better for school managers and instructors to direct efforts on the content quality, system quality and service quality because they had better importance and improvements which can lead to more significant enhancements in explaining the endogenous construct. Nevertheless, a unit increase in the performance of learners' quality would bring about a 0.20 increase in the performance of learners' satisfaction. Meanwhile, Hair et al. (2010, 2016); Henseler et al. (2009) argued that predictive accuracy (R^2) shows to what degree the exogenous construct(s) are explaining the endogenous construct. Hair et al. (2017b) recommended as a rule of thumb that R^2 values of 0.25, 0.50, and 0.75 represent weak, moderate, and substantial level, respectively. Therefore, in this study, the R^2 value was 0.759 for learners' satisfaction endogenous construct. This outcome infers that all the exogenous constructs significantly explain 75.9% variance observed in learners' satisfaction.

Table 4: Performance of Latent Variables in the Model

Constructs	**Latent Variable Performances**
Content Quality	71.21
Learners' Quality	70.27
Service Quality	70.51
System Quality	70.68

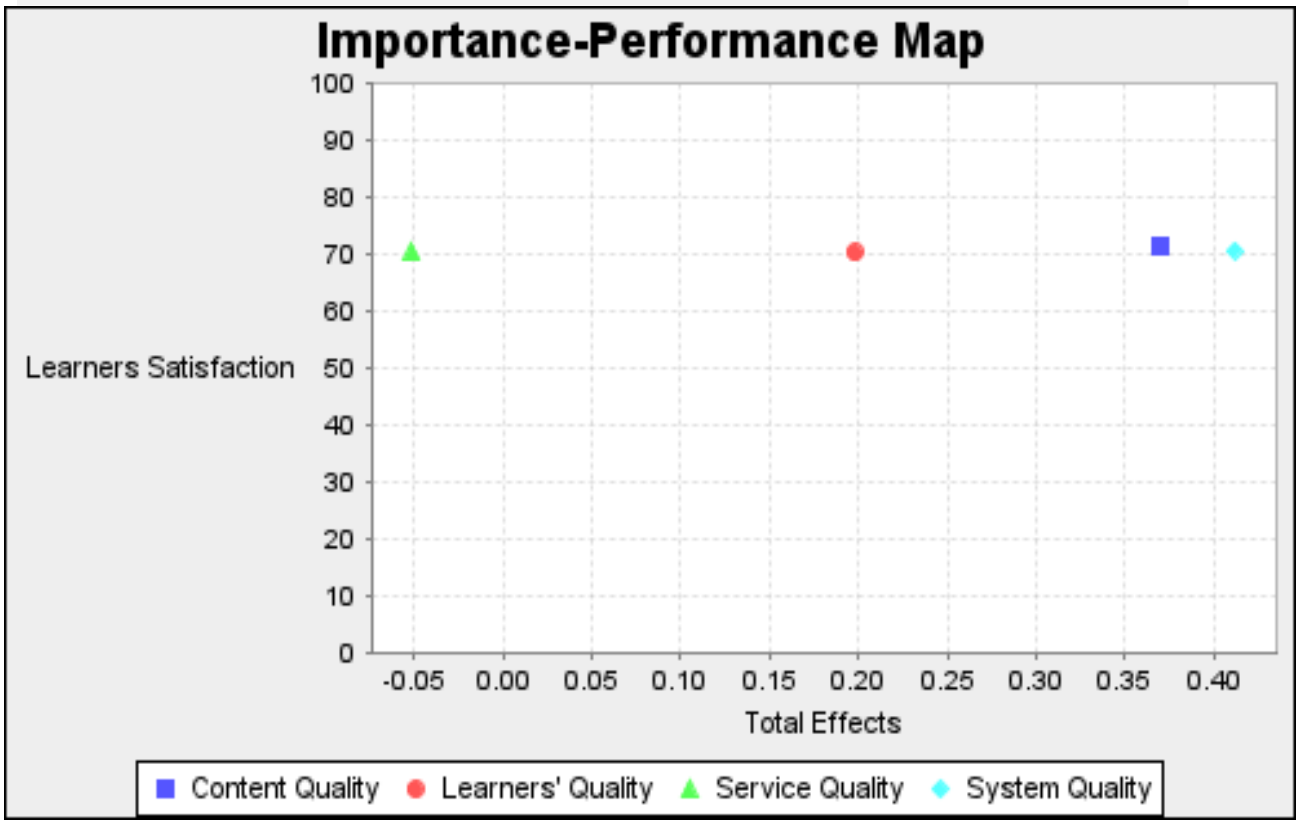

Figure 2: Importance-Performance Map Analysis of Constructs in the Model

Structural Model Assessment

In this study, the bootstrapping approach was used to check for structural path significance implemented in SmartPLS software. In achieving this, Henseler et al. (2009) suggested that in PLS-SEM, the significance of a path coefficient is measured using the 95% bias-corrected and accelerated (BCa) bootstrap confidence intervals. Alternatively, one may revert to the bootstrap p-values. This method used 500 bootstrap samples and 501 cases to establishing the significance of the path coefficients for the direct effect. Thus, Table 4 and Figure 3 present comprehensive estimates of the structural model alongside with statistics relating to the direct relationship of the constructs.

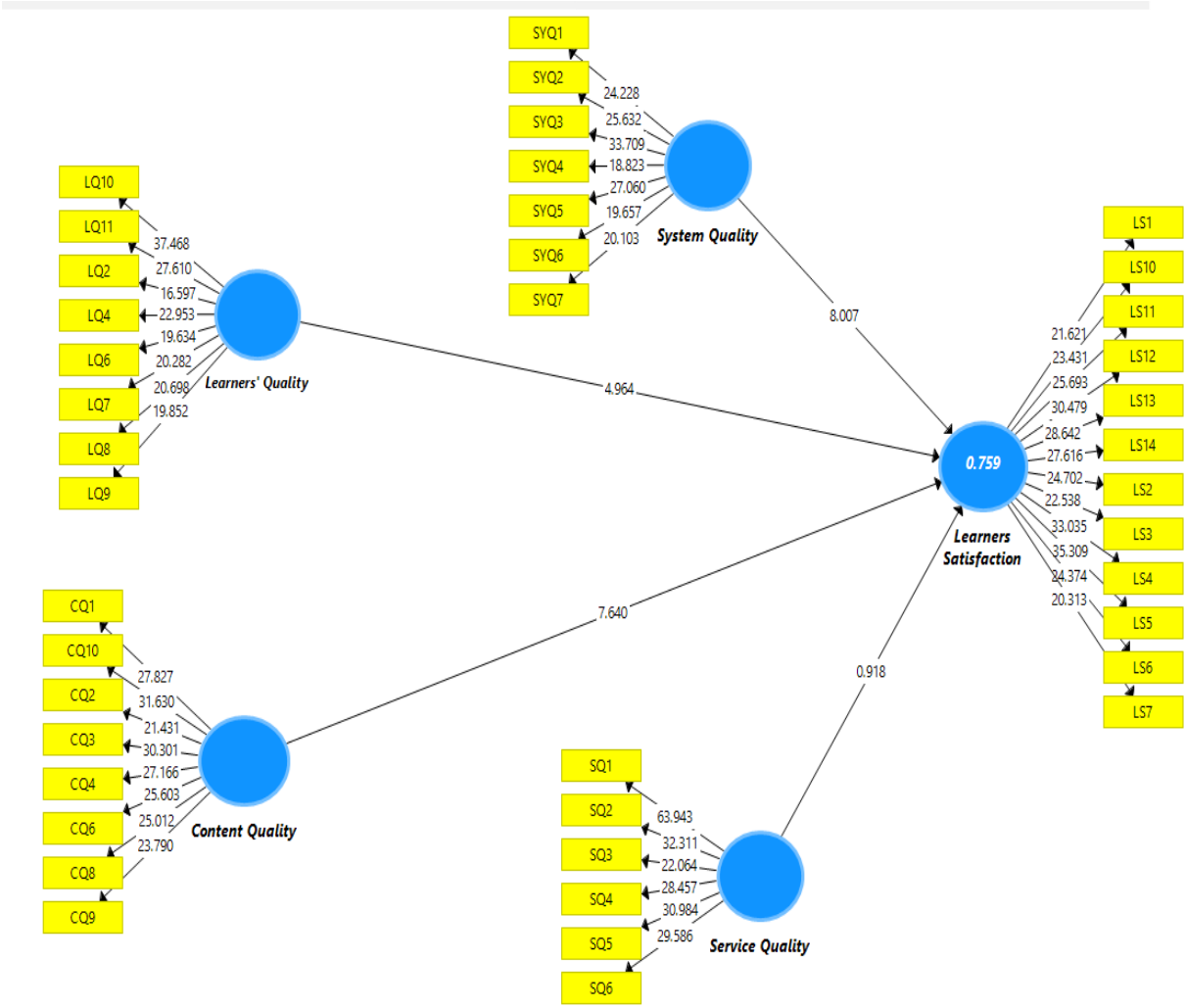

Figure 3: Structural Model

Table 4: Bootstrapping results of path coefficients in the structural models

Hypothesis	Constructs Relationship	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	Bias	Lower bound 2.50%	Upper bound 97.50%	T Statistics (|O/STDEV|)	Sig.	Remarks
H_{01}	Content Quality -> Learners Satisfaction	0.39	0.38	0.05	0.00	0.28	0.48	7.64	0.00	**Reject**
H_{02}	Learners' Quality -> Learners Satisfaction	0.20	0.20	0.04	0.00	0.13	0.28	4.96	0.00	**Reject**
H_{03}	Service Quality -> Learners Satisfaction	-0.06	-0.06	0.06	0.00	-0.18	0.06	0.92	0.36	**Do Not Reject**
H_{04}	System Quality -> Learners Satisfaction	0.41	0.41	0.05	0.00	0.30	0.50	8.01	0.00	**Reject**

Table 4 shows the magnitude and direction of the direct effects on the model. The result obtained showed the direct effect of content quality on learners' satisfaction was 0.39 ($p < 0.05$). This result showed that there was a significant direct causal relationship between content quality on learners ' satisfaction. This result implies that every unit increase in content quality increases learners ' satisfaction by 0.39 unit for every 0.05 standard deviation while controlling for other variables. Also, Table 4 showed positive and significant relationship between content, learners' and system quality and learners' satisfaction with ($\beta = 0.39; 0.20; 0.41$, $t = 7.64; 4.96; 8.01$, respectively with all $p < 0.05$). Consequently, the stated null hypotheses H_{01}, H_{02} and H_{04} were rejected. More so, Table 4 shows that service quality had no significant and negative relationship with learners 'satisfaction with ($\beta = -0.06$, $t = 0.92$, $p = 0.36; > 0.05$). Therefore, the hypothesis which stated that there is no significant relationship between system quality and learners' satisfaction H_{03} was not rejected. It implies that a unit increase in system quality, accounted for the 41% improvement in learners' satisfaction.

Discussion

The structural validity and reliability of the instruments were examined using measurement model implemented in SmartPLS software. The results showed that the instrument measured adequately what it designed to measure (i.e components of online learning during Covid-19 pandemic) using average variance extracted (AVEs' > 0.40). Also, the Cronbach Alpha (CA) and composite reliability (CR) for measuring internal consistency of the instrument were substantial at CA > 0.60 and CR >0.60 for all the construct variables. Findings from structural model showed that out of sub-components of online learning, only content quality, learners' quality and system quality had positive and significant relationship to satisfaction derived by the learners during online teaching and learning processes. This position laid credence to the findings of Hassanzadeh, et al. (2012); Maina and Nzuki (2015); Lashavo and Johar (2018); Oyeniran, et al. (2020) who submitted that many educators are enthusiastic about the use of computer-based technology for teaching and learning, and have adapted strategies from small-group and interactive techniques to the online mediums. Also, the researchers remarked that students who are the receiving end of the online teaching and learning activities are gauged in terms of satisfaction such as quality of the content, system quality and learners' quality in determining the effectiveness of online learning for achieving behavioural objectives.

Conclusion

This study introduced the partial least square structural equation model (PLS-SEM) method to the virtual learning concerning learners' Satisfaction during COVID- 19. The results of PLS-SEM showed that about 75.9% of the observed variation in learners' satisfaction could be explained by a parsimonious model of 41 reflective indicators defining content quality, learner's quality, system quality and service quality. Furthermore, the path coefficients indicated that the exogenous constructs such as content quality, learner's quality and system quality play a very significant role in explaining learners' Satisfaction during COVID- 19 online teachings. These results are dependable because various consistency, reliability, validity and significance tests were satisfactory, and IPMA confirmed the PLS-SEM findings.

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