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COVID-19 crisis and the continuous use of virtual classes

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ABSTRACT

COVID-19 is a serious epidemic that has an unmistakable impact on all aspects of our lives, including the educational process. Most of the world has adopted Virtual Classes (VCs) to sustain teaching and learning. While prior research about such e-learning technologies has been focusing on the initial adoption, this research investigates the factors influencing the students' desire and intention to continue using VCs, especially after the crisis subsides. This study extends the literature by developing a model that integrates pre-and post-adoption constructs and incorporates technological characteristics, namely, task technology fit, convenience, and compatibility into the Expectation Confirmation Model (ECM) to study the post-adoption Continuance Intention (CI) of VCs. The model is empirically validated using the partial least squares–structural equation modelling method and proved to have a reasonable description power (R^2=62%) in terms of students' CI. The survey empirical data is also supported by interviews with some students. The results support all the hypothesized relationships and confirm that the integration of technical characteristics in the ECM provides an appropriate framework to explain students' intention to continue using VCs, which forms a good base for practitioners to consider a wide range of technological features for preparing applications. Yet, the model still requires to be extended with other stakeholders, including teachers, and other constructs like personal, psychological, social, and environmental factors.

1. Introduction

Human history is full of events that have radically and eternally reshaped it. This includes the constant and profound evolution of the educational systems. In preliterate times, the culture was transmitted in an oral manner from a generation to another (Madden et al., 2006). Main paradigm shifts then started with the invention of writing, papyrus sheets, and black ink in ancient Egypt (Nehusi, 2010; Houston, 2016). Afterward, a series of consecutive developments have been spotted, for example, in China, Greece, the Arab world, and Europe (Ornstein et al., 2011).

Within each paradigm shift, there have been even minor though significant changes in the methods of teaching and learning (Ornstein et al., 2011). Every shift, main or minor, has guided us towards our contemporary educational systems and should inform us towards our future practices as well.

During the last century, several main catastrophic events gravely hit the world. These include World War I (1914-1918), the Spanish flu pandemic (1918-1920), the great depression (1929-1939), and World War II (1939-1945). These crises have had a devastating effect on the globe and have been deeply studied from political, economic, and socio-economic perspectives. In contrast, to the best of our knowledge, a limited number of studies have investigated the certain impact of these events on the shifts in the educational systems. The studies have focused mainly on the social influence of each crisis on the students, the impact of closing the schools on education, and the typical reporting statistical data of enrolments, dropouts, and teaching forces during and after the abnormal situation (see, for example, (Carr and Mallam, 1943; Lungu, 1993. Little attention has been paid to the shifts that have occurred or supposed-to-occur in teaching and learning during and after each crisis.

Coronavirus (COVID-19) is currently the most serious threat facing humanity. According to the UN

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Chief, Antonio Guterres, it is the worst global crisis since World War II. The manifestations of the pandemic are apparently everywhere. Reports and studies about the influence of the virus on politics, society, and the world economy have already been underway (Bloomberg, 2020; NBSOC, 2020; Ratha et al., 2020; WBG, 2020c; 2020b). The crisis is even referred to in economic terms like the "Great Lockdown" or the "Coronavirus Recession" (IMF, 2020; Jones et al., 2020).

The impact of the outbreak on the educational systems is equally apparent. As of 24 March 2020, more than 160 countries applied some form of school closures impacting at least 1.5 billion students around the world (WBG, 2020d). In consequence, most of the world's educational institutes have adopted some different contingency plans to mitigate the problem. They have already approved teaching strategies, assessment methods, and evaluation mechanisms that have been rejected for a long for being claimed ineffective (Guri-Rosenblit, 2005). Currently, virtual classes sustain the teaching process, online exams are ongoing for assessments, instructional e-materials are replacing the printed ones, and the cloud is the arena. Large-scale, considerable efforts have been exerted to utilize the technology in the support of online learning (WBG, 2020a).

The good news is that the world has a chance to turn the massive calamity into substantive opportunities for reshaping our lives. Germany's labor minister aims to put forward legislation of the right to work from home as long as it is feasible, even after the pandemic subsides. The UAE announced that they will permanently legalize the remote work system for some employees. The Saudi minister of education already declared that distance education will be a strategic choice for the future, not just a temporary alternative (SPA, 2020). The World Bank has commenced studies to help to avert the problem and evaluate the experience (WBG, 2020d; WBG, 2020a).

In that respect, intensive studies about the expected educational paradigm shift are still required. It is the right time to evaluate the online teaching experience, from different perspectives, including the social, economic, environmental, technological, and lifestyle aspects. Interdisciplinary research would answer questions like: would/should the aftermath of the crisis includes a paradigm shift in the educational system? Would there be any economic gain from the "online education" paradigm? If yes, would that economic gain pay off for the expected loss in the teaching effectiveness? If no, would saving the students' commute hassle and time by the new paradigm pay off for the claimed teaching ineffectiveness? How would the technology, especially the 5G networks, help in alleviating the shortcomings of the new paradigm? Etc.

This study is an attempt towards that direction. It investigates the potential effect of the epidemic on the educational system from the perspective of technology adoption and continuous use. The current study focuses on the students' CI to use the virtual classes after the crisis. However, as the continuous use of e-learning is basically a governmental decision, the research could be considered an investigation of the students' desire to continue using the new system.

Based on a thorough literature review, this study proposes a comprehensive model that incorporates technological characteristics, namely, Task Technology Fit (TTF), convenience, and compatibility into the Expectation Confirmation Model (ECM) (Bhattacherjee, 2001). For the empirical validation of the model, Partial Least Squares–Structural Equation Modelling (PLS-SEM) method is utilized. The PLS-SEM results supported all the hypothesized relationships. The validated model proves to have a reasonable description power (R^2=62%) in terms of students' CI to use virtual classes. Prior research has investigated the initial adoption of e-learning technologies while conducting research on students' CI to use virtual classes is somewhat a neglected area. This study contributes to the literature by addressing the continuance usage within the framework of virtual classes through the integration of technological characteristics to ECM.

This paper is organized as follows. In Section 2, an introduction about e-learning and virtual classes is presented. In Section 3, the related research is summarized. Section 4 describes the conceptual model. Section 5 introduces the research methodology including the development of the instrument and a description of the sample. Section 6 presents the data analysis, including the measurement model analysis and the structural model analysis. In Section 7, the results are discussed and the findings are concluded. Finally, Appendix A presents the measurement items of the questionnaire.

2. E-learning and virtual classes

The concept of e-learning does not really have a single definition that is agreed upon in the literature. E-Learning is even confused with many other concepts that are part of the whole new educational system. Guri-Rosenblit (2005), for example, was concerned with explaining the differences between "e-learning" and "distance education", claiming that they overlap but are not identical.

Regardless of the debate, as it is out of the scope of this research, Sangrà et al. (2012) comprehensively defined e-learning as "an approach to teaching and learning, representing all or part of the educational model applied, that is based on the use of electronic media and devices as tools for improving access to training, communication and interaction and that facilitates the adoption of new ways of understanding and developing learning." According to the definition, a number of early primitive forms of e-learning, e.g., the correspondence university (Bower and Hardy,

2004), should be excluded to unambiguously understand the new concept and unmistakably identify its main elements. The first form of modern e-learning systems has started around three decades ago with Computer-Based Training (CBT) (Hubackova, 2015). Since then, e-learning systems have been evolving into many complex ecosystems. Evidently, virtual classes are an essential key element in the new paradigm since its beginning (Hiltz, 1994). The present generations are habitual of virtual environments and they expect the availability of virtual environments for learning, therefore the universities have to invest in developing virtual learning environments (Henritius et al., 2019).

A virtual class is defined as a shared online learning space where dynamic interaction between the learners and instructors is supported by collaborative learning structures (Arbaugh, 2000). Videoconferencing is usually the arena. Instructors present the educational content and play the role of a moderator to control the learning process. Learners attend the classes and participate in the activities and discussions monitored by the instructor.

Since its early beginning, e-learning, including virtual classes, has shown considerable potentials as a new educational paradigm shift. In the early 1990s, entrepreneurs have argued that e-learning might be the biggest web industry in the future. In 1999, European experts met in Stockholm to discuss the concept of "virtual universities" and later on Arnold (1999) and Molen (2001), amongst others, have envisaged that the advantages of distance learning will ultimately lead it to surpass the face-to-face traditional classes.

Among the key advantages of e-learning is ubiquity where education has no more limitation by time or place (Hubackova, 2015). As using mobile devices has been the norm, it has never been easier for learners to attend any course, anytime, and anywhere. Logistics cost including travel, place, and materials are the least. Moreover, the comprehensive, detailed, constant evaluations and analytics required by the modern accreditation systems for quality assurance, which have been quite unmanageable in the traditional learning environments (Akhter and Ibrahim, 2016), could seamlessly be incorporated into the e-learning ecosystems. Novel educational techniques including gaming and adaptive learning are more native in the interactive online systems. Even more, the e-learning novel teaching/learning strategies and tools have proven to be effective not only in virtual classes but also in traditional education (Hubackova, 2015).

Even before the coronavirus epidemic, there has already been a high growth and adoption in the new education technology. Giant technology companies, for example, Google and Microsoft, have invested in the new online learning. In 2019, the overall global investment in education technology is estimated to be around US$18.6 billion, while the overall market for e-education is projected to be $350 Billion by 2025 (RAM, 2019).

Despite the enormous potentials and apparent advantages, e-learning still has its own challenges and drawbacks. Typical human resistance to such a massive transformation was expected by Molen (2001). Noesgaard and Ørngreen (2015) highlighted the need for huge investments and radical changes in the direction for e-learning to succeed. They also argued that e-learning and traditional education should be measured based on different definitions, approaches, and in sum different pedagogy. In addition, student's socialization and benefit of support networks of colleagues and lecturers in traditional education environments may be unsustainable in online systems. In that respect, high dropout rates in e-learning are usually reported (Tan and Shao, 2015). Moreover, courses and training, such as medical training, still require physical contact to be effective. Advanced virtual reality and simulation technology that can effectively support such a kind, of course, is still out of reach. The adoption rate of digital content, as a key element in the paradigm, has been slower than expected (Arshad and Akram, 2018). It is believed that digital content is not welcomed by everyone due to complaints about eye strain and fatigue. Moreover, the industry still requires a universal technology standard for sharing digital content among various users with different platforms (Rehman et al., 2020). Finally, the infrastructure required to fully adopt the paradigm is believed not equally available to every country. Bad internet connection, losing connection, and failing to enter are still among the regular complaints of the users (Table 1).

Ahead of weighing the advantages and disadvantages of e-learning, students' satisfaction with the new paradigm should be considered as a decisive factor in technology adoption. The current lockdown has provided us with the opportunity to entirely adopt the technology and evaluate the whole experience. The following section summarizes the frameworks of the pre-and post-adoption of the technology, based on which the conceptual model of the current research is developed.

3. Literature review

As presented above, e-learning is a considerable education paradigm shift that requires novel pedagogy, applications, and technologies. In that respect, investigating the pre-adoption expectations and post-adoption behavior is crucial for understanding the initial and continued usage of the new ecosystem. While the pre-adoption beliefs are based on indirect experience and perceptions of a system, the post-adoption usage is based on instrumentality beliefs and past experience of using it (Karahanna et al., 1999).

Regarding the pre-adoption models, Task-Technology Fit (TTF) is a popular model that was proposed by Goodhue (1995) as an explicit construct to be used for effective user evaluation of information systems (ISs). TTF model avoids the lack of task-focus criticism of the previous Technology

Acceptance Models (TAM) (Davis et al., 1989). The model theory argues that IT is more likely to enhance performance and be adopted if the system characteristics are fairly linked with the tasks to be done. Goodhue and Thompson (1995) developed a measure of TTF in which "fit" refers to the degree to which the functionality of the technology matches both the task requirements and individual abilities. The model included eight components that were successfully measured: quality, capability, authorization, compatibility, ease of use/training, production timeliness, systems reliability, and relationship with users.

With respect to the post-adoption models, Expectation Confirmation Theory (ECT) is the widely, accepted theory in investigating user satisfaction (Eshaghi and Taeizadeh, 2015). ECT is originated in the consumer behavior literature to explain post-adoption satisfaction as a function of expectations, perceived performance, and confirmation of beliefs (Oliver, 1977; 1980). The theory is adapted and underpinned with theoretical and empirical research of ISs usage to articulate a model of Information Systems Continuance (ISC) use (Bhattacherjee, 2001). The new ECM includes two variables: confirmation of expectations and post-adoption Perceived Usefulness (PU) that influence the user satisfaction and hence the ISC intention. Through the ECM, Bhattacherjee (2001) untangled the confusion between the acceptance and continuance behaviors, creating one of the key models of ISC use.

The wide acceptance of the TTF model and ECM has made them popular in the prediction and explanation of utilization, satisfaction, and CI, especially with the novel technologies. With respect to e-learning, a number of authors have confirmed that student motivation to CI results from the degree of satisfaction and the fit of the technology. Almarashdeh (2016), for example, showed that Learning Management Systems (LMS) should be designed based on the needs of the instructors and students; otherwise, the dissatisfaction will negatively affect the distance learning outcomes. Joo et al. (2017), in their study about the CI to use digital textbooks, employed an ECM to show that satisfying more expectations of digital textbooks positively influences the students' PU. In addition, the PU and satisfaction showed a direct and positive influence on the CI to use digital textbooks. Liaw et al. (2007), in their study about the instructors' and learners' attitudes toward e-learning usage, concluded that e-learning is based on human factors and is concerned about the level of satisfaction of learners and instructors. Al-Fraihat et al. (2020) identified the determinants of the e-learning perceived satisfaction as the quality of the technical system, information, service, support system, learner, instructor, and PU, while the perceived satisfaction, PU, and use determine the e-learning benefits.

Both the TTF model and ECM have been also extended by adding unique factors to enhance their capabilities. Tan and Shao (2015), for example, developed an improved ECM-ISC model that incorporated two constructs from the field of pedagogical dropout theories, namely, academic integration and social integration, to study the mechanisms determining e-learners' decision to continue/discontinue their studies. Results demonstrated that all original pathways of the model were supported, suggesting the applicability of the ECM in explaining students' CI. In addition, e-learners' satisfaction has shown a considerable influence on the students' persistence to complete their studies. Cheng (2019) studied the role of TTF in cloud-based e-learning continuance, confirming direct significant impacts of TTF on the confirmation, PU, and satisfaction. The current research assumes direct impacts of TTF on confirmation and indirect impacts on PU, satisfaction, and compatibility.

Huang et al. (2017) incorporated convenience (Brown, 1990), referring to the time/effort required, in a TTF model to explore the factors that affect users' satisfaction with commercial e-book stores. The results showed that convenience, among other factors including functional service and mobility, is a significant factor that influences users' TTF behavior, which in turn improves user satisfaction. Similarly, Stone and Baker-Eveleth (2013) extended the ECM with convenience to examine the CI of e-textbooks as an essential ingredient in modern educational systems. The results showed that confirmation influences PU and satisfaction of e-books, which influence the CI. Moreover, adding more tools to the platforms increases students' convenience and hence students' confirmation of pre-and post-adoption expectations. Keeping in view the above discussion, this study assumes the direct positive impacts of convenience on the confirmation.

Compatibility, i.e., the innovation-system fit, has been adopted from the diffusion of innovations (Rogers, 1995) to extend the e-learning adoption and CI models. Islam (2016), for example, proved the moderating role of the perceived compatibility on the relationship between e-learning system use and its outcomes. Isaac et al. (2019), in contrast, examined the mediating roles of TTF and compatibility. The findings suggested that the overall quality influences compatibility, which influences user satisfaction and practical use, which influence TTF. In addition, compatibility mediates the associations among overall quality and either satisfaction or practical usage, while TTF mediates the associations among satisfaction and practical usage.

Mokhtar et al. (2018) extended the TAM with several factors, including TTF, compatibility, and convenience, to study the instructors' behavioral intention to use LMS. The results showed that TTF, PU, and Perceived Ease of Use (PEOU) have direct impacts on the behavioral intention while TTF, compatibility, convenience, self-efficacy, personal innovativeness, and subjective norm have significant impacts on PU and PEOU. Rehman et al. (2020) investigated the motives facilitating the users' CI for digital contents in academia by extending the ECM,

incorporating personal and technological antecedents of users' CI. The results confirmed that compatibility, convenience, self-efficacy, and facilitating conditions are the predictors of the confirmation and usefulness of the digital content, which leads to greater satisfaction, which in turn leads to users' CI of the digital content. In the context of this study, students are assumed to find the technology more compatible after the initial use, which enhances their PU, which in turn positively affects their CI.

Both of TTF model and ECM have been also integrated. Cheng (2014), for example, synthesized TTF and ECM to explain nurses' intention to continue using a blended e-learning system within medical institutions. The results showed that TTF has the greatest impact on the nurses' CI by increasing the extent of the nurses' confirmation to the system. The results suggested that e-learning systems, to succeed, should be developed to fit with the goals and needs. Besides, the results revealed that user network has also an intense influence on the intention to continue using the system.

4. Conceptual model

As presented above, by incorporating technological characteristics, namely, TTF, convenience, and compatibility into the well-established ECM, an improved conceptual model for investigating the e-learners CI to use virtual classes are developed (Fig. 1). The model thus integrates pre-and post-adoption constructs to study the post-adoption CI. Accordingly, this study hypothesizes:

- H1: Pre-adoption TTF positively affects confirmation.
- H2: Pre-adoption convenience positively affects confirmation.
- H3: Confirmation positively affects post-adoption compatibility.
- H4: Confirmation positively affects post-adoption PU.
- H5: Confirmation positively affects post-adoption satisfaction.
- H6: Post-adoption Compatibility positively affects post-adoption PU.
- H7: Post-adoption PU positively affects post-adoption satisfaction.
- H8: Post-adoption compatibility positively affects continuance intention.
- H9: Post-adoption PU positively affects continuance intention.
- H10: Post-adoption satisfaction positively affects continuance intention.

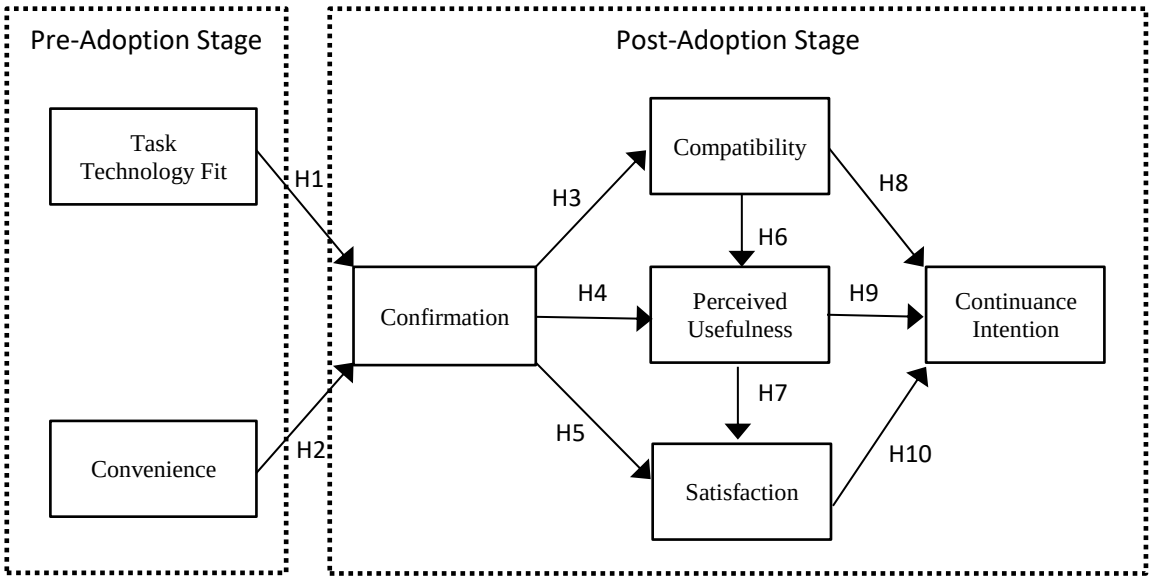


Fig. 1: The proposed conceptual model

5. Research methodology

5.1. Instrument development

This study basically uses a survey approach to validate the proposed model. All the measurement items of the study have been adapted from prior relevant research and modifications were applied according to the research context. The items of the TTF were adapted from Goodhue and Thompson (1995) and Zhou et al. (2010). The items of the convenience (CONVEN) construct was adapted from Lai and Ulhas (2012), while the items to measure the compatibility (COMP) were taken from Jin (2014). Regards the items of the constructs of the ECM, i.e., Confirmation (CONF), Perceived Usefulness (PU), Satisfaction (SAT), and Continuance Intention (CI), they all were adapted from Bhattacherjee (2001). The questionnaire is composed of two parts. The first part contains questions about the demographic information. The second part contains 24 measurement items about the constructs of the whole model (see Appendix A for the measurement items).

In addition, the questionnaire included an "Add Your Comment" part. Fourteen students accepted to

be interviewed, share their experience with us and explain their comments. The interviews, though was not the main methodology in this research, have enlightened the authors about the different viewpoints of the students and their unique suggestions, which yield richer information about the whole experience (Gill et al., 2008). Face-to-face interviews were not applicable due to the coronavirus lockdown, so online interviews through the Zoom video conferencing service were employed. The interviews included open-ended questions and follow-up questions. The comments of the students were also discussed. Question examples included "tell me what was your virtual classes experience like?", "how do you evaluate the whole experience?", "If you are a decision-maker, what would be your decision with respect to the continuance use of virtual classes?", and "what would be done to improve the virtual classes' effectiveness?" A brief summary of these interviews is presented in the Discussion and Conclusion section.

5.2. Sample

The target sample of this research is undergraduate and postgraduate students. An online questionnaire was developed and distributed to different universities, mainly in Saudi Arabia. The questionnaire is also distributed to some particular colleges in Egypt and Pakistan, however, the response from there was quite limited. The total number of responses was 248, leading to an approximately 5% response rate. Out of the 248 cases, eight cases were discarded as the respondents were not students. The remaining 240 cases were used for the data analysis. The URL of the questionnaire was posted online on April 15th, 2020, and closed on May 15th, 2020. There was no compensation or benefits offered for taking part in the survey. The results were shared and discussed with 14 particular respondents who chose to provide us with more details about their comments. The demographic profile of all the respondents is listed in Table 1.

Table 1: Demographic Information of the Sample

Item	Characteristics	Percentage
Gender	Male	74.5
	Female	25.5
Age Group	Less than 21 years	25.8
	21 to 30 years	73.8
	31 to 40 years	0.4
Academic Position	Undergraduate Student	81.6
	Master Student	16.7
	Ph.D. Student	1.7
Nationality	Saudi Arabia	91.2
	Egypt	4.2
	Pakistan	3.8
	Other	0.8
What program/website you use most for virtual classes (*you may choose more than one answer*)?	Blackboard	82.4
	Zoom the free version	64.6
	Zoom the full version	10.4
	Microsoft Teams	12.1
	Other:	2.5
Have you ever used any virtual classes' website/application before the coronavirus crisis?	Yes	50.4
	No	49.6
What is the device you used most to access the virtual classes?	Mobile Phone	23.1
	Tablet	5.8
	Desktop computer	16.3
	Laptop computer	54.8
	Other:	0.0
What are the most difficult problems you encountered in using the virtual classes (*you may choose more than one answer*)?	Failed to enter to the system	44.2
	Bad Internet connection	29.6
	Losing connection and reconnecting again	58.3
	Other:	6.3

6. Data analysis and results

To examine the conceptual model, the PLS-SEM method is employed (Hair et al., 2016). According to Fornell and Larcker (1981), the PLS-SEM is the prevalent method to test the psychometric properties of the measurement scale and to help to determine the significance of the hypothesized relationships. The toolbox used to analyze the data included the SmartPLS-3.2.7 and SPSS-23 software. Details about the measurement model and the structural model assessments are presented in the onward subsections.

6.1. Measurement model analysis

The measurement model analysis is concerned with the reliability and validity of the measurement scales. First, to assess the reliability of the scales, the tests of internal consistency reliability, composite reliability, and indicators reliability were conducted (Hair et al., 2010). The internal consistency reliability is checked through the values of Cronbach's alpha (>0.6). The threshold value for the composite reliability and indicator reliability is 0.7. The outer loadings of the measurement items were examined to assess the reliability of the indicators. The results, summarized in the second, third, and

fifth columns of Table 2, show that all the items are found reliable and can thus undergo further analysis.

Second, with respect to the validity of the measurement model, convergent validity and discriminant validity were assessed (Hair et al., 2010). As regards the convergent validity, the Average Variance Extracted (AVE>0.5) is used. The values listed in the last column of Table 2 show that all the AVE values are greater than 0.5, which indicates the existence of convergent validity.

Table2: Summary of reliability and validity tests

Construct	Cronbach's alpha	Composite Reliability	Items	Indicators' Reliability	Construct AVE>0.5
	>0.6	>0.7		>=0.7	
Continuance Intention	0.882	0.927	CI1	0.918	0.810
			CI2	0.903	
			CI3	0.878	
Compatibility	0.891	0.932	COMP1	0.913	0.821
			COMP2	0.900	
			COMP3	0.906	
Confirmation	0.815	0.891	CONF1	0.860	0.731
			CONF2	0.888	
			CONF3	0.816	
Convenience	0.781	0.859	CONVEN1	0.804	0.605
			CONVEN2	0.801	
			CONVEN3	0.774	
			CONVEN4	0.728	
Perceived Usefulness	0.873	0.913	PU1	0.862	0.725
			PU2	0.874	
			PU3	0.860	
			PU4	0.808	
Satisfaction	0.883	0.919	SAT1	0.867	0.741
			SAT2	0.852	
			SAT3	0.879	
			SAT4	0.844	
Task Technology Fit	0.861	0.915	TTF1	0.896	0.782
			TTF2	0.892	
			TTF3	0.865	

Regards the discriminant validity, both the Fornell-Larcker's criterion and the Heterotrait-Monotrait ratio (HTMT) approaches were implemented. First, according to Fornell and Larcker (1981), the square root of the AVE of each variable should be greater than the corresponding correlation with the other variables (see the diagonal elements in Table 3). Second, according to Henseler et al. (2015), the HTMT ratio between any two constructs should be less than 0.90. Both of these two conditions are fulfilled as presented in Table 3. Discriminant Validity, which clearly indicates the establishment of discriminant validity.

Table 3: Discriminant validity

	CI	COMP	CONF	CONVEN	PU	SAT	TTF
CI	0.900	0.691	0.600	0.600	0.779	0.783	0.659
COMP	0.618	0.906	0.560	0.593	0.665	0.572	0.576
CONF	0.510	0.478	0.855	0.764	0.637	0.741	0.689
CONVEN	0.496	0.494	0.610	0.778	0.630	0.666	0.624
PU	0.684	0.593	0.538	0.517	0.851	0.714	0.618
SAT	0.692	0.508	0.630	0.554	0.627	0.861	0.733
TTF	0.574	0.503	0.576	0.510	0.534	0.639	0.884

Note: Values above the diagonal are HTMT ratios. The diagonal values are showing the square-root of AVE while values below the diagonal are the inter-construct correlations

6.2. Common method bias

The Common Method Bias (CMB) refers to the bias caused by the use of the same source, e.g., a survey, to collect information about the dependent and independent variables. The CMB exists if a single factor explains most of the variance amongst the other variables (Podsakoff et al., 2003). To examine the CMB, Harman's single-factor test was implemented. The test showed that a single factor is accounted for 44% of the variance, which is below 50%, and hence the CMB does not exist. Additionally, a full collinearity test to check the presence of CMB in the data was also carried out. The Variance Inflation Factor (VIF) values of all the latent variables were found below the threshold value of 3.3, suggested by Kock and Lynn (2012), which also confirmed that CMB is not an issue in the data.

6.3. Structural model analysis

Before testing the hypothesized relationships, the scales were checked for collinearity issues by assessing the tolerance and VIF values (Hair et al., 2010). All the tolerance values are found greater than 0.2 and the VIF values are less than 5, which indicates the non-existence of any collinearity issues.

The predictive power of the model is then evaluated by examining the coefficient of determination (R2) (Hair et al., 2010). The R2 values

for the endogenous variables are found to be: confirmation: 0.47, compatibility: 0.23, PU: 0.44, and satisfaction: 0.51. The R2 value of the dependent variable, i.e., the CI, is 0.62. These indicate that the conceptual model has a reasonable level of explanatory power to interpret the students' CI to use the virtual classes.

To evaluate the results of the hypothesis testing, the path coefficients, with relevant t- and p-values were considered (Hair et al., 2016). To assess the t-values and the significance of the hypothesized relationships, bootstrapping procedure was employed, using 5000 bootstrap subsamples. The results, summarized in Table 4, show that all the hypothesized relationships are supported at a significance level of p<0.01.

According to the findings, the TTF has a significant effect on the confirmation (β: 0.358, p<0.01) which supports the first hypothesis (H1). The relationship of the convenience with the confirmation (β: 0.427, p<0.01) is also significant which supports the second hypothesis (H2). Data analysis results confirmed significant impacts of the confirmation on the three mediating variables: compatibility (β: 0.478, p<0.01), PU (β: 0.329, p<0.01), and satisfaction (β: 0.411, p<0.01), thus supporting the hypotheses (H3), (H4), and (H5). The compatibility has significant effects on both of the PU (β: 0.436, p<0.01) and CI (β: 0.248, p<0.01) which supports the hypotheses (H6) and (H8). The findings also confirmed the significant impacts of the PU on both the satisfaction (β: 0.406, p<0.01) and CI (β: 0.300, p<0.01) which provides the support for both hypotheses (H7) and (H9). Finally, the satisfaction proves to have a significant impact on the CI (β: 0.378, p<0.01) and thus supports the last hypothesis (H10).

Table 4: Summary of the path coefficients, t-values, and p-values

Hyp. #	Path	Path Coefficient	Standard Deviation	t values	p values	Sig. Level
H1	TTF → CONF	0.358	0.074	4.850	0.000	***
H2	CONVEN → CONF	0.427	0.076	5.623	0.000	***
H3	CONF → COMP	0.478	0.056	8.480	0.000	***
H4	CONF → PU	0.329	0.068	4.872	0.000	***
H5	CONF → SAT	0.411	0.061	6.747	0.000	***
H6	COMP → PU	0.436	0.063	6.887	0.000	***
H7	PU → SAT	0.406	0.055	7.451	0.000	***
H8	COMP → CI	0.248	0.057	4.362	0.000	***
H9	PU → CI	0.300	0.062	4.836	0.000	***
H10	SAT → CI	0.378	0.065	5.791	0.000	***

***p<0.01

Table 5 lists the total indirect effects of each of the independent variables: TTF and convenience, on the mediating variables: Confirmation, compatibility, PU, and satisfaction, and the dependent variable CI. The direct and indirect significant effects of the TTF and convenience on the compatibility, PU, satisfaction, and CI show that each of these variables plays a significant role in affecting the students' intention to continue using the virtual classes.

Table 5: Total indirect effects

Relationship	Estimate	t values	p values
COMP → CI	0.198	5.134	0.000
COMP → SAT	0.177	4.854	0.000
CONF → CI	0.518	12.796	0.000
CONF → PU	0.208	5.007	0.000
CONF → SAT	0.218	5.768	0.000
CONVEN→ CI	0.221	4.903	0.000
CONVEN→ COMP	0.204	4.263	0.000
CONVEN→ PU	0.229	4.557	0.000
CONVEN→ SAT	0.269	5.050	0.000
PU → CI	0.153	4.017	0.000
TTF → CI	0.186	4.283	0.000
TTF → COMP	0.171	4.041	0.000
TTF → PU	0.193	4.293	0.000
TTF → SAT	0.226	4.268	0.000

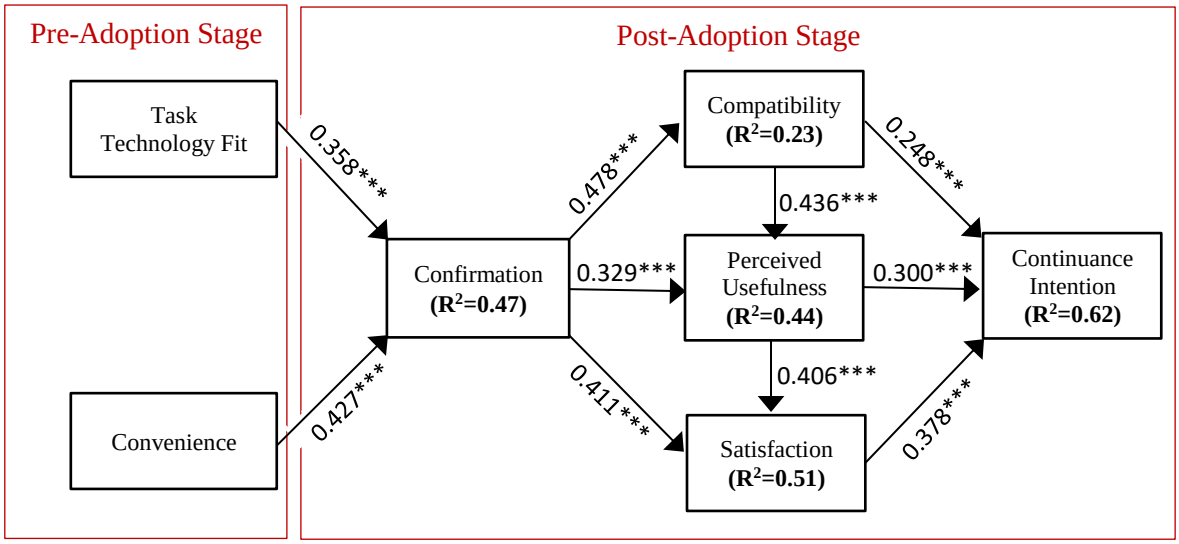
Fig. 2 summarizes the Bootstrapping results as produced by the SmartPLS-3.2.7 software.

7. Discussion and conclusion

To investigate the significant factors that influence the students' CI to use the virtual classes, especially after the coronavirus epidemic subsides, this study builds on the ECM-ISC model of Bhattacherjee (2001) and incorporates technological characteristics, namely, TTF, convenience, and compatibility to ECM to present an empirically validated model. Consequently, this study offers implications to both academia and practice. This research makes a significant contribution to the literature by enhancing the ECM through the incorporation of the technological characteristics into the model.

The findings confirmed that the TTF and convenience have significant effects on the confirmation. These results are consistent with prior research (Stone and Baker-Eveleth, 2013; Cheng, 2014; Huang et al., 2017), which indicates that technological characteristics like TTF and convenience play a significant role in forming one's intention to use a specific technology at the pre-adoption stage. At this stage, the users have some expectations about the technology, such as the technology best fit and convenient for performing the tasks required. After the initial use, the expectations are confirmed or disconfirmed. In the case of positive confirmation, the users typically find the technology more compatible with their needs, and their perceptions about the usefulness of the technology are enhanced. The confirmation of their expectations, along with the increase in their PU level, has a positive impact on their satisfaction level. The results proved that in the post-adoption stage,

the confirmation has a significant impact on compatibility, PU, and satisfaction. Moreover, the compatibility showed to influence the PU, which in turn boosts the users' satisfaction. Furthermore, the findings of this study confirmed that the three factors, namely, compatibility, PU, and satisfaction, significantly influence the students' CI to use the virtual classes. The findings also supported the hypothesized relationships of the proposed model, which are in perfect accordance with the prior research including (Islam, 2016; Mokhtar et al., 2018; Isaac et al., 2019; Rehman et al., 2020).



Note: * p < 0.05; ** p < 0.01; *** P < 0.001

Fig. 2: Results of hypotheses testing

Findings of the study suggest that if the virtual class technology is in line with the students' needs, i.e., it is fit to the required task and more convenient to use, then their expectations with the technology are confirmed. These results are consistent with the prior research in the field of e-learning (Cheng, 2019). Due to the positive confirmation of expectations, they perceive it as more compatible and more useful, which in turn enhances their satisfaction. These findings are in conformity with the prior research (Jin, 2014; Mokhtar et al., 2018; Rehman et al., 2020). Higher levels of perceptions about compatibility and usefulness along with the increased satisfaction positively influence the students' continuance intentions to use virtual class technology.

This study not only provides empirical evidence of the role of the ECM in explaining the students' CI but also advances it by incorporating technological characteristics as independent and mediating variables in the model. The empirical results suggest that the technical characteristics are essential for the students at both the pre-and post-adoption stages. Therefore, the production companies of virtual classes should develop virtual class/e-learning technologies in accordance with the users' expectations and demands.

7.1. Theoretical and managerial implications

The findings of this study indicate that the conceptual proposed model has a reasonable explanation power (R^2=0.62) to justify the students' CI to use the virtual classes. This research contributes to the literature by extending the ECM with technological characteristics like TTF, convenience, and compatibility, and provides empirical evidence of the role of these variables in explaining the CI in the context of virtual classes/e-learning usage. The new model is considered comprehensive as it covers different perspectives like the technological features, the fulfillment of users' expectations, usefulness perceptions, satisfaction, and CI, which all encompass the main components of the information systems continuance.

The validated model of the study has vital implications for the practice as well. It essentially provides a good base for the adoption and continuance of the applications of e-learning. The designers and programmers of this type of application are advised to consider a wider range of technical characteristics like TTF, convenience, and compatibility in addition to the typical usefulness of the application. The virtual class frameworks should be fit for all the different types of educational activities while at the same time convenient to use by the learners and teachers at all levels. The applications should be also compatible with the various technology platforms. Such technological features will be helpful in fulfilling users' expectations, enhance their perceptions about the usefulness of the technology, and boost their satisfaction level. Higher levels of compatibility, PU, and satisfaction will strengthen the CI of users.

In addition, the students' evaluations of virtual classes in terms of the technical characteristics can accurately help in identifying the technical problems, and subsequently provide better guidance to practitioners than the typical general indicators including the PU and satisfaction level. The

practitioners can then improve the virtual classes' frameworks by addressing the problems identified and thus enhance users' PU and satisfaction.

7.2. Students' interview

The authors had the chance to interview 14 students, who chose to provide us with more details about their answers and discuss the students' comments. Although the main theme of the interviews complied with the survey empirical data, the interviewees had some utterances. First, although most of the students see that the e-learning applications are fit for most of the teaching/learning activities, they are still reluctant about the effectiveness of these applications in some interactive activities. They declared that they miss, for example, class, group, and panel discussions in the traditional way. Similarly, several doubts have been expressed about the suitability of the virtual classes to all subjects. The students stressed that some types of courses, such as programming, still need to be taught in physical classes, as contemporary technology would not allow that level of interaction required in such a type of module. Advancements in the Internet speed and bandwidth, e.g., 5G technology, along with the incorporation of virtual reality with the e-learning frameworks would reduce the worries, some students suggested. However, another student expressed his concerns about the validity of the study to some countries without a competent technological infrastructure like what is available in Saudi Arabia (Saudi Arabia ranked 38th in ICT adoption, 11th in technology governance, and 36th in the global competitiveness report (Schwab, 2019)).

In addition, some students thought to be the hard-workers, see that online exams could be unfair, as there will often be a chance for cheating. Nevertheless, they added, replacing exams with an exhaustive set of homework, assignments, and projects would not be preferable too. Artificial intelligence should be a default option in virtual examination environments, a student suggested. Furthermore, some new educational ecosystems including new assessment methods and evaluation paradigms are vital for the e-learning CI, they all agreed upon.

Finally, some students added, although e-learning proves to save time and hassle, not as ineffective as it is thought to be, and has some unique advantages like recording the classes, it is still better to be blended with physical classes until the concerns, presented above, are tackled (in compliance with Cheng (2014)). They suggested that a mixture of day-on, day-off schedules, for example, would be a good compromise. The classes that require physical presence would be scheduled accordingly.

The viewpoints presented have confirmed that the students' have the wish to continue using the virtual classes, despite their worries and concerns, and provided further support for the integrated proposed model that considers technological characteristics (like TTF, convenience, and compatibility) in the ECM framework.

7.3. Limitations and future research

Although the model of this study extends the current understanding of the CI about the use of virtual classes by providing theoretical and empirical appraisals, there are still some limitations that offer opportunities for further research. First, this research investigated only university students' CI to use the virtual classes. In any learning process, faculty members and students are stakeholders. Future studies can test the model by using both faculty and students' data which can enrich the research and may help in a better understanding of the phenomenon. Second, this study incorporated only technology features to ECM. Future research may consider the integration of other factors to ECM like personal, psychological, social, and environmental factors. Moreover, relevant factors from UTAUT (Venkatesh et al., 2003; DeLone and McLean, 2003) information system success model can also be incorporated. Third, this study has not tested moderating effects of any demographic variable like age, gender, academic position, or field of studies, which could be a topic of future research. Fourth, a cross-sectional survey was used for this study. Keeping in view the dynamic nature of information technology, longitudinal studies may provide more insights into the phenomenon. Finally, the model of this research can be tested in other contexts of information systems.

Appendix A: Measurement items

Task Technology Fit (Goodhue and Thompson, 1995; Zhou et al., 2010)

1. The functions of a virtual learning website are enough to help manage my virtual learning.
2. The functions of the virtual learning website are appropriate to help manage my virtual learning.
3. In general, the functions of the virtual learning website fully meet my needs of virtual learning.

Convenience (Lai and Ulhas, 2012)

4. Using a virtual learning website saves my effort in acquiring information/knowledge.
5. Using a virtual learning website allows me to acquire information/knowledge quickly.
6. I can conveniently upload, download and deliver learning content.
7. Using a virtual learning website enables me to search for the information I need without time constraints.

Confirmation (Bhattacherjee, 2001)

8. My experience of using the virtual learning website was better than what I expected.
9. My experience of using virtual learning website content greatly exceeded my initial expectations.
10. Overall, most of my expectations from using virtual learning websites were confirmed.

Compatibility (Jin, 2014)

11. Using a virtual learning website is appropriate for my education/research activities.
12. Using a virtual learning website does not conflict with my education/research activities.
13. Using a virtual learning website is more compatible with my educational activities than attending physical classroom activities.

Perceived usefulness (Bhattacherjee, 2001)

14. Using a virtual learning website improves my academic performance.
15. Using a virtual learning website increases the productivity of my studies/work.
16. Using a virtual learning website enhances the effectiveness of my academic affairs.
17. Overall, I find the virtual learning website to be useful in my academic affairs.

Satisfaction (Bhattacherjee, 2001)

18. I am pleased with the experience of using virtual learning websites.
19. I am delighted with the experience of using virtual learning websites.
20. I am contented with the experience of using virtual learning websites.
21. Overall, I am satisfied with the virtual learning website.

Continuance Intention (Bhattacherjee, 2001)

22. I intend to continue using virtual learning websites in my academic activities.
23. My intentions are to continue using virtual learning websites for educational activities in the future.
24. I intend to continue using the virtual learning website for most of my education/research activities.

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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