

The functionality and interactivity of video conferencing technologies: A synchronous technology adoption model

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In the past few years, educators started using synchronous video conferencing software like Google Meet, Microsoft Teams or Zoom, among others, in addition to traditional teaching methodologies. Therefore, this contribution examines the students' perceptions about the functionality and interactivity features of these technologies, as well as the facilitating conditions of a higher education institution (HEI) in a Southern European context. A survey questionnaire integrated valid measures that were drawn from the relevant literature on technology adoption. The analysis was carried out through SmartPLS to shed light on the causal paths affecting the students' intentions to continue using synchronous technologies in higher education. The results suggest that the students feel that the functionality of the conferencing software in terms of their ease-to-use and efficient designs, as well as their HEI's facilitating conditions, including the technical support they are given, and their accessibility to adequate resources, are affecting their intentions to continue using these interactive technologies, to achieve their learning outcomes.

CCS CONCEPTS •Human-centered computing~Interaction design~Interaction design theory, concepts and paradigms•Human-centered computing~Human computer interaction (HCI)~Interaction paradigms

Additional Keywords and Phrases: conferencing technology, functionality, perceived interactivity, facilitating conditions, synchronous learning, technology adoption.

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1 INTRODUCTION

Following the outbreak of COVID-19, education institutions including universities and colleges were expected to follow their regulatory institutions' preventative measures including their social distancing policies and hygienic procedures, to prevent contagion [1]. In many cases, HEIs continued to deliver their educational services [2] through learning management systems (LMS) and via synchronous conferencing technologies [3]. During the first waves of the pandemic many educators were expected to quickly adapt to a fully virtual learning environment [4]. Initially, this transition resulted in a number of challenges to students and instructors [5]. Educators were pressurized to utilize digital technologies. Many of them relied on their institutions' Moodle or similar software to share their learning resources including videos, power point presentations and links to online notes. Hence, they also started to acquaint themselves with video-conferencing platforms like Google Meet, Microsoft Teams and Zoom, among others.

Eventually, policy makers have eased their restrictive measures and educational institutions. Eventually, HEIs reopened their doors to students and employees. Nevertheless, several educators are still delivering remote lectures or are adopting blended/hybrid approaches by using video conferencing programs in addition to conventional teaching methodologies. In this light, this research explores the students' perceptions about the functionality and usability features of interactive technologies in a higher education setting. Moreover, it also investigates their stance about the facilitating conditions that could have assisted them in their transition from face-to-face, classroom-based teaching to a fully virtual, remote learning environment.

This study integrates a technical functionality construct that is related to the electronic service quality literature [6] with perceived interactivity [7] and with facilitating conditions and behavioral intentions [8, 9] to use technologies drawn from the Unified Theory of Acceptance and use of Technology (UTAUT/UTAUT2). Specifically, this contribution raises awareness on the ease of use, instrumental utility, design features and technical attributes of synchronous technologies like conferencing software, as they enable two-way video communications among online users, in real time. Moreover, it investigates the facilitating conditions, in terms of technical support like a student help desk and the provision of appropriate resources including personal computers, laptops or ubiquitous devices, as well as fast and reliable Internet connections via broadband or WiFi services, among others, at home and on campus. This research hypothesizes that these issues are having an impact on the students' intentions to use remote technologies like conferencing programs, and on their motivation to continue using them to achieve their learning outcomes.

Currently, there are no studies in academia that have utilized the same constructs that are featured in this empirical investigation. This contribution differentiates itself from previous theoretical underpinnings as it evaluates the students' perceptions about the functionality and interactivity aspects of synchronous learning technologies. These constructs were frequently overlooked from technology adoption research. This academic gap is even more pronounced in the education technology literature. In sum, this research implies that these factors as well as their access to adequate facilitating conditions, are significantly affecting the students' intentions to use synchronous technologies to improve their learning experiences.

2 LITERATURE REVIEW

Web designers are expected to create and develop high quality online domains that are functional and appealing for their users. The design of the website or of a mobile application (apps) is an important dimension of electronic

service quality [6,10]. The structure, layout and organization of the content that is featured online can capture the individuals' attention. Alternatively, they may lure users away from them and to engage with other apps [11].

Many authors argue that the functionality of various technologies is defined by the ease with which users engage with them, with minimal efforts [12]. A technical functionality construct is intended to measure the instrumental utility, technical capability and efficiency of websites or mobile apps. Individuals are more likely to browse websites that are easy to use, in a seamless manner, without any difficulties, disruptions and faults [13]. They should be able to access and to navigate through their content, to find all the information they need through personal computers, laptops, netbooks, tablets and smartphones, as quickly and smoothly as possible.

Mobile users should find it simple and straightforward to access and to find their way through websites including conferencing programs. They should be in a position to maneuver effortlessly and quickly, back and forth, through these synchronous technologies, as they want to use them to communicate and to listen to others, without any delay.

The technical functionality of websites and mobile apps is one of the most important factors that can have a significant effect on the users' intentions to continue availing from them in the future [12,13]. Previous research that is focused on wireless devices indicated that the functionality of mobile technologies such as their battery life, display, speed, and functions were affecting the individuals' perceptions and intentions to use them [14].

Other researchers noted that the tablets' functionality features, with their innovative touch screens and intuitive interfaces, provide good support to search for information, to read documents, to enjoy different forms of media like listening to music and podcasts [15], and to utilize video conferencing apps that enable two or more individuals to interact in real time through a virtual environment [16]. A few commentators reported that the synchronous technologies' functionality features can have a positive influence on the individuals' intentions to continue using them [17]. This leads to the following hypothesis:

H1: The technical functionality features of video conferencing technologies significantly affect the individuals' intentions to use them.

In the past few years, a number of researchers contended that there is scope for educators to use interactive learning technologies to encourage their students to actively participate and to engage with their course instructors (and with their peers) when they attend to their virtual classes [18]. This argumentation is synonymous with social constructivism and active-based learning [16, 19]. Such learning approaches differentiate themselves from teacher-centered methodologies, where the students play a passive, receptive role [20].

The video conferencing programs' synchronous processes allow their users to engage in two-way communications in real time [5, 21]. Similarly, the voice over internet protocol (VOIP), text chat, live chat, digital games, among others, facilitate reciprocal, responsive and simultaneous exchanges of information among online users [22-27]. However, individuals may hold different perceptions toward such interactive media.

Many researchers sought to explore two-way interactions among online users [28]. They strived in their endeavors to identify the key attributes of computer mediated communications by using different constructs including perceived behavioral control, perceived responsiveness, connectedness, perceived personalization, real time interactions, personalization and playfulness, among others [29, 30].

The perceived interactivity of technologies has a significant impact on the individuals' acceptance and use of certain technologies [31], as interactive media can facilitate online conversations amongst them [32]. Hence

the interactivity features of video conferencing software can have a significant effect on the students' intentions to use them to improve their learning outcomes. Hence, this research explores the following hypothesis:

H2: The individuals' perceptions about the interactivity attributes of video conferencing technologies significantly affect their intentions to use them.

The individuals' engagement with interactive technologies can be affected by certain factors like their access to affordable resources, equipment and software (e.g. powerful personal computers / laptops, high speed internet connections through broadband and WiFi, among others) [33]. Alternatively, they may necessitate intangible aspects (like the provision of ongoing training and development opportunities to use learning management systems, continuous online and offline support, et cetera) [34].

The delivery of ongoing courses and continuous development programs could encourage more students to use educational technologies [35]. Today's students would surely benefit from the latest computer infrastructures, ubiquitous devices like tablets and smart phones, as well as from a seamless internet connectivity on campus and at home, to join course instructors and their peers in virtual lectures [36, 37]. In addition, the technical assistance from a help desk can have a positive effect on the students' perceptions and attitudes towards certain technologies like WebCT [38].

These facilitating conditions could impact on the students' readiness to use the video conferencing programs [8, 9]. This UTAUT/UTAUT2 construct measures the research participants' perceptions on physical environmental features (e.g. infrastructures and equipment) and intangible aspects (like training and development, or the provision of ongoing support and assistance to technology users, among others) [34]. Certain facilitating conditions significantly affect the individuals' intentions as well as their actual engagement dispositions with interactive or synchronous technologies [8]. Similarly, many researchers reported that facilitating conditions were influencing the students' intentions to use education technologies [39]. Thus, the researchers hypothesize that:

H3: The facilitating conditions significantly affect the individuals' intentions to use video conferencing technologies.

3 METHODOLOGY

3.1 The measures

This study's survey items were drawn from reliable and valid measures as they were tried and tested in academia. They were used in previous studies that sought to explore the individuals' engagement with technology. The questionnaire featured 11 questions that comprised socio-demographic variables including age, gender and experience with the use of video conferencing technologies. The measuring items that were used in this study are featured in Table 1.

The respondents could complete the questionnaire within a few minutes. The responses to the survey questions were coded through a 5-point Likert scale, where 1 represented 'strongly disagree' and 5 strongly agree, whilst 3 signaled a neutral position.

Table 1: The survey questionnaire's constructs and their corresponding items

Construct	Source	Definition	Items
Functionality	Electronic Service Quality [6, 12, 13].	This construct refers to the individuals' perceptions about the design and technical capabilities of information technologies, in terms of their instrumental utility, efficiency and ease of use.	Funct1: The video conferencing technologies are organized and work well. Funct2: It is quick and easy to use the video conferencing technologies.
Perceived interactivity	Perceived interactivity [7]	Perceived interactivity is defined as web-based, two-way communications among persons, in real time.	PI1: Video conferencing technologies enable two-way communications. PI2: Video conferencing technologies facilitate virtual conversations with other individuals.
Facilitating conditions	Unified theory of acceptance and use of technology [8, 9].	Facilitating conditions is defined as the degree to which individuals believe that they can avail themselves of technical resources, knowledge and support from others (to use technologies).	FC1: I have the resources I need to use the video conferencing technologies. FC2: I can ask for support from a helpdesk if I encounter difficulties in using video conferencing technologies.
Intentions to use the technology	Unified theory of acceptance and use of technology [8, 9].	Intention is defined as a measure of strength of one's intention to perform a specific behavior.	I1: Most probably, I shall continue using video conferencing technologies in the future. I2: It is very likely that I will use video conferencing technologies at university.

3.2 The sample

The respondents were registered students in a Southern European university. A cover letter comprising a link to this study's survey questionnaire was disseminated via email to more than 11,000 students. The recipients of this email were following full time, part time and distance learning courses. They were informed about the objectives of this empirical investigation and were given guidelines on how to complete the questionnaire.

After a week, there were 117 responses to this survey. The returned questionnaires were carefully examined and crosschecked to determine if they had incomplete responses. There were four questionnaires that were not included in the analysis as they had missing values. Hence, the research sample of this study consisted of 113 valid responses. The frequency table reported that there were seventy-one females ($n=71$) and forty-two males ($n=42$) who took part in this study. The respondents were classified into five age groups (18-23; 24-29; 30-35; 36-41 and over 42 years of age). Most of the research participants were between 18 and 23 years of age ($n=82$), followed by those between 24 and 29 years of age ($n=11$). The majority of respondents ($n=107$) revealed that they have been using remote technologies, including asynchronous LMS as well as video conferencing technologies, during COVID-19.

4. RESULTS

4.1 The descriptive statistics

This study examined the mean (M) scores and the standard deviations (SD) through SmartPLS 3.3.3 statistical software. Generally, the respondents agreed with the survey's statements as there were high mean scores above the midpoint (3). Whilst F2 reported the lowest mean score (M=4.021), the highest mean scores were registered for PI1 (M=4.331), I1 (M=4.312) and F1 (M=4.156). There were small variances in the participants' responses. The values of the standard deviation (SD) varied from 0.8 (for F2) to 1.09 (for PI1), as featured in Table 2.

Table 2. An assessment of the composite reliability, convergent validity and discriminant validity

Construct	Items	Outer Loadings	Mean	SD	CR	AVE	1	2	3	4
1 Facilitating conditions	FC1	0.735	4.135	0.82	0.75	0.607	0.779	0.268	0.871	0.605
	FC2	0.9	4.075	0.89						
2 Functionality	F1	0.96	4.156	0.88	0.864	0.762	0.13	0.873	0.648	0.193
	F2	0.777	4.021	0.8						
3 Intentions to use the technology	I1	0.871	4.312	0.78	0.866	0.764	0.524	0.515	0.874	0.778
	I2	0.877	4.048	0.83						
4 Perceived Interactivity	PI1	0.748	4.331	1.09	0.775	0.633	0.236	0.023	0.425	0.796
	PI2	0.841	4.042	0.99						

The square root of the average variance extracted (AVE) (in bold) for each construct was greater than the correlation of the other constructs, in the same column, as per Fornell-Larcker criterion [40]. The results from the Heterotrait Monotrait Ratio (HTMT) are presented on the right-hand side of the AVE.

4.2 Confirmatory composite analysis

This study relied on the SmartPLS' confirmatory composite analysis (CCA) to assess this research model [42]. The PLS algorithm shed light on the results from the outer loadings, composite reliability, average variance extracted (AVE) and discriminant validity values. Table 3 indicates that the composite reliability values were between 0.75 and 0.866. It also confirmed that the values for AVE were higher than 0.6. There was evidence of discriminant validity as the square root value of AVE was greater than the correlation values among the latent variables [40]. This study also examined heterotrait-monotrait (HTMT) ratio of the correlations, thus it re-confirmed the presence of discriminant validity as HTMT values were lower than 0.9 threshold [41].

4.3 Structural model assessment and an interpretation of the findings

The assessment criteria involved an examination of the collinearity among the constructs. The results indicated that there were no collinearity issues as the variance inflation factors (VIFs) were lower than the recommended threshold of 3.3 (Hair et al., 2020). The results reported that R^2 was 0.577. Evidently, the constructs that were used in this study predicted 57.7% of the participants' intentions to continue using the conferencing

technologies. The functionality construct had the highest effect on the participants' intentions to use the technology, where $f^2=0.487$. There were other effects between facilitating conditions-intentions ($f^2=0.332$) and perceived interactivity-intentions ($f^2=0.233$). A bootstrapping procedure was used to explore the statistical significance and relevance of this research model's path coefficients. Table 3 reveals the results of the hypotheses of this study. It sheds light on the direct effects among the constructs. It features the standardized beta coefficients (original sample and sample means), standard deviation, t-statistics and the significance values (p).

Table 3. Testing of the Hypotheses

Path	Coefficient	Original Sample	Sample Mean	Standard Deviation	T-Statistics	p	Decision
H1	Functionality -> Intentions to use the technology	0.458	0.452	0.063	7.244	0.000	Supported.
H2	Perceived interactivity -> Intentions to use the technology	0.323	0.319	0.061	5.332	0.000	Supported.
H3	Facilitating conditions -> Intentions to use the technology	0.389	0.391	0.067	5.793	0.000	Supported.

Note: Critical values are $t > 1.96$; $p < 0.001$ for H1-H3.

H1: This study reported that functionality was a precursor of intentions to use the technology ($\beta = 0.458$, $t = 7.244$, $p < 0.001$). This was the strongest antecedent in this research model. H2: The findings indicated that perceived interactivity was significantly affecting the students' intentions ($\beta = 0.323$, $t = 5.332$, $p < 0.001$). H3: These results also confirmed that the university's facilitating conditions were a significant antecedent of their intentions, as well ($\beta = 0.389$, $t = 5.793$, $p < 0.001$). Figure 1 depicts the explanatory power of this research model. It illustrates the total effects, outer loadings and the coefficient of determination (R^2).

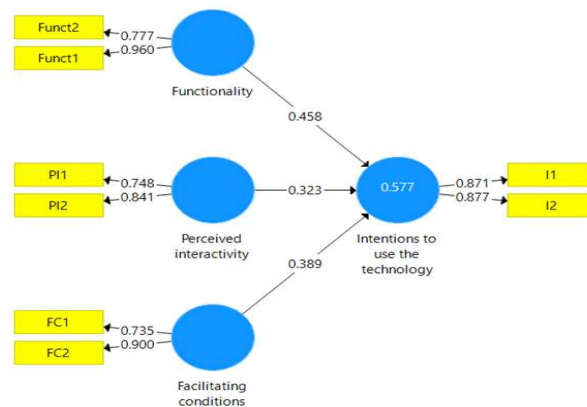


Figure 1. The graphical illustration of the results from SmartPLS algorithm

5. CONCLUSIONS

COVID-19 has had an impact on the delivery of higher educational services. It has disrupted the education of millions of students in different contexts. However, on a positive note, it has opened a window of opportunity for

higher education stakeholders. This unexpected pandemic and its preventative measures have triggered HEIs (and their course instructors) to use new teaching methodologies involving synchronous, interactive communications to continue delivering their curricula and educational programs. Their sudden and unprecedented closure has led them to experiment with virtual education technologies and to engage with their students in real time, through video conferencing software.

This study has included an electronic service quality (eSERVQUAL) dimension, namely 'functionality' [6, 12, 13] and integrated it with two UTAUT constructs, including facilitating conditions and behavioral intentions [8, 9], as well with perceived interactivity [7]. It sought to investigate the effects of facilitating conditions and of having functional, interactive (conferencing) technologies on the university students' intentions to continue using them, to achieve their learning outcomes.

Prior research has never incorporated the same measures that were used in this empirical investigation. This contribution suggests that educators ought to monitor their students' engagement during their virtual sessions. It revealed that the students' perceived interactivity as well as their HEIs' facilitating conditions were having an effect on their intentions to use them. These digital technologies were supporting the research participants in their learning journeys, whether they were at home or on campus.

In sum, this study indicated that the functionality construct has a highly significant effect on the individuals' intentions to utilize conferencing technologies in higher education. It confirmed that university students are evaluating the ease of use, design, instrumental utility and technical capabilities of these synchronous technologies [12, 13] to continue their learning journeys. The findings reported that the students valued their interactive attributes. These factors have led them to embrace these synchronous technologies during their learning journey [5, 16]. This study also confirmed that the universities' facilitating conditions had a significant effect on their intentions to use these technologies.

Although, the number of respondents was relatively low when compared to the targeted research participants, the results confirmed that the measures that were used in this study were reliable and valid. The findings indicated that the three formulated hypotheses were supported. There were highly significant effects that predicted the students' intentions to continue using video conferencing software. Therefore, this contribution puts forward plausible research avenues to academia.

It is hoped that prospective research could validate this study's measures in other contexts to determine the effects of facilitating conditions as well as of the interactivity features and of the functionality aspects on the acceptance and usage of synchronous technologies.

Future studies may consider using these constructs to examine the individuals' perceptions and/or attitudes toward augmented reality (AR), virtual reality (VR) and Metaverse technologies in the educational context. Other methodologies and sampling frames could be employed to capture and analyze primary data in higher education or in other settings. For instance, inductive studies can explore the consumers' in-depth opinions and beliefs on this topic. Interpretative research may shed light on important insights on how to improve the efficacy and the usefulness of these interactive technologies in a post-COVID scenario.

Arguably, the integration of education technologies in higher education may be accelerated in the foreseeable future as the utilization of remote communications could add value to traditional teaching methodologies in a post COVID-19 era. Therefore, HEIs ought to invest in online learning infrastructures, resources and facilitating conditions, for the benefit of their students and faculty employees.

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