Kasetsart Journal of Social Sciences 45 (2024) 483–492

Kasetsart Journal of Social Sciences

journal homepage: http://kjss.kasetsart.org

Students' acceptance toward Asynchronous Virtual Education during COVID-19 pandemic

Mónica Elva Vaca-Cárdenas[a,*], Ermenson Ricardo Ordonez-Avila[b,†], Leticia Azucena Vaca-Cárdenas[b,†], Antoni Neptalí Vaca-Cárdenas[c,†]

[a] *Departamento de Pedagogía de los Idiomas Nacionales y Extranjeros, Facultad de Filosofía, Letras y Ciencias de la Educación, Universidad Técnica de Manabí, Portoviejo, Manabí 130103, Ecuador*

[b] *Departamento de Sistemas Computacionales, Facultad de Ciencias Informáticas, Universidad Técnica de Manabí, Portoviejo, Manabí 130103, Ecuador*

[c] *Carrera de Comunicación, Facultad de Ciencias Políticas y Administrativas, Universidad Nacional de Chimborazo, Portoviejo, Manabí 060110, Ecuador*

Article Info

Article history:
Received 26 May 2023
Revised 8 August 2023
Accepted 4 September 2023
Available online 22 April 2024

Keywords:
acceptance,
COVID-19,
higher education,
TAM,
virtual education

Abstract

Because of the global pandemic, governments around the world suspended many activities, including education. This unexpected situation made many educational institutions switch from face-to-face classes to a Virtual Education modality; neither teachers nor students were prepared. Therefore, the main goal of this research was to measure the students' acceptance toward Asynchronous Virtual Education during COVID-19 pandemic at a public university. This study had a quantitative approach where 1,358 university students participated voluntarily. The technique for data collection was a survey, and the instrument was a questionnaire elaborated through google forms by the researchers. Confirmatory Factor Analysis was used to elaborate and choose the best model of the Asynchronous Virtual Education Acceptance Scale for Students (AVEASS). Main results showed that the use of Asynchronous Virtual Education had a negative acceptance of students with 51 percent. Even though students had previous experience working in virtual environments, the majority of them did not find the use of Asynchronous Virtual Education fun or interesting. Thus, it is concluded that the Asynchronous Virtual Education was not accepted by more than a half of the population of students. Therefore, it is recommended that university authorities provide more training to professors and students about the best ways of using Asynchronous Virtual Education in a more active and fun way as possible.

* Corresponding author.
E-mail address: monica.vaca@utm.edu.ec (M. E. Vaca-Cárdenas).
† Co-first authors.
E-mail address: ermenson.ordonez@utm.edu.ec (E. R. Ordonez-Avila).
E-mail address: leticia.vaca@utm.edu.ec (L. A. Vaca-Cárdenas).
E-mail address: neptali.vaca@unach.edu.ec (A. N. Vaca-Cárdenas).

https://doi.org/10.34044/j.kjss.2024.45.2.14
2452–3151/© 2024 Kasetsart University.

Introduction

Because of COVID-19, governments around the world suspended many activities including education; so, people started a period of home confinement known as "lockdown" (World Health Organization [WHO], 2020). The crisis due to COVID-19 pandemic had a hard impact on students, teachers and the whole population, which can be summarized in three main aspects (Naciones, 2021): (1) interruption of education, (2) difficulties for those who were just entering the labor market or for those who were looking for a job at the beginning of 2020, and (3) loss of jobs, reduction of salaries or degradation of the working conditions of those who were working. The unemployment rate reached 23 percent on average representing approximately 7 million of young people (Naciones, 2021).

The general goal for the world was to combat the spread of the COVID-19 pandemic from March 16th, 2020. This decision switched face-to-face classes to distance classes in all levels. In this particular context, the higher education sector switched too in order to ensure pedagogical continuity of teaching (Nisrine & Abdelwahed, 2021). According to UNESCO, three main fields of action arose in the region: the deployment of distance learning modalities through the use of a variety of formats and platforms (with or without the use of technology), the support and mobilization of the educational staff and communities, and the attention to the health and integral well-being of the students (CEPAL-UNESCO, 2020; Messina & García, 2020).

However, during this time, the learning outcomes were not the expected ones due to inequalities in access to information and communication media. The pandemic period was unpredictable and increased the educational gap (Chetty et al., 2018). Contradictorily, the lockdown, instead of creating similar conditions, fostered inequality. The digital gap increased between specific geographical areas, considered in developing countries, and population in advanced countries. Specifically, students of public universities of Ecuador faced many obstacles like lack of connectivity and technological resources to continue with their education. The Universidad Técnica de Manabí (UTM) in Ecuador, adopted the Asynchronous Virtual Education modality supported by the Moodle LMS (Learning Management System). Therefore, the main goal of this research was to measure the Students' acceptance toward Asynchronous Virtual Education during COVID-19 pandemic at the UTM University.

Considering the sudden change of modality and the different problematics that our country, university and students faced, it was necessary to conduct this study to have a general understanding of the acceptance of the asynchronous modality by our students. Thus, with the results of this study, the authorities and the educative community can make better decisions, take action, and apply better strategies to improve the teaching and learning process.

Literature Review

Changes in Education

There is no doubt that the pandemic accelerated the digitization and connectivism process and broke some deeply rooted practices in the educational system. Overnight, there was a shift from face-to-face education—in which everyone learns at the same time and in the same place—to an education in which learning can take place at any time and in any place. The role of the teaching staff was modified; students had to learn more autonomously with the support of technology, and good training. This had potentially become a much more flexible and independent education (Estrada Araoz et al., 2020; Méndez Landa, 2021).

Online learning industry revenues have grown by more than 90 percent since 2000. The interest in online education has seen a rapid increase in recent years; moreover, the pandemic has given it a stronger boost. The increase in demand for online education also causes greater demand for high-quality courses and well-established processes for content instruction and the creation of virtual classrooms (Colman, 2021).

Quickly during COVID-19 lockdown, distance education (DE) became the best alternative to confront the emergency. Such means that students are not always physically present, and it can be both synchronous and asynchronous modalities. In this context, the IT adoption and usage by users becomes a critical prerequisite (Farooq et al., 2021; Sukendro et al., 2020).

Teachers play a key role in the effective integration of technology for teaching and learning. Even though it may appear that technology integration is part of a teacher's job requirements, the reality is very different. With the growing advance of technologies, there is greater pressure on teachers to engage varied types of applications or tools in conceptualizing, preparing, and delivering lessons. In addition, with the greater expectations from their digital natives' students, teachers may feel that engaging technology in classes could be a hard option to exercise (Teo, 2014).

Virtual Education

Nominated as online education (Jogezai et al., 2021). Web learning is a vital component of e-learning and distance learning, aiming to improve students' knowledge and learning quality. The personalization opportunity, said by Davis, is an essential dimension of e-learning (Davis, 1985, 1989).

Technology Acceptance Model (TAM)

The models that predict the use of a certain technology are clearly useful. The Technology Acceptance Model (TAM) developed by Davis (1985) is widely recognized as a valuable tool for representing the factors that influence users' adoption and usage decisions in various IT environments. Indeed, TAM has proven to be a validated model capable of collecting a large portion of the variation in users' behavioral intentions about IT adoption and usage in a range of scenarios (Farooq et al., 2021).

It is an effective and highly proven model in predicting the use of information and communication technologies. The Technology Acceptance Model (TAM) was used at the beginning to predict the use of ICT, based on two main characteristics: Perceived Usefulness and Perceived Ease of Use (Davis, 1985, 1989). Although the TAM model helps to know if a technology is going to be used optimally, it is also necessary to identify the external variables that affect it as the causes of directly influencing the usefulness and ease of use perceived by ICT users, as well as to determine the relationship between these variables and the result of their use (Jatmikowati et al., 2021; Sukendro et al., 2020).

Many studies about technology acceptance have been published in recent years considering the pandemic situation, some of them are listed in Table 1.

Methodology

This research has a quantitative approach since quantitative data collection methods were applied.

Participants

The participants in this study were 1,358 university students at the Universidad Técnica de Manabí (UTM, by its acronym in Spanish), who agreed to collaborate voluntarily with this study; where, 851 students, which

Table 1 Some research about technology acceptance

Reference #	Title	Study aim
Jatmikowati et al. (2021)	Technology Acceptance Model in using E-learning on Early Childhood Teacher Education Program's student during pandemic.	This study aimed to examine the determinant factors of behavioral intention of using e-learning associated with the Technology Acceptance Model (TAM) for early childhood teacher education students.
Pal and Vanijja (2020)	Perceived usability evaluation of Microsoft Teams as an online learning platform during COVID-19 using system usability scale and technology acceptance model in India.	Microsoft Teams is used as the reference platform for which the perceived usability is evaluated.
Meirovitz et al. (2022)	English as a foreign language teachers' perception regarding their pedagogical-technological knowledge and its implementation in distance learning during COVID-19	This study investigates whether teachers of English as a Foreign Language (EFL) are confident that they have the requisite knowledge of how particular technologies are used for remote teaching, both during COVID-19 and as they look to the future
Méndez Landa (2021)	The hybridization of synchronous and asynchronous classes in online university education: A strategy for a better use of time	A Mexican analysis of the synchronous and asynchronous classes.
Dalipi et al. (2022)	Going digital as a result of COVID-19: Insights from students' and teachers' impressions in a Swedish university.	It is a case study about students' and teachers' impressions and experiences regarding the changes that have happened due to pandemic conditions in university courses in informatics at a Swedish university.
Delgado and Larrú (2022)	DEIFDC framework: Evaluation of digital education deployment in India in the midst of the COVID-19 pandemic.	Despite significant Government efforts on scaling up Digital Education, primarily due to the COVID- 19 pandemic school closure, the 0.596 DEIFDC score has shown Inadequate Digital Education Deployment, derived mainly from poor school infrastructure, limited pedagogical capabilities and modest students' skills.

corresponds to 62.7 percent, were female; while 507 were male, corresponding to 37.3 percent. Their ages ranged between 17 and 57 years old. The SD was 5.52, the average age was 24, and the average number of years studying at the university was 3.5. The majority of students were 21 years old as it is determined in the mode. Finally, all the students, at the moment of conducting the research, were studying under an Asynchronous Virtual Education at the UTM because of COVID-19.

Technique and Instrument

The technique for data collection was a survey, and the instrument for data collection was a structured questionnaire elaborated through google forms. This instrument was composed out of thirty-one items divided into two sections. The first section included the participants' demographic information (age, years of study, campus, modality, previous use of virtual education, training, platforms, tools, and activities in virtual education). Finally, the second section was formed by Likert scale type questions.

For measuring the students' acceptance toward Asynchronous Virtual Education during COVID-19 pandemic at the UTM, a measurement instrument was created adapted from the TAMPST (Technology Acceptance Measure for Preservice Teachers) (Jatmikowati et al., 2021; Ligorio et al., 2020; Sukendro et al., 2020; Teo, 2010). This instrument is called: Asynchronous Virtual Education Acceptance Scale for Students (AVEASS). The Likert Scale questions of the AVEASS instrument included the following statements (see Table 2):

Procedure

The survey was sent via institutional mail to UTM students for estimating a non-probability random sample. Participation was voluntary, therefore, students who participated in this research signed an informed consent virtually included in the form.

The AVEASS measured students' acceptance of Asynchronous Virtual Education during the COVID-19 pandemic period. Asynchronous Virtual Education Acceptance was measured taking into account seven factors:

1. Perceived Usefulness (PU), which was composed of three questions.
2. Perceived Ease of Use (PEU), which was composed of three questions.
3. Subjective Norm (SN), which was composed of two questions.
4. Facilitating Conditions (FC), which was composed of three questions.
5. Attitude Toward Computer Use (ATCU), which was composed of four questions.
6. Future Intentions (FI), which was composed of four questions.

The questions were measured on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree).

Table 2 Likert Scale questions of AVEASS instrument

Question #	Description
Q 12	The use of Asynchronous Virtual Education has improved my learning.
Q 13	The use of Asynchronous Virtual Education makes the study be more interesting.
Q 14	I interact with the tools for Asynchronous Virtual Education in a simple and easy way.
Q 15	I am excited about those aspects of my studies that require the use of Asynchronous Virtual Education.
Q 16	When I need help with Asynchronous Virtual Education, there are specialized instructions and resources available to help me.
Q 17	Working with Asynchronous Virtual Education is fun.
Q 18	It is easy for me to make sure that the tools I use for Asynchronous Virtual Education meet my goals.
Q 19	In the future I will use some Asynchronous Virtual Education tools.
Q 20	Using Asynchronous Virtual Education has increased my learning productivity and effectiveness.
Q 21	Asynchronous Virtual Education is easy for me.
Q 22	When I need to use Asynchronous Virtual Education, the (UTM) personnel is available to help me.
Q 23	I would strongly recommend professors to integrate Virtual Education with face-to-face education.
Q 24	Asynchronous Virtual Education requires more dedication time to my studies.
Q 25	I like to use Asynchronous Virtual Education.
Q 26	People who are important to me encourage me to use Asynchronous Virtual Education.
Q 27	When I need help for Asynchronous Virtual Education, I always have available help from teachers, colleagues, or friends.
Q 28	I consider that Asynchronous Virtual Education is a useful modality for my studies.

Data Analysis

The ordinal questions were analyzed by using the Confirmatory Factor Analysis (CFA) technique, to categorize homogeneous groups of variables from the factors related to the acceptance of the asynchronous modality (Fernández Aráuz, 2015). For this purpose, the maximum likelihood estimation method and a correlation matrix were used (Gutiérrez Doña, 2008), by using the LISREL 8.8 software (Jöreskog & Sörbom, 2007). In addition, SPSS software was used to pre-process data and for descriptive statistics. Due to there being multiple selection questions, the number of repetitions was calculated for the analysis. Finally, Cronbach's alpha was also applied to assess reliability (Pekrun et al., 2011).

Results and Discussion

Demographic Results

The descriptive analysis showed a major participation of women with 62.7 percent; while, the participation of men was 37.3 percent; meaning that 6 out of 10 students were women. Most students were studying at the main campus located in Portoviejo city, that is, 1,259 students, which corresponds to 92.7 percent. In contrast, only 45 students, which represents 3.4 percent, studied at the Lodana branch campus, 31 students, or 2.3 percent, at Sucre branch campus, and 22 students, or 1.6 percent, at Chone branch campus. This means that 9 out of 10 participant students were studying at the Portoviejo campus.

Students belong to 11 colleges and 35 Departments. They reported having studied at the UTM from 1 to 7 years; however, 74.3 percent are in the range of 1 to 4 years of study. These results can be explained because 1,288 students, representing 94.8 percent, study undergraduate programs, and 70 students, corresponding to 5.2 percent, study graduate programs.

Regarding the students' experiences in virtual education before the change due to the pandemic, only 524 students (38.6%) indicated not having worked in virtual education while the majority, 834 students (61.4%), reported previous virtual education experience. This means that six out of ten students have had experience working in virtual education before the pandemic. This was an advantage. Different results showed that many teachers and students had little to no experience with online learning prior to this change (Conrad et al., 2022).

In relation to the modality in which students were studying before the activation of Asynchronous Virtual Education, 608 students reported face-to-face modality, at 44.8 percent, while 353 students (26.0%) stated that they were inserted in a hybrid modality: face-to-face and virtual learning. Additionally, 112 (8.2%) of students reported synchronous experience, and 135 students (9.9%) asynchronous modality. Finally, 150 students (11%) reported experience with both modalities. Thus, more than half of the students participated in some kind of virtual experience.

As for training in virtual environments before the activation of asynchronous virtual education, the majority of students did not have formal training; this is 618 students, which corresponds to 45 percent, while 740 students representing 55 percent had formal training. Regarding the kind of training students did, 283 (20.8%) indicated having received training promoted by the institution to which they belonged, while 41 students (3%) indicated having received training organized by another institution. Besides, 443 students 273 (20.2%) indicated that they had carried out only personal self-training. Finally, 149 students (11%) reported self-training plus training promoted by the Institution. These results revealed that half of the students did not receive formal training on asynchronous virtual education. The pandemic forced educational institutions to move quickly and did not leave time to adapt content that was pedagogically effective in face-to-face learning to online mode (Conrad et al., 2022).

For the questions about the platform students used at the asynchronous virtual education, students could choose different options; therefore, the most repeated answers were counted. Results showed that 1,303 students, which corresponds to 95.9 percent, reported the use of the UTM Moodle platform. Additionally, in a descendent order, 286 students (21.1%) reported the use of Google Classroom, 211 students (15.5%) the use of Canvas, 147 students (10.8%) the use of Microsoft Teams, and in smaller quantities the use of EDMODO Platform. This means that almost every student used the UTM Moodle Platform for Asynchronous Virtual Education during the pandemic. According to Gonzalez et al. (2017), in the educational field, different platforms and proposals are being implemented by educational institutions for virtual education or e-Learning.

As for the tools employed by their professors for the academic activities in the asynchronous virtual education, multiple options were also selected. Among them, the WhatsApp application was the most popular tool, where 1,164 students (85.7%) reported its use. In descending

order, 1,152 students (84.8%) reported the use of video conferencing tools, 962 (70.8%) the use of email, and in minimal proportions, the use of social networks and google suite applications, meaning nine out of ten students interacted with their professors through the WhatsApp application for academic activities.

Asynchronous Virtual Education Acceptance Scale for Students (AVEASS)

Confirmatory Factor Analysis (CFA)

The ordinal variables from question 12 to question 28 were analyzed using Confirmatory Factor Analysis (CFA). Model A excluded questions 24 and 26 from the subjective Norm factor (SN) because they did not share a common causal factor (Fernández Aráuz, 2015). Model B was the second proposal, where in addition to excluding the SN variables, question 19 and 23 from the future intentions factor (FI) were also eliminated under the suggestions for model adjustments proposed by LISREL. Finally, Model C was accepted.

This model did not include the questions of the SN and FI factors. Table 3 presents the preliminary results of the CFA for model C, where the factors and their observed variables, the standardized and non-standardized estimation parameters, the value of t and the coefficient of determination of the X (R2) were observed.

In model C, 80 percent, 85 percent, and 75 percent of the variance in questions 12, 20 and 28 were explained by the latent factor PU. With similar representation, 69 percent of the variance contained in questions 14, 18 and 21, respectively, were explained by the latent factor PEU. Likewise, the levels of variance explained in the CF factor were low, with 73, 75, and 61 percent for the variables: Q16, Q22, and Q27 respectively.

However, the latent factor ATCU explained the variability of data with better proportions, with values of 82 percent, 81 percent, 83 percent, and 81 percent respectively for the observable variables Q13, Q15, Q17, and Q25. Thus, there were representative correlation values between the latent variables. Table 4 presents the results of the correlation matrix between the latent factors or variables.

Table 4 Correlation matrix of independent variables from Model C

Factor	PU	PEU	FC	ATCU
PU	1.00			
PEU	0.89	1.00		
FC	0.79	0.84	1.00	
ATCU	1.00	0.86	0.76	1.00

The asymmetry and kurtosis values, the Mean (*M*), the Standard Error of the Mean (*SEM*), and the Standard Deviation (*SD*) of the observed variables were used to analyze the univariate normality. The mean values were between 4.7 and 5.8, and the standard deviation values were between 1.3 and 1.8. These results reflect a positive participation of the respondents, and a greater confidence in the results. Table 5 shows the descriptive statistics for each observed variable.

Table 3 Confirmatory factor analysis results Model C

Factor / Question	Unstandardized estimate	Standardized solution	*t*-value	R2
PU				
Q12	1.76	0.89	42.27	0.80
Q20	1.88	0.92	44.57	0.85
Q28	1.87	0.86	39.91	0.75
PEU				
Q14	1.52	0.83	36.50	0.69
Q18	1.52	0.83	36.62	0.69
Q21	1.65	0.83	36.59	0.69
FC				
Q16	1.59	0.85	37.80	0.73
Q22	1.65	0.86	38.54	0.75
Q27	1.38	0.78	33.11	0.61
ATCU				
Q13	1.86	0.91	43.36	0.82
Q15	1.82	0.90	42.66	0.81
Q17	1.92	0.91	43.60	0.83
Q25	1.99	0.90	42.83	0.81

Table 5 Descriptive statistics of the observed variables

Question #	*M*	*SEM*	*SD*
Q12	3.94	0.053	1.963
Q13	3.75	0.055	2.043
Q14	4.88	0.05	1.828
Q15	4.12	0.055	2.019
Q16	4.7	0.051	1.868
Q17	3.56	0.057	2.106
Q18	4.54	0.05	1.83
Q20	3.96	0.055	2.033
Q21	4.6	0.054	1.984
Q22	4.4	0.052	1.909
Q25	3.79	0.06	2.201
Q27	5.02	0.048	1.77
Q28	4.41	0.059	2.166

Note: Mean (*M*), Standard Error of the mean (*SEM*) and Standard Deviation (*SD*).

Table 6 Results comparison of models A, B and C

Index	A	B	C
χ^2	1105.98	1250.36	782.63
p-value	.00000	.00000	.000
df	80	94	59
(χ^2/*df*)	13.82	13.30	13.26
RMSEA	0.097	0.095	0.095
SRMR	0.027	0.033	0.024
GFI	0.90	0.90	0.92
CFI	0.99	0.98	0.99
TLI	0.98	0.98	0.98
NFI	0.98	0.98	0.99
AGFI	0.85	0.85	0.87
AIC	1185.98	1334.36	846.63

The value of the multivariate normality test was 117.93 in multivariate asymmetry, and 529.68 in kurtosis, by using the Mardia test (Mardia, 1970). These results showed that data do not follow a normal distribution, with *p*-value indices of .000 of kurtosis and .000 of multivariate skewness coefficients. Therefore, the null hypothesis was rejected, and the alternative hypothesis was accepted, since the data do not approximate a normal distribution.

The correlation matrix as data entry, and the maximum likelihood estimation method (Maximum-Likelihood) ML were used for the ordinal variables. As well, the Chi-square statistic was used as the goodness of fit index. However, because the chi-square statistic χ^2 is sensitive to the size of the sample and to the violation of the assumption of multivariate normality (Pérez-Gil et al., 2000); different goodness of fit indexes was used to correct this issue χ^2/gl. The indexes were: relative chi-square, goodness of fit index (GFI), adjusted goodness of fit index (AGFI), normed fit index (NFI), comparative fit index (CFI), relative fit index (RFI), standardized root mean squared residual (SRMR), and root mean square error of approximation (RMSEA). These measures are governed by criteria of validity and reliability.

In addition, the chi-square was applied. The models produced a p-value of .000 for each one; therefore, they were significant. Table 6 shows the results of the model's fit indicators, through a comparison between A, B and C models, where model C got the best results. The RMSEA revealed a ratio of 0.10, determined with a moderate measure between 0.05 and 0.10. Moreover, the SRMR was below 0.08, which is suitable (Table 6).

The Adjusted Goodness of Fit Index AGFI was also applied, which is the GFI adjusted to the number of freedom degrees, where both should oscillate between 0 and +1. The ideal value is close to +1, which is a good adjustment indicator (Gutiérrez Doña, 2008). Model C indicated an index closer to 1 for each measure, with a value of 0.87 and 0.92 respectively, according to global parameters. Therefore, model C was established as the most reasonable model (Figure 1).

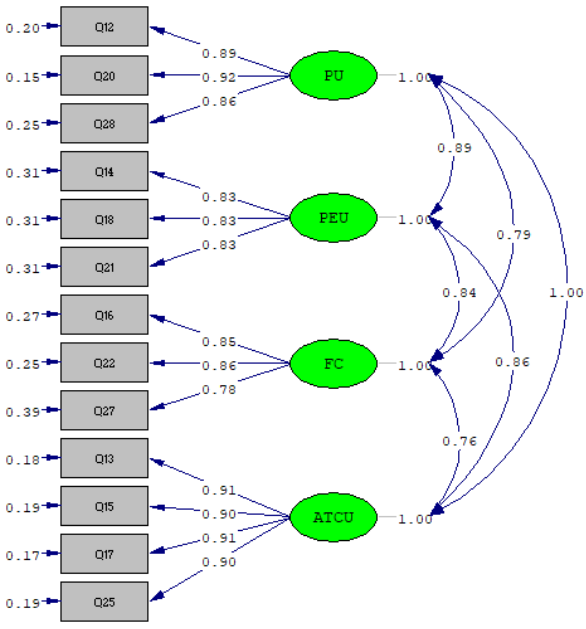

Figure 1 Standardized solution of model C

In the analysis, model C best fits the data, and high factor loadings were observed in each factor, mostly with correlation coefficients greater than .8. A distinction was made among the results of the CFA. Strong correlations, for those that had a coefficient greater than or equal to .85, in descending order, significant correlations with coefficients between .70 and .84, and moderate correlations for those that had less than .70. Each of the factors had high factor loadings and at the same time, each observed variable had strong correlation coefficients (Figure 1).

Acceptance levels of Asynchronous Virtual Education

Results showed that only 668 students, corresponding to 49 percent of students, had a positive acceptance of the Asynchronous Virtual Education modality, while 690 students, representing 51 percent, had a negative acceptance of it. This reveals a negative acceptance from more than a half of the students (Table 7).

Table 7 Acceptance levels of asynchronous virtual education

Question #	Count		Percentage	
	Positive	Negative	Positive	Negative
Q 12	570	788	42	58
Q 13	521	837	38	62
Q 14	826	532	61	39
Q 15	624	734	46	54
Q 16	773	585	57	43
Q 17	485	873	36	64
Q 18	726	632	53	47
Q 20	585	773	43	57
Q 21	773	585	57	43
Q 22	675	683	50	50
Q 25	558	800	41	59
Q 27	858	500	63	37
Q 28	705	653	52	48
	Mean	Mean	Mean	Mean
	668	690	49	51

The highest percentage of positive acceptance was question 27 with 63 percent, followed by question 14 with 61 percent. This means that six out of ten students stated that when they needed help for Asynchronous Virtual Education, they always had available help from teachers, colleagues, or friends. Additionally, six out of ten students interacted with the tools for Asynchronous Virtual Education in a simple and easy way. This could be explained because the majority of students reported previous experience working in a virtual education environment and did some kind of formal training and self-training during the pandemic. Society has changed as a result of new technologies and in the same way education has changed too. As a result, Connectivism, the new learning theory for the digital age, has played an important role (Vaca-Cardenas et al., 2020a).

On the other hand, the highest negative acceptance percentages were question 17, followed by questions 13, and 25. In question 17,873 students, representing 64 percent, did not think that working with Asynchronous Virtual Education was fun. In question 13, 837 students, representing 62 percent, did not believe that the use of Asynchronous Virtual Education made the study be more interesting. Finally, 800 students, representing 59 percent, did not like to use Asynchronous Virtual Education. Therefore, six out of ten students had a negative acceptance of Asynchronous Virtual Education.

It was recognized that the emergency forced a quick change in the education system, and the adoption of virtual education became the best alternative to confront the emergency. The decision of the university to choose an asynchronous modality was based on the inequalities that our students faced at the time in accessing internet connection or having an electronic device. Additionally, the fact that the university already had a platform and a virtual classroom for each subject was a great strength in times of a pandemic. However, even though all the students had already used the platform before the pandemic, and more than a half of the students had had formal training, the majority of them did not accept the asynchronous virtual education. Most of the students did not like to use Asynchronous Virtual Education, they did not think it was fun or interesting, and they felt alone. Therefore, they desired to have direct contact with the professor. Even though students belong to a digital age, and they enjoy using technology in class, they still prefer to also have the presence of professors and not only an asynchronous environment. Thus, teachers play an important role for the success of the teaching and learning process in any modality.

Previous literature showed that students in online learning were stressed and felt the distance as they were unable to get involved in their studies (Sim et al., 2020). The feeling of being alone in an Asynchronous Virtual Education modality was also a consequence for the results of this study. Students perceived that Asynchronous Virtual Education was not fun or interesting; therefore, it is assumed that teachers need to make the process more attractive for students, so they do not feel alone. In a digital age, it is important to create better learning environments to improve education and get a better

and more practical citizen lifestyle (Vaca-Cárdenas et al., 2020b). The web is full of resources and tools that should be used by teachers and students in online environments.

Conclusion and Recommendation

It is concluded that model C was selected as the best model, since it reasonably fits the data and meets the acceptable, permissible and reasonable criteria as stipulated measures of validity and reliability. The chi-square p-value was significant for this data set; furthermore, the evaluation of each adjustment indicator established it as an acceptable model.

Even though students had had some experience working in virtual education before the pandemic, they needed formal training on asynchronous virtual education.

The most popular application for interacting in academic activities was WhatsApp.

More than a half of the students had a negative acceptance of Asynchronous Virtual Education, mainly because they do not think that working with Asynchronous Virtual Education is fun and interesting.

Therefore, it is recommended that university authorities provide more training to professors and students about best ways of using Asynchronous Virtual Education in a more active and fun way as possible. It is also recommended that teachers with their didactic expertise make Asynchronous Virtual Education more attractive for students, so they don't feel distant and alone, by using interesting tools and activities in their virtual classes.

Future research will be a qualitative study to explore deeply students' problems and perspectives about Asynchronous Virtual Education.

Conflict of Interest

The authors declare that there is no conflict of interest.

References

CEPAL-UNESCO. (2020). La educación en tiempos de la pandemia COVID-19 [Education in times of pandemic COVID-19]. *Comisión Económica para América Latina y el Caribe (CEPAL) y la Oficina Regional de Educación para América Latina y el Caribe de la Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura*, *11*, 11–18. https://repositorio.cepal.org/server/api/core/bitstreams/c29b3843-bd8f-4796-8c6d-5fcb9c139449/content [in Spanish]

Chetty, R., Friedman, J. N., Hendren, N., Jones, M. R., Porter, S. R., Hall, R., & Hendren Harvard, N. (2018). *The opportunity atlas: Mapping the childhood roots of social mobility*. https://www.opportunityatlas.orgtract-leveldataisavailableat

Colman, H. (2021). *La pandemia por COVID-19 cambió la industria de la educación* [The COVID-19 pandemic changed the education industry]. Observatorio, Instituto para el Futuro de la Educación. https://observatorio.tec.mx/edu-bits-blog/la-pandemia-cambio-la-industria-de-la-educacion-para-siempre [in Spanish]

Conrad, C., Deng, Q., Caron, I., Shkurska, O., Skerrett, P., & Sundararajan, B. (2022). How student perceptions about online learning difficulty influenced their satisfaction during Canada's COVID-19 response. *British Journal of Educational Technology*, *53*(3), 534–557. https://doi.org/10.1111/BJET.13206

Dalipi, F., Jokela, P., Kastrati, Z., Kurti, A., & Elm, P. (2022). Going digital as a result of COVID-19: Insights from students' and teachers' impressions in a Swedish university. *International Journal of Educational Research Open*, *3*, 100136. https://doi.org/10.1016/J.IJEDRO.2022.100136

Davis, F. D. (1985). *A technology acceptance model for empirically testing new end-user information systems: Theory and results*. Massachusetts Institute of Technology. (MIT). http://hdl.handle.net/1721.1/15192

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly: Management Information Systems*, *13*(3), 319–339. https://doi.org/10.2307/249008

Delgado, A. V., & Larrú J. M. (2022). DEIFDC framework: Evaluation of digital education deployment in India in the midst of the COVID-19 pandemic. *Social Sciences & Humanities Open*, 100281. https://doi.org/10.1016/J.SSAHO.2022.100281

Estrada Araoz, E. G., Gallegos Ramos, N. A., Mamani Uchasara, H. J., & Huaypar Loayza, K. H. (2020). Actitud de los estudiantes universitarios frente a la educación virtual en tiempos de la pandemia de COVID-19 [Attitude of university students towards virtual education during the COVID-19 pandemic]. *Revista Brasileira de Educação Do Campo*, 1–19. https://doi.org/10.20873/uft.rbec.e10237 [in Spanish]

Farooq, S., Ahmad, Z., Hassan, N., & Sarfraz, K. M. (2021). Technology acceptance model for E-learning during COVID-19: Empirical insight from Pakistan. *Ilkogretim Online-Elementary Education Online, Year*, *20*(4), 975–984. https://doi.org/10.17051/ilkonline.2021.04.105

Fernández Aráuz, A. (2015). Aplicación del análisis factorial confirmatorio a un modelo de medición del rendimiento académico en lectura [Application of confirmatory factor analysis to a model for measuring academic achievement in reading]. *Revista de Ciencias Económicas*, *33*(2), 39. https://doi.org/10.15517/rce.v33i2.22216 [in Spanish]

Gonzalez. V. H., Amparo Villota, E. J., & Medina Agredo, P. (2017). Strategies used by Professors through virtual educational platforms in face-to-face classes: A view from the Chamilo platform. *English Language Teaching*, *10*(8), 1–10. https://doi.org/10.5539/elt.v10n8p1

Gutiérrez Doña, B. (2008). Modelos Lineales Estructurales: Conceptos básicos, aplicaiones y programación con Lisrel [Structural Linear Models: Basic concepts, applications and programming with Lisrel]. *Serie Cuadernos Metodológicos*, *2*, 89. https://iip.ucr.ac.cr/sites/default/files/contenido/cuamet2.pdf [in Spanish]

Jatmikowati, T. E., Rachman, A. U., & Adwitiya, A. B. (2021). Technology acceptance model in using E-learning on early childhood teacher education program's student during pandemic. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *5*(2), 1501–1511. https://doi.org/10.31004/obsesi.v5i2.801

Jogezai, N. A., Baloch, F. A., Jaffar, M., Shah, T., Khilji, G. K., & Bashir, S. (2021). Teachers' attitudes towards social media (SM) use in online learning amid the COVID-19 pandemic: The effects of SM use by teachers and religious scholars during physical distancing. *Heliyon*, *7*(4), 1–9. https://doi.org/10.1016/j.heliyon.2021.e06781

Jöreskog, K. G., & Sörbom, D. (2007). *LISREL 8.80.* Scientific Software International. Inc. https://ssicentral.com/index.php/products/lisrel/

Ligorio, M. B., Cacciamani, S., & Cesareni, D. (2020). L'accettazione della didattica a distanza: Una ricerca nel contesto universitario [The acceptance of distance education: A research in the university context]. In M. Beatrice Ligorio (Eds.), *Quaderni di Qwerty* (pp. 91–102). https://www.ckbg.org/wp-content/uploads/2022/01/Didattica-Universitaria.-Tra-emergenza-e-futuro.pdf

Mardia, K. V. (1970). Measures of multivariate skewness and kurtosis with applications. *Biometrika*, *57*(3), 519–530. https://doi.org/10.1093/biomet/57.3.519

Meirovitz, T., Russak, S., & Zur, A. (2022). English as a foreign language teachers' perceptions regarding their pedagogical-technological knowledge and its implementation in distance learning during COVID-19. *Heliyon*, *8*(4), e09175. https://doi.org/10.1016/j.heliyon.2022.e09175

Méndez Landa, F. J. (2021). La hibridación de clases sincrónicas y asincrónicas en la educación universitaria online: Una estrategia para un mejor aprovechamiento del tiempo [Hybridization of synchronous and asynchronous classes in online university education: A strategy for better time utilization]. *Medios Digitales y Metodologías Docentes: Mejorar La Educación Desde Un Abordaje Integral* (pp. 74–82) Agaya Press. https://www.adayapress.com/wp-content/uploads/2021/06/medidoc8.pdf [in Spanish]

Messina, D., & García, L. (2020). *Estudio diagnóstico sobre docentes en América Latina y el Caribe* [Diagnostic study on teachers in Latin America and the Caribbean]. Documento de Trabajo. Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura (UNESCO). [in Spanish]

Naciones, U. (2021). *Estudio Económico de América Latina y el Caribe 2021* [Economic Survey of Latin America and the Caribbean 2021]. https://+www.cepal.org/apps [in Spanish]

Nisrine, S., & Abdelwahed, N. (2021). Distance education in the context of the COVID-19 pandemic case of the Faculty of Sciences Ben M'Sick. *Procedia Computer Science*, *198*, 441–447. https://doi.org/10.1016/J.PROCS.2021.12.267

Pal, D., & Vanijja, V. (2020). *Perceived usability evaluation of Microsoft Teams as an online learning platform during COVID-19 using system usability scale and technology acceptance model in India*. https://doi.org/10.1016/j.childyouth.2020.105535

Pekrun, R., Goetz, T., Frenzel, A. C., & Barchfeld, P. (2011). Measuring emotions in students' learning and performance. *Contemporary Educational Psychology*, *36*(1), 36–48.

Pérez-Gil, J. A., Chacón Moscoso, S., & Moreno Rodríguez, R. (2000). Validez de constructo: El uso de análisis factorial exploratorio-confirmatorio para obtener evidencias de validez [The use of exploratory-confirmatory factor analysis to obtain valid evidence]. *Psicothema*, *12*(SUPPL. 2), 442–446. https://reunido.uniovi.es/index.php/PST/article/view/7727/7591 [in Spanish]

Sim, S. P. L., Sim, H. P. K., & Quah, C. S. (2020). Online learning: A post COVID-19 alternative pedagogy for university students. *Asian Journal of University Education*, *16*(4), 137–151. https://doi.org/10.24191/ajue.v16i4.11963

Sukendro, S., Habibi, A., Khaeruddin, K., Indrayana, B., Syahruddin, S., Makadada, F. A., & Hakim, H. (2020). Using an extended Technology Acceptance Model to understand students' use of e-learning during COVID-19: Indonesian sport science education context. *Heliyon*, *6*(11), e05410. https://doi.org/10.1016/J.HELIYON.2020.E05410

Teo, T. (2010). Validation of the technology acceptance measure for pre-service teachers (TAMPST) on a Malaysian sample: A cross-cultural study. *Multicultural Education & Technology Journal*, *4*(3), 163–172. https://doi.org/10.1108/17504971011075165

Teo, T. (2014). Unpacking teachers' acceptance of technology: Tests of measurement invariance and latent mean differences. *Computers and Education*, *75*, 127–135. https://doi.org/10.1016/j.compedu.2014.01.014

Vaca-Cardenas, M. E., Meza, J., Estrada, A., & Vaca-Cardenas, L. A. (2020a). Connectivism as a driver to improve citizen learning in cognitive cities: A literature review. *The IAFOR International Conference on Education – Hawaii 2020 Official Conference Proceedings*, 1–16. https://doi.org/10.22492/issn.2189-1036.2020.1

Vaca-Cárdenas, M. E., Ordoñez Ávila, E. R., Vaca-Cárdenas, L. A., Vargas Estrada, A., & Vaca-Cárdenas, A. N. (2020b). Connectivism as a potential factor to advertise housing let or sale. A multiple case study applied in ecuadorian cities. *Information Technology, Education and Society*, *17*(2), 5–21. https://doi.org/10.7459/ites/17.2.02

World Health Organization [WHO]. (2020). *WHO coronavirus (COVID-19) dashboard with vaccination data*. https://covid19.who.int/