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Asynchronous Virtual Education Acceptance of University Faculty During Covid-19

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Abstract

Due to COVID-19, education has been blocked out on a global scale. Most countries around the world stopped educational activities and moved to virtual education. Even though most teachers and students were not prepared, they had to execute this unexpected change. Therefore, the purpose of this research was to measure the Asynchronous Virtual Education Acceptance of university faculty during the COVID-19 pandemic period. An Asynchronous Virtual Education Acceptance Scale for Faculty was designed and validated, which is an adapted version of the TAMPST (Technology Acceptance Measure for Preservice Teachers) questionnaire. A sample of 222 faculty of a public university in the coastal region of Ecuador responded to 28 technology items. The main results showed 75 percent of Faculty acceptance toward Asynchronous Virtual Education with strong correlations between the questions and their factors. It is concluded that training and previous use of the Virtual Platform helped to achieve this acceptance.

Keywords: *Covid-19; University Faculty; Asynchronous Virtual Education; ICT; University faculty.*

Introduction

On 30th January 2020, the World Health Organization (WHO) announced a state of international emergency due to the spread of the new Coronavirus, also known as SARS-CoV-2. In March 2020, the WHO declared a global pandemic and most governments suspended many work activities, including attendance at educational institutions, and citizens have begun a period of home confinement known as 'lockdown' (World Health Organization, 2020). Since the end of the Second World War, this is the first time that education has been blocked out on a global scale.

The lockdown followed the path of the virus, which geographically ran from East to West, so that, in succession, around the world schools and universities were closed. Most of the countries that joined the lockdown also stopped educational activities and moved to distance learning or mixed learning (synchronous and asynchronous). In this context, the learning results were not homogeneous due to inequalities in access to information and communication media. The digital gap was configured as a cultural division in both specific geographical areas, considered peripheral, and in population groups in advanced countries (Chetty et al., 2018). Paradoxically, the current closure, instead of putting everyone on an equal foundation, was a further disparity between learners who have been deprived of the right to study for years due to conflicts, humanitarian and health crises, and their peers, who are only now being kept away from educational facilities (Mónica Elva Vaca-Cárdenas, Ordonez-Avila, Vaca-Cárdenas, & Vaca-Cárdenas, 2024).

On the other hand, the efforts governments make to purchase digital devices also represent an opportunity (Kumar & Kumara, 2018; Lavery et al., 2018). This pandemic was an unprecedented circumstance, making educational communities more vulnerable, especially if a concrete commitment to protecting training and education is lacking. The pandemic emergency has increased the educational gap, which is also based on differences due to socio-technological gaps. A large part of the measures that the countries of the region

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have adopted to face the crisis was related to the suspension of face-to-face classes at all levels, which has given rise to three main fields of action: 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).

Most teachers and students around the world, who moved from a face-to-face modality to a virtual (synchronous and asynchronous) learning were not prepared; however, they had to execute this unexpected change (Khan et al., 2019; 2020). This university decided to adopt an Asynchronous Virtual Education during the pandemic. However, any technological innovation introduced in an educational context has to be accepted both by educators and students. Academic authorities can better implement institutional strategic plans and make decisions if they better understand faculty perceptions about teaching online. Therefore, the purpose of this research was to measure the Asynchronous Virtual Education Acceptance of university faculty during the COVID-19 pandemic period. For this purpose, an Asynchronous Virtual Education Acceptance Scale for Faculty (AVEASF) was designed and validated. This instrument is an adapted version of the TAMPST (Technology Acceptance Measure for Preservice Teachers) questionnaire (Teo, 2008).

Literature Review

Impact of COVID-19 Pandemic on Higher Education

The COVID-19 pandemic abruptly and profoundly changed the traditional way in which universities organized and offered their courses. In this exceptional emergency, the professor's educational approach is critical for the academic success of all students, which can positively affect student performance and outcomes. Many problems affecting professors in approaching the technological platform for Distance Education (DE) arise inside educational institutions. This also brings a big question of how universities can be intrinsically inclusive (CEPAL-UNESCO, 2020; Messina & García, 2020).

In the past, face-to-face teaching and mixed or upside-down classrooms were used or supplemented by educators. With the pandemic emergency, around the world, most institutions adopted face-to-face classroom teaching with social distancing or blended learning with a limited number of students on the campus or online education. Suddenly, Virtual or Distance Education became the best alternative to confront the emergency in such situations.

Virtual Education is an education in which students are not always physically present, and it can be both synchronous and asynchronous modalities. In this framework, the importance of the adoption and usage of Information Technology (IT) become critical prerequisites for educational success. Various theoretical perspectives have been advanced to address this issue, such as the Technology Acceptance Model.

Technology Acceptance Model and Higher Education

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. The theory on which TAM is based states that the intention to adopt technology is a good predictor of its actual usage. Users' intentions to adopt an IT are explained by two essential criteria: the perceived ease of use and the perceived usefulness. TAM was developed to predict users' intention to adopt new technology and explain and forecast future user behaviour based on collecting user preferences after a brief interaction with technology.

Davis (1989) & Davis, Al-Suqri, and Al-Aufi (1989) developed a revised Technology Acceptance Model (TAM)) questionnaire, to explore factors that may impact university teachers' acceptance of Distance Education (DE). This study, involving a representative sample of Ecuador faculty members, collected data

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to verify the reliability of the Technology Acceptance Model (TAM). As well, Teo (2008) elaborated a questionnaire, which is an adapted version of the TAMPST (Technology Acceptance Measure for Preservice Teachers) instrument, to verify the direct effects of all constructs on which the tool is based on V.E. Table 1 presents a summary of different case studies done on regards to TAM model.

Table 1. TAM case studies.

Study	Application
Azhar and Rani (2020)	A TAM model was proposed by including the e-learning elements and the readiness factor as external variables.
Pal and Vanijja (2020)	TAM and System Usability Scale were used to evaluate the perceived usability of the online learning platforms focusing on the digital-divide aspect that the COVID-19 scenario globally forced.
Sukendro et al. (2020)	TAM was used to explore factors predicting the use of e-learning Covid-19 pandemic among sports science education students in Indonesia.
Aguilera-Hermida (2020)	How college students' perceptions affect the adoption, use, and acceptance of emergency online learning.
Baber (2021)	TAM analyzed the attitude, competency, and interaction of the instructor, student motivation, mindset and collaboration, and the intention of students to use e-learning in the future.
Farooq, Ahmad, Hassan, and Sarfraz Khan (2021)	The authors investigated students' behavior and attitudes toward online education during the pandemic to identify the factors that can increase online education acceptance.
Ibrahim et al. (2021)	Medical students' acceptance and perceptions of the benefits, enablers, and barriers to e-learning during the Covid-19 were examined at the King Abdulaziz University.
Jatmikowati, Rachman, and Adwitiya (2021)	AM tool has been used to collect data on how early childhood teacher education students perceive e-learning.
Lazim, Ismail, and Tazilah (2021)	TAM analyzed the components that influence online learning for undergraduate accounting students at the University Tunku Abdul Rahman.
Yu et al. (2021)	This study provides insight into preschool teachers' technology acceptance and how to improve their willingness to employ educational technology in the future.
Mukminin et al. (2022)	TAM was used to understand which factors can affect Social Media Use in Teaching Foreign Languages during COVID-19.

Materials and Methods

Research Context and Sample

Two hundred and twenty-two university professors (faculty) who have an appointment at a public university in the coastal region of Ecuador participated in this study. To get a random sample of participants, the survey was sent via institutional mail to all faculty, where 222 of them agreed to collaborate with this study. This is a representative sample of the total faculty population (22.2%). Participation in this study was voluntary and no reward of any kind was given. Participants were informed on the purpose of the research and about their participation rights in the survey; so, they gave implicit consent to take part in this research.

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Of the 222 faculty, 102 (5,90%) were female, and 120 (54.1) percent were male. Their ages ranged between 27 and 78 years old. The SD was 10,35, the average age was 48, and the average of years of experience as teachers was 15 (see Figure 1). All participants were at that moment applying an Asynchronous Virtual Learning at the university because of the Covid-19 pandemic.

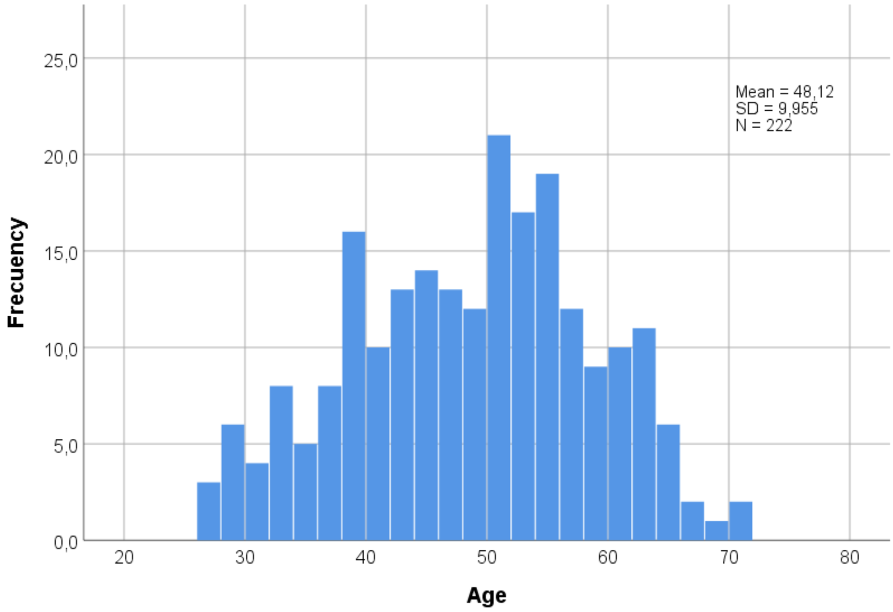

Figure 1. Frequency of faculty' ages

Instrument

An Asynchronous Virtual Education Acceptance Scale for Faculty (AVEASF) was designed and validated. This instrument was adapted from the TAMPST (Technology Acceptance Measure for Preservice Teachers) questionnaire (Chetty et al., 2018; Kumar & Kumara, 2018; Lavery et al., 2018; Lazim et al., 2021; Ligorio, Cacciamani, & Cesareni, 2020; Mardia, 1970; Messina & García, 2020). A back-translation technique and adaptations were applied to the questionnaire generation stage to ensure that all the items were related to the context reality and could be understood by the potential participants.

The survey was designed in Google Forms for data collection. This instrument was composed of thirty-one items divided into two sections. The first section was dedicated to participants' demographic background (age, gender, location), teaching experience, and training in virtual environments. And the second section was formed by Likert scale type of questions, by applying the Asynchronous Virtual Education Acceptance Scale for Faculty (AVEASF)

AVEASF Likert Scale Questions

- Q12. The use of Asynchronous Virtual Education has improved my work.
- Q13. The use of Asynchronous Virtual Education makes my work more interesting.
- Q14. I interact with the tools for Asynchronous Virtual Education in a simple and clear way.
- Q15. I am excited about those aspects of my work that require the use of Asynchronous Virtual Education.
- Q16. When I need help with Asynchronous Virtual Education, there are specialized instructions and resources available to help me.

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- Q17. Working with Asynchronous Virtual Education is fun.
- Q18. It is easy for me to make the tools I use for Asynchronous Virtual Education meet my goals.
- Q19. In the future, I will use some Asynchronous Virtual Education tools.
- Q20. Using Asynchronous Virtual Education has increased my productivity and effectiveness.
- Q21. Asynchronous Virtual Education is easy for me.
- Q22. When I need to use Asynchronous Virtual Education, there are specific personnel available to help me.
- Q23. I would strongly recommend to other colleagues the integration of Virtual Education with face-to-face education.
- Q24. Asynchronous Virtual Education requires more dedication time to my work?
- Q25. I like to use Asynchronous Virtual Education.
- Q26. People who are important to me support me to use Asynchronous Virtual Education.
- Q27. When I need help for Asynchronous Virtual Education, I always have available help, whether they are teachers, colleagues, or friends.
- Q28. I find that Asynchronous Virtual Education has been a useful modality for my work.

AVEASF measured the Asynchronous Virtual Learning Acceptance of Faculty during the COVID-19 pandemic period, taking into account four factors: 1. Perceived Usefulness (PU), composed of three questions. 2. Perceived Ease of Use (PEU), composed of three items. 3. Subjective Norm (SN), composed of two items. 4. Facilitating Conditions (FC), composed of three items. 5. Attitude Toward Computer Use (ATCU), composed of four items. And, 6. Future Intentions (FI), composed of four items. Each item was measured over a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree).

Data Analysis

For data analysis, the LISREL 8.80 software (Mukminin et al., 2022) was used to test latent and observable variables from the configuration of structural equations through Confirmatory Factor Analysis (CFA) with the method of estimation of Maximum Likelihood and a correlation matrix as data enter (Gutiérrez-Doña, 2008). Additionally, SPSS software was applied to pre-process the data and for descriptive statistics. Finally, Cronbach's alpha was also applied to assess reliability (Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011). The ordinal questions were analysed through the Confirmatory Factor Analysis (CFA) to reduce the data and identify homogeneous groups of variables in factors proposed conceptually (Fernández Aráuz, 2015).

Results and Discussion

Demographic Information

A descriptive analysis of the data was carried out through the analysis of frequencies in nominal and polytonic variables, from a socio-demographic context. A participation of 46 percent of women and 54 percent of men was observed (See Figure 2).

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Regarding the campus where the faculty work, results showed that 89 percent of professors were working at the main campus. Smaller quantities of faculty were working at the branch campuses (Figure 2). Faculty belonged to 11 colleges and 23 Departments. Finally, 81 percent of faculty were working in undergraduate programs (Figure 2).

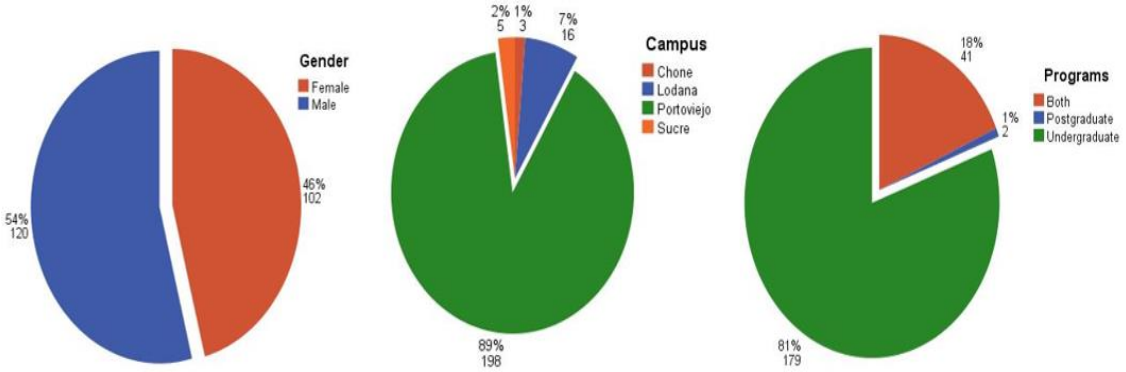

Figure 2. Gender, Campuses, and Study Programs.

Experience in Virtual Learning

Regarding faculty' experiences in virtual learning before the blockade; 53.6 percent of faculty indicated not having worked in virtual education, in contrast to 46.6 percent reported experience working in virtual education. Regarding the modality in which the faculty worked before the activation of Asynchronous Virtual Education, the majority of them reported previous experiences in face-to-face study modality (75.2%), 19.8% a hybrid modality, synchronous, asynchronous, or both (5%).

Training

Results showed that 93.7 percent of faculty received training related to virtual environments before and during the activation of asynchronous virtual education, while 6.3 percent stated the opposite. Eighty-seven percent indicated having received training promoted by the university, training organized by another institution (44%), personal self-training (49%). Only 6 percent of faculty indicated that they had not carried out any training.

Virtual Platforms and Tools

The use of content management platforms used by faculty for asynchronous virtual learning was also analysed. In this regard, 222 (100%) of faculty, reported the use of the university Moodle platform. In respective order, 28 percent used also Google Classroom, Microsoft Teams (10%), and in smaller percentages a variety of Platforms such as Edmodo, Canva, Educaxia, Classcraft, Exelearning, Classdojo, Kahoot, Jamboard, and Padlet. As well, faculty reported several tools employed as support for the development of their academic activities at the asynchronous virtual education. Among them, WhatsApp application (91%), video conferencing tools (88%), email (63%), and in minimal proportions, social networks and Google Suite applications.

Confirmatory Factor Analysis

Table 2 shows the Likert Scale questions considered for CFA analysis. A first iteration was carried out, in which all the variables observed from questions Q12 to Q28 were included. These 17 variables resulted in a non-convergent model because the matrix was not positive. Model A was presented, where questions 24 and 26, grouped in the subjective Norm factor (SN), were excluded from the tests due to the absence of a relationship between them and because they did not share a common causal factor (Fernández Aráuz, 2015).

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Model B was presented, where recommendations of model A were applied. This model suggested to eliminate Q19 and Q23 grouped in the future intentions factor (FI), under the suggestions for model adjustments proposed by LISREL. Finally, model C presented the best results. In this model, the questions of the SN and FI factors were not included.

Table 2 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 t value, and the coefficient of determination of the X (R2) were observed.

Table 2. Model C Confirmatory Factor Analysis (CFA).

Factor / Question	**Unstandardized coefficients**	**Standardized coefficients**	**t-value**	**R^2**
PU				
Q12	1.42	0.84	15.32	0.71
Q20	1.54	0.85	15.62	0.73
Q28	1.26	0.81	14.53	0.66
PEU				
Q14	0.87	0.67	10.63	0.44
Q18	1.23	0.81	13.80	0.66
Q21	1.10	0.69	11.18	0.48
FC				
Q16	1.11	0.76	12.17	0.57
Q22	1.40	0.81	13.19	0.65
Q27	1.11	0.77	12.34	0.59
ATCU				
Q13	1.52	0.85	15.70	0.73
Q15	1.47	0.88	16.63	0.78
Q17	1.47	0.83	15.01	0.69
Q25	1.58	0.88	16.34	0.77

The t value was calculated by dividing the value of the parameter by its standard error. For a parameter to be significant, the value of the t must be outside the range $-1.96 <= t <= 1.96$. In other words, for a parameter to be meaningful, the value of t must be greater than or equal to the absolute value of 1.96. Meanwhile, the coefficient of determination of the X (R2) is set between 0.00 and 1.00 and it serves as an indicator of the variance explained by the latent factors. In this sense, about model C, 71 percent, 73 percent, and 66 percent of the variance in the variables Q12, Q20, and Q28 were explained by the latent factor PU.

On the other hand, small representations of 44 percent, 66 percent, and 48 percent of the variance contained in the variables Q14, Q18, and Q21, respectively were explained by the latent factor PEU. Similarly, the levels of variance explained in the CF factor were low, with 57 percent, 66 percent, and 59 percent for the variables Q16, Q22, and Q27 respectively. Meanwhile, the latent factor ATCU explained the variability of the data with greater proportions, with values of 73 percent, 78 percent, 69 percent, and 77 percent respectively for the observable variables Q13, Q15, Q17, and Q25.

Alternatively, there were representative correlation values between the latent variables. Table 3 presents the results of the correlation matrix between the latent factors or variables.

Table 3. Model C Correlation Matrix of Independent Variables.

	PU	PEU	FC	ATCU
PU	1.00			
PEU	0.90	1.00		
FC	0.54	0.65	1.00	
ATCU	0.99	0.90	0.48	1.00

Univariate normality was analysed, using asymmetry and kurtosis values, together with the Mean (M), the Standard Error of the Mean (SEM), and the Standard Deviation (SD) of the observed variables. The mean values were between 4.7 and 5.8, and the standard deviations were between 1.3 and 1.8; reflecting positive participation of the respondents, and greater confidence in the results.

In addition, the multivariate normality test was performed through the Mardia (1970) obtaining a value of 117.93 in multivariate asymmetry, and 529.68 in kurtosis. These results showed that the data do not follow a normal distribution, with p-value indices of 0.000 and 0.000 in both coefficients of kurtosis and multivariate skewness, respectively. Therefore, the null hypothesis was rejected, and the alternative hypothesis was accepted since the data do not approximate a normal distribution.

The observed variables were treated as ordinal; then, the correlation matrix as data entry, and the maximum likelihood estimation method (Maximum-Likelihood) ML was used. For this purpose, the Chi-square statistic was used as the goodness of fit index, although, it is a known the fact that the chi-square statistic $\chi 2$ is sensitive to the size of the sample and to the violation of the assumption of multivariate normality of the observed variables (Pérez-Gil et al., 2000). For this reason, different kinds of goodness of fit indexes were used to correct this issue $\chi 2$ / gl: 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 were governed by criteria of validity and reliability. Table 4 presents the criteria for a sample n: $n < 250$, and several variables m: $12 < m < 30$.

Table 4. Stipulated measures of validity and reliability of the model.

Index	Criteria
$\chi 2$	Significant p-values even with good fit
($\chi 2$/df)	Permissible < 5
RMSEA	Moderate .05 - .10
SRMR	0.08 or less (with CFI 0.95 or higher)
GFI	0.90 or better
CFI or TLI	0.95 or better
NFI	0.95 or better
AGFI	0.90 or better
AIC	The lowest or closest to zero

The size of $\chi 2$ should be as small as possible, and if the $\chi 2$ test (Ho: $\chi = 0$) is accepted, then it is inferred that the model fits exactly the population parameters. The $\chi 2$ test of statistical significance in model C approached zero, which indicates that the differences between the observed and estimated matrices are not statistically significant, and therefore it is the lowest of the coefficients about models A and B. In relatively large samples there is a tendency to identify the chi-square with significance tests of $p < 0.05$ (Gutiérrez-Doña, 2008). Considering that, the values that the evaluated models produced were of a p-value of 0.000 for each one; therefore, they are significant.

Table 5 presents the results of the model's fit indicators, through a comparison between A, B, and C, where model C got the better results. The RMSEA revealed a ratio of 0.10, determined with a moderate measure between 0.05 and 0.10. Besides, the SRMR was allowable, since it was below 0.08.

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Table 5. Comparison of models A, B and C.

Index	A	B	C
χ2	289.75	334.43	222.39
p-value	0.000	0.000	0.000
df	80	94	59
(χ2/df)	3.62	3.55	3.77
RMSEA	0.11	0.11	0.10
SRMR	0.055	0.075	0.056
GFI	0.85	0.84	0.87
CFI	0.97	0.96	0.97
TLI	0.96	0.95	0.96
NFI	0.95	0.95	0.96
AGFI	0.78	0.77	0.79
AIC	369.75	418.43	286.39

Another of the most used indexes is the goodness of fit index GFI and an adjusted variant of it, AGFI. The AGFI is the GFI adjusted to the number of freedom degrees, both should oscillate between 0 and +1 and ideally the values close to +1 are a good adjustment indicator (Gutiérrez-Doña, 2008), in this sense, model C indicates an index closer to 1 for each measure, with a value of 0.79 and 0.87 respectively. The AKAIKE information criterion (AIC) index interprets greater parsimony, at the lowest value in the comparison among models to define the appropriate one, the one that is close to zero. The lower the value, the greater the parsimony of the model. The Akaike information criterion is a measure of the goodness of fit of a statistical model. It can be said that it describes the relationship between bias and variance in the construction of the model, or in a general way about the accuracy and complexity of the model (Gutiérrez-Doña, 2008).

Finally, Figure. 3 presents the standardized solution of model C, which is established as a reasonable model according to the global parameters.

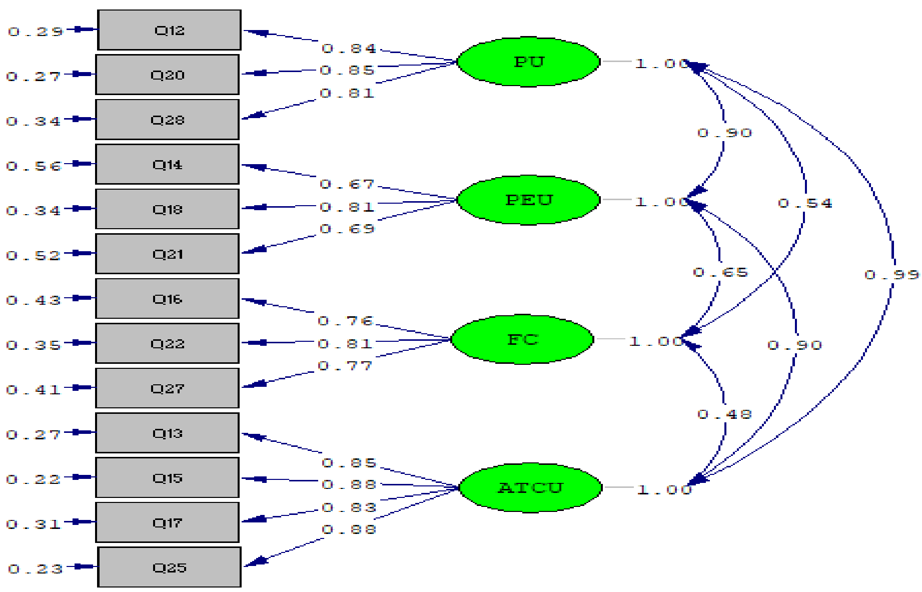

Figure 1. Standardized solution of model C.

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Model C was determined as the model that best fit the data. The validity of AVEASF has been verified by the results of the confirmatory factor analysis. This is consistent with existing research about the instrument from which AVEASF was adapted; which states that TAM is a valid instrument to explain the acceptance of technology by teachers (Teo, 2010b). As well, different researchers have applied extended versions of this instrument to explain technology acceptance (Davis, 1989; Davis et al., 1989; Huang, Sánchez-Prieto, & Teo, 2020; Ligorio et al., 2020; Teo, 2008, 2010a; Teo, 2010b; Teo, 2014; Teo, Lee, & Chai, 2007). Figure 3 shows the existing correlations or factor loadings between the items or observed variables and the latent variables or factors and table 6 shows the questions organized by factors.

High factor loadings were observed in each factor, mostly with correlation coefficients greater than 0.8. A distinction was made among the results of the CFA, with strong correlations on those that had a coefficient greater than or equal to 0.85. In descending order, significant correlations with coefficients between 0.70 and 0.84, and less than 0.70, correspond to moderate correlations.

Table 6 presents data that reveal levels of acceptance of the Asynchronous Virtual Education modality by faculty. In the left column, each of the factors incorporates the cumulative acceptance percentages, obtained from the mean of the item responses defined as "positive". This percentage was calculated from the selected options: 5, 6, and 7 from the Likert scale, which was defined from 1 to 7, where (1) is "Total disagreement", and (7) is "Total agreement". This scale was considered suitable for this research (Sangthong, 2020).

Table 6. Factor loadings in scale acceptance.

Factors	Questions	Factorial loads	Negative scale acceptance percentage (likert: 1, 2, 3, 4)	Positive scale acceptance percentage (likert: 5, 6, 7)
PU (71.7%)	Q12	0.84	35.7	65.3
	Q20	0.85	29.3	70.7
	Q28	0.81	20.8	79.2
PEU (82.1%)	Q14	0.67	12.2	87.8
	Q18	0.81	20.7	79.3
	Q21	0.69	20.7	79.3
FC (82.2%)	Q16	0.76	16.7	83.3
	Q22	0.81	23.9	76.1
	Q27	0.77	12.7	87.3
ATCU (65.3%)	Q13	0.85	37.4	62.6
	Q15	0.88	32.8	67.2
	Q17	0.83	40.5	59.5
	Q25	0.88	27.9	72.1

The options selected in the survey, from 1 to 4 on the Likert scale, were considered negative responses. Point 4 of the scale was included as a negative reference in the responses, based on the criteria of ambiguity, indifference, and irrelevance proposed in Edwards (1946). In addition, this table includes the distribution of the items or observable variables in each factor and a column of factor loadings that represent the correlation between the items and the factors.

Regarding the Perceived Usefulness factor (PU), question (Q)12 showed that for 65.3 percent of faculty, the use of asynchronous virtual education has improved their work. This indicator has a strong factorial load (fl) of 0.84. In Q20, 70.7 percent of faculty reported that using virtual education has increased their productivity and effectiveness, which represents a strong fl of 0.85. Therefore, Q20 is the one that correlates the most with this factor. In Q28, 79.2 percent of faculty informed that asynchronous virtual education has

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been a useful modality for their work (0.81 fl). However, not all teachers and students had real access to the technological devices to perform their roles successfully. Careaga-Butter, Badilla-Quintana, and Fuentes-Henríquez (2020) affirmed that the need to transfer from traditional classrooms to online methods was urgent, and the shift required digital tools and resources to maintain teaching.

Regarding the Perceived Ease of Use factor (PEU), in Q14, 87.8 percent of faculty indicated that they interacted with tools for Asynchronous Virtual Education simply and clearly (0.67 fl). In Q18, 79.3 percent of faculty indicated that it was easy for them to make sure that the tools they use for Asynchronous Virtual Education (0.81 fl). Finally, according to Q21, 79.3 percent of faculty found Asynchronous Virtual Education easy (0.69 fl).

Results revealed that the conditions for using Asynchronous Virtual Education were mostly favourable and promoted collaboration. This is mainly because, Faculty received training provided by the university, where they could find support and resources available on its platform. According to Bojović, Bojović, Vujošević, and Šuh (2020) when it comes to a transition to virtual education, universities should not just assume that faculty can teach efficiently online; but, should instead provide faculty with instructional courses and training.

Regarding the questions about the Facilitating Conditions factor (FC), in Q16, 83.3 percent of faculty indicated that when they needed help with Asynchronous Virtual Education there were instructions and specialized resources available to help them (0.76 fl). Also, in question Q22, 76.1 percent of teachers indicated that when they needed help with Asynchronous Virtual Education, there was specific university staff available to help them (0.81 fl). In Q27, 87.3 percent of teachers revealed that when they needed help with Asynchronous Virtual Education, they could always find available help, whether with teachers, classmates, or friends (0.77 fl). In a digital age, it is important to create better learning environments and a better and more practical citizen lifestyle, searching for efficiency, order, and progress that our society needs (Vaca-Cardenas, Meza, Estrada, & Vaca-Cardenas, 2020b). Hodges, Moore, Lockee, Trust, and Bond (2020) found a different approach. They argue that what institutions have been doing during the confinement was not online education, but merely trying to use certain technologies to overcome the existing social distancing command produced by the pandemic.

Finally, about the Attitude Toward Computer Use (ATCU), Q13 reported that for 62.6 percent of teachers, the use of Asynchronous Virtual Education made the work more interesting (0.85 fl). In Q15, 67.2 percent of teachers were excited about those aspects of their work that required the use of Asynchronous Virtual Education (0.88 fl). Q17 showed that for 59.5 percent of teachers, their work with Asynchronous Virtual Education was fun (0.83 fl). Finally, Q25 showed that 72.1 percent of teachers liked to use Asynchronous Virtual Education (0.88 fl). The Attitude Toward Computer Use (ATCU) factor reached 65 percent. This could be a consequence of the average age of the respondents, which is 48 years old with a maximum of 70 years; considering that younger people have native qualities in the technology use. Even, though this factor collaborates to a lesser extent to the degree of general acceptance of Asynchronous Virtual Education, it still showed positive results. Several studies have pointed out that one of the main factors for faculty satisfaction with online education is flexibility. Faculty appreciated the fact that online education was not bound by time or space and the top motivator was the flexible schedule (Chapman, 2011; Green, Alejandro, Brown, & Green, 2023).

Each of the factors showed high levels of acceptance for this type of modality. The Perceived Usefulness factor (PU) revealed 71.7 percent of acceptance, the Perceived Ease of Use factor (PEU) (82.1%), the Facilitating Conditions factor (FC) (82.2%), and the Attitude Toward Computer Use factor (ATCU) (65.3%). These levels of acceptance were representative individually and as a whole with an average of 75 percent of asynchronous virtual education acceptance. Likewise, each item individually revealed the degree of acceptance in particular. Moreover, Question 14, had the highest percentage of the survey with 87.8 percent.

These results could be a consequence of the education and previous experience reported by the participating teachers, revealing a high degree of training that contributed to the work in this type of study. The training

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promoted by the institution was key to adaptation. The current and frequent interaction with virtual learning platforms of teachers strengthens the attitude towards the use of the computer (ATCU) and is strongly correlated with the perception of ease of use (PEU). Saiyad, Virk, Mahajan, and Singh (2020) stated that Faculty roles and abilities for online learning are different compared to traditional teaching-learning. Faculty need to develop ability in three major areas: technology, pedagogy, and content knowledge. Online learning platforms now offer many opportunities that are being widely used by professors around the world. The range extends from websites, discussion forums, online discussions, and a variety of communication apps. Moreover, we live in a digital age, where Connectivism, the new learning theory for the digital age, plays an important role (Vaca-Cárdenas, Ordoñez Ávila, Vaca-Cárdenas, Vargas Estrada, & Vaca-Cárdenas, 2020a). Connectivism states that people learn from different sources, nodes, in a collective and networking way; where technology is a major part of the process (Vaca-Cardenas et al., 2020b).

Conclusions

Model C presented the best overall results, explaining the variability of the data in a reasonable fit for each construct. This model met the acceptable, permissible and reasonable criteria established as validity and reliability measures. Besides, the p-value was significant for this data set.

It was observed that Facilitating Conditions (FC) with 82.2 percent and the Perceived Ease of Use (PEU) with 82.1 percent were the factors that gave greater support to the acceptance of the Asynchronous Virtual Education modality by Faculty at this university of Ecuador. While, the question with the highest degree of acceptance was Q14 (87.8%), meaning that about 9 out of 10 professors found that their interaction with the tools in the Asynchronous Virtual Education was simple and clear.

The positive responses collectively gave a 75 percent acceptance of the Asynchronous Virtual Education modality. This means that about 8 out of 10 professors accepted the use of Asynchronous Virtual Education at this university of Ecuador. These positive results might be a consequence of the training offered by the university, self-training, and professors' prior knowledge and experience in virtual education. The university already managed a Virtual Platform which even though was not being used by all professors, when the pandemic came, it was an advantage to have it.

Today, investment in digital infrastructure in the scholar system is vital, since most countries have opted for the continuity of the educational process through online modalities. The use of the Internet offers a unique opportunity for bringing the school and educational processes closer to students in confined conditions.

Finally, virtual education now offers many tools, resources, apps, platforms, and many other pedagogical and didactic resources that educators can use in a virtual learning modality and also for complementing face-to-face classes in a blended learning environment.

Future research will be a comparison between students' and faculty acceptance of asynchronous virtual education.

Authors' contributions

All the authors collaborated in the elaboration of the data collection instrument and process. Lorella Gabriele and Leticia Azucena Vaca-Cardenas worked mainly in the Introduction and Literature Review. Mónica Elva Vaca-Cárdenas and Ricardo Ordonez-Avila worked mainly in the methodology, results, discussion, and conclusions. Ricardo Ordonez-Avila worked mainly in the scale selection. Monica wrote, edited, and revised the whole paper in English language.

Author ethical declarations

We confirm that the work has not been published elsewhere in any form or language

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Declaration of interests

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