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**VALIDATION OF POST-  
COVID-19 PANDEMIC  
TEACHING IN  
HIGHER EDUCATION  
THROUGH THE SEEQ  
QUESTIONNAIRE**

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**Abstract:** The COVID-19 pandemic has changed the teaching-learning process at all educational levels, just as it has changed the lives of people around the world. **Introduction:** This research has been carried out with the students of the Information Security subject that is taught in two University Degrees of the University of Extremadura, analyzing the data collected from the 2012-13 academic year to the current 2021-22 academic year. **Objectives:** To analyze if there has been a significant change in the teaching-learning process from the COVID-19 pandemic in higher education in the field of computer and telematics engineering using the validated SEEQ questionnaire. **Methods:** The statistical analysis has been carried out with the SPSS program of the results of the application of the SEEQ questionnaire. To do this, all the data has been divided into two large groups, one called pre-pandemic and the other post-pandemic, which correspond to the 2019-20 academic year as the last year of the pre-pandemic group and the two subsequent ones as the post-pandemic group. **Results:** the statistical analysis of the data leads us to have to use non-parametric tests since the normality requirements of the Kolmogorov-Smirnov and Shapiro-Wilks tests are not met. Consequently, we have applied the Mann-Whitney U, where in all cases the result is to preserve the null hypothesis, which indicates that the changes are not significant. **Conclusions:** The general conclusion of this study determines that although the mean of all the categories of the SEEQ questionnaire continues to increase, this change is not statistically significant. Likewise, it is very important to highlight that the average of all the categories is above half on the Likert scale, moreover, the vast majority is around 4 out of 5 points, a result that is very positive. **Keywords:** COVID-19, universities, SEEQ questionnaire, teacher changes.

## INTRODUCTION

Since the beginning of the pandemic caused by the coronavirus disease (COVID-19) (Maguiña Vargas, Gastelo Acosta, & Tequen Bernilla, 2020), education, like other activities worldwide, is going through a transcendental moment. It is a true fact that the current world has never had an epidemiological situation as complex as this. Higher level studies have been affected by this pandemic as well as secondary education and primary education.

This research compares data that we have been recording since the 2012-13 course of the Information Security subject using the SEEQ validated questionnaire (Matés & Bouzada, 2010). This subject is taught simultaneously in the third year of the Degree in Computer Engineering in Information Technologies (GIITI) and in the fourth year of the Degree in Telematics Engineering (GIT) of the University Center of Mérida of the University of Extremadura. It is a subject with a distribution of 4.5 theoretical credits, 1.5 practical credits and 0.3 follow-up activities, scheduled tutorials or “ECTS” (European Credit Transfer System) tutorials. The latter correspond to 3 face-to-face hours for each working group.

The proportion of credits assigned to the ECTS activity is small, however, it must be noted that this figure only corresponds to face-to-face tutoring sessions. In these sessions, the work proposal is made to the different groups, the follow-up of the activities and the clarification of the doubts that arise during the development. However, in the scope of our experience, this face-to-face time has materialized by developing a group work scheme that contributes to the effective development of the work. Most of the group and individual work is done in a non-face-to-face way.

Very briefly we mention what specific competences are the ones that this subject addresses and that can be consulted in more detail in (Arias Masa, 2021):

- Knowledge of the rules and regulations of telecommunications at the national, European and international levels. (GIT).
- Ability to apply the techniques on which telematic networks, services and applications are based, such as management, signaling and switching systems, routing and routing, security (cryptographic protocols, tunneling, firewalls, charging, authentication and protection mechanisms) of content), traffic engineering (graph theory, queuing theory and teletraffic) charging and reliability and quality of service, both in fixed, mobile, personal, local or long-distance environments, with different bandwidths, including telephony and data. (GIT).
- Ability to understand, apply and manage the guarantee and security of computer systems. (GIITI).

On the other hand, the assigned transversal competences are no less important, thus, for this subject they are:

- Communicate effectively (in expression and comprehension) orally and in writing, knowledge, procedures, results and ideas related to ICT, with special emphasis on the writing of technical documentation.
- Be motivated by quality and continuous improvement, acting with rigor, responsibility and professional ethics.

Additionally, the University of Extremadura carries out, in each academic year, its own quality measurements and opinion surveys of students, managed by the Vice-rectorate for quality through the strategic plan that it has launched ("PlanEstrategicoUEX.pdf, " 2010). The opinion offered by the students of each teacher

is processed and used to prepare a report that is provided to the faculty and managers of the University. However, despite already having an official system such as the one described, this teaching team wants to try to make the evaluation of the subject summative and formative (López Pastor, 2009), the objective is to identify the strengths and weaknesses of the teaching-learning process followed by a teacher, enabling the latter to reflect and make the appropriate decisions, and thus improve those deficiencies detected or insufficient aspects within the actions carried out in the classroom.

## **OBJECTIVES AND HYPOTHESES**

The fundamental objective of this research is to validate whether there has been a significant change in the perception that higher education students have in the teaching-learning process since the COVID-19 pandemic. This study has been carried out based on the data that has been collected in all academic years from 2012 to 2022 with the SEEQ questionnaire passed to the students of the Information Security subject.

## **SEEQ QUESTIONNAIRE**

The SEEQ Questionnaire<sup>1</sup>, created by (MARSH & Roche, 1970) and later updated (Marsh, 1982) allows to analyze the efficiency of teaching using a series of factors, each one of them consists of several items valued on a Likert scale (Maldonado Luna, 2012) of 5 options (strongly disagree, disagree, neither agree nor disagree, agree and strongly agree). Many others have emerged from this questionnaire that have been validated and used to evaluate teaching. Among them we want to mention, for example, the Course Experience Questionnaire (CEQ) initially developed by (Ramsden, 1991) and later

1. students' evaluation of educational quality

revised by (Wilson, Lizzio, & Ramsden, 1997); as well as, we have also analyzed the possible use of the Student Course Experience Questionnaire (SCEQ) of (Ginns, Prosser, & Barrie, 2007). In all of them, the common objective was to allow teachers to have an instrument to analyze and improve their teaching practice (Balam & Shannon, 2010). However, its use has been generalized with the routine incorporation for the accreditation of university teaching staff, as well as in the evaluation of quality systems of university education.

For the choice of the SEEQ questionnaire, we started from the advantages that (Matés & Bouzada, 2010) describe in their communication and that are the following psychometric properties (Marsh, 1984), its wide use in universities around the world and the large number of existing material for the improvement of each of the analyzed variables.

In the adaptation of the SEEQ, 8 categories have been used, as can be seen in Table 1, with a total of 35 questions. In the first seven categories, the Likert scale is used, and in the eighth category, "Overview", open questions are used. The objective is that the students can express themselves openly and contribute those data that they believe are not collected in the preceding questions, the analysis of this last category is not carried out in the work presented here.

Category	Name
C1	Learning
C2	Enthusiasm
C3	Organization
C4	Interaction with the group
C5	Personal attitude
C6	Tests
C7	Bibliography
C8	General view

Table 1. SEEQ Questionnaire Categories.

## APPLICATION OF THE SEEQ QUESTIONNAIRE

The application of the questionnaire has always been carried out anonymously through "Google Forms" (Lorca Montoya, Carrera, & Casanovas Català, 2016), which allows students to answer whenever they want from the moment in which the questionnaire is available, and with the obvious advantage of rapid feedback to the teaching team. The questionnaire is available, through a direct link from the Moodle virtual classroom of the subject, from the moment in which the students have their final grades, in the corresponding minutes, and until approximately two weeks later, with the objective that your thinking about the survey questions be as aseptic as possible.

This questionnaire has been carried out since the 2012-13 academic year, with the basic objective of maintaining a history of evaluation data as a file, but also, and more importantly, to be able to contrast the opinion of the students in each academic year with the previous ones, and thus be able to verify how the methodological changes that have been taking place have been affecting, mainly in relation to ECTS activities, and of which studies have already been published in different forums (Morze, Makhachashvili, & Zhylytsov, 2016). This questionnaire can be taken from the second week of February for this Information Security subject. In (Arias Masa, Espada, Becerra, Vas, & Delgado, 2017) the results of the introduction of the use of Digital Storytelling in ECTS activities were published. In the following courses (2016-17), the questionnaire has continued to be applied and the results of each academic course have been saved.

## METHODOLOGY

The research methodology consisted in the application of a mixed research method. The

objective is to support the strengths of both methods (qualitative and quantitative) trying to make our data as rich as possible. Although qualitative research is not characterized by a statistical analysis, we consider our research mixed, because in order to carry it out, we have carried out a survey to be able to statistically analyze the data. Hence, we consider our research an intermediate between the qualitative and the quantitative (Cedeño Viteri, 2012).

According to (Arias, 2006) the steps of the scientific method in its mechanistic conception contemplate:

1. Identification of the reality under study.
2. Formulation of hypotheses from the theory.
3. Measurement of the phenomenon, with the use of valid and reliable instruments.
4. Data analysis, application of statistical techniques to contrast the formulated hypotheses.
5. Conclusion. Based on the analysis of the data, the formulated hypotheses are approved or rejected.

This is the methodological scheme that we have followed and that we are embodying in this document. Thus the first point is defined at the beginning of the document in the introduction. The second point is reflected in the objective and hypothesis section, which are then contrasted in the results analysis section where the fourth point is reflected. The third point is described in the sections of the SEEQ questionnaire and in the application section of the questionnaire. And finally, the fifth point in the corresponding section of conclusions.

## **ANALYSIS OF RESULTS**

The analysis of results has been done with the program: SPSS<sup>2</sup> (Nie, Bent, & Hull, 1970), which allows an effective analysis of the data with relative ease of use.

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2. *Statistical Package for the Social Sciences.*

In this study, as defined in the general objective, it is evaluated whether there has been a change in the average opinion of students in post-pandemic courses compared to pre-pandemic courses. To do this, the complete data we have from the 2012-13 academic year to the 2021-22 academic year has been divided into two groups: pre-pandemic and post-pandemic. The first would cover from the 2012-13 academic year to the 2019-20 academic year. The second group, post-pandemic, has data from the 2020-21 and 2021-22 academic years. This is because the subject is from the first semester and the pandemic began in Spain in March 2020, so the teaching of this subject never really took place during the extreme confinement that Spain suffered from March to May 2020.

A quick summary of these means is reflected in Fig. 1. But to determine whether or not these changes in the means are significant and appropriate, the statistical analysis performed is detailed in the following paragraphs.

In the first place, the Null Hypothesis (H<sub>0</sub>) is defined, which represents the affirmation that the pandemic does not improve the teaching-learning process, and the Alternative Hypothesis (H<sub>1</sub>) that affirms that there is some degree of relationship or dependence of the pandemic with improvement in the teaching-learning process (Hurtado Rubio & Silvente Berlanga, 2012). Next, the homogeneity, variance and normality tests, prior to the statistical test, are detailed.

## **HOMOGENEITY OF VARIANCES**

In SPSS, to perform the Levene test for equality of variances, it is necessary to perform the Student's t-test (Ostle, 1979). Student's t-test is performed for two independent samples (Hurtado Rubio & Silvente Berlanga, 2012), on the 7 categories of the questionnaire evaluated with a Likert scale. The two

Group statistics					
		N	Half	Standard deviation	Mean standard error
Media_Learning	Pre-pandemic	121	3,8843	0,86485	0,07862
Medium_enthusiasm	Post-pandemic	20	4,0875	0,54577	0,12204
	Pre-pandemic	121	3,7348	0,92634	0,08421
	Post-pandemic	20	3,9375	0,6633	0,14832
Media_Organization	Pre-pandemic	121	3,6157	0,91972	0,08361
	Post-pandemic	20	3,6875	0,5311	0,11876
Average_interaction	Pre-pandemic	121	4,0413	0,77885	0,0708
	Post-pandemic	20	4,0375	0,69904	0,15631
Average_Personal_Attitude	Pre-pandemic	121	4,069	0,83073	0,07552
	Post-pandemic	20	4,175	0,5432	0,12146
Media_Exams	Pre-pandemic	121	4,0427	0,82847	0,07532
	Post-pandemic	20	4,2833	0,65136	0,14565
Half_Bibliography	Pre-pandemic	120	3,6167	0,99734	0,09104
	Post-pandemic	20	3,925	0,78262	0,175
Half_Vision_General	Pre-pandemic	121	3,3719	0,93114	0,08465
	Post-pandemic	20	3,7167	0,73568	0,1645

Figure 1. T-test for independent samples in the pre-pandemic and post-pandemic groups.

Independent samples test		F	Sig	t	g <sup>1</sup>	Sig.(bilateral)
lower	Higher					
Media_Learning	Variance is assumed	3,325	0,07	-1,016	139	0,311
	Equal variances are not assumed			-1,4	37,035	0,17
half_enthusiasm	Variance is assumed	2,933	0,089	-0,938	139	0,35
	Equal variances are not assumed			-1,188	32,687	0,243
Medium Organization	Variance is assumed	7,322	0,008	-0,339	139	0,735
	Equal variances are not assumed			-0,494	40,912	0,624
Average_Interaction	Variance is assumed	0,403	0,527	0,021	139	0,984
	Equal variances are not assumed			0,022	27,414	0,982
Average_Personal_Attitude	Variance is assumed	2,807	0,096	0,551	139	0,583
	Equal variances are not assumed			0,741	35,685	0,463
Media_Exams	Variance is assumed	0,849	0,358	-1,236	139	0,219
	Equal variances are not assumed			-1,468	30,178	0,153
Media_Bibliography	Variance is assumed	3,881	0,051	-1,315	138	0,191
	Equal variances are not assumed			-1,563	30,322	0,128
Media_Vision_General	Variance is assumed	0,738	0,392	-1,575	139	0,118
	Equal variances are not assumed			-1,864	30,06	0,072

Figure 2. Levene's test of equality of variances by categories.



independent samples correspond to the mean of the evaluations of the 2020-21 and 2021-22 courses compared to the rest of the courses that go from 2012-13 to the 2019-20 course, the first group being called pre-pandemic and post-pandemic. -pandemics the second group, see Fig. 1. The results of the Levene test for equality of variance are shown in Figure 2.

For the requirement of homoscedasticity (equal variances) to be met in Levene's test, the significance must be greater than 0.05. But previously it is necessary to know if the value of the upper or lower row is taken. The latter is based on the value of the column "Sig." which will determine whether "equal variances have been assumed" or "equal variances are not assumed" is chosen. Therefore, as it appears marked in the Sig (bilateral) column of Figure 2, in all cases, hypothesis 0 must be rejected, that the pandemic and the teaching changes have not changed the teaching-learning process, and alternative hypothesis H1 of if there are significant changes.

## NORMALITY

To determine the statistical test to apply, in addition to analyzing the equality of variances of the dependent variable, it must

also be analyzed whether its values follow a normal distribution (Hurtado Rubio & Silvente Berlanga, 2012). To determine if the variable follows a normal distribution, the Kolmogorov-Smirnov (K-S) or Shapiro-Wilks (S-W) test can be applied, among others, depending on the sample size. In this case, the SPSS program shows the results of both tests, as can be seen in Fig. 3. In this analysis, the S-W test is chosen, given that the population is less than 50. In all cases, the value of the "Next" column is less than 0.05, consequently in all cases the data do not follow a normal distribution.

Although there are several authors (SFPIE UV, n.d.) who indicate that the Student's t-test is robust enough to be applied even if the Normality assumption is not fully met, in this study a non-parametric test will be applied, with in order to remedy this deficiency in the data.

## NONPARAMETRIC TESTS

Since the data does not follow a normal distribution, as determined by the S-W and K-S tests, and some categories do not meet the equality of variances, we must apply the non-parametric tests. In this case, the Mann-

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistical	gl	Sig.	Statistical	gl	Sig.
Media_Learning	,140	140	<,001	,926	140	<,001
half_enthusiasm	,134	140	<,001	,929	140	<,001
Average_Organiztion	,087	140	,011	,968	140	,002
Half_Interaction	,105	140	<,001	,928	140	<,001
Medium Personal Attitude	,146	140	<,001	,896	140	<,001
Half_exams	,185	140	<,001	,894	140	<,001
Half_Bibliography	,172	140	<,001	,927	140	<,001
Half_Vision_General	,095	140	,003	,968	140	,002

<sup>a</sup>. Lilliefors significance correction

Figure 3. K-S and S-W normality test.

Whitney U test will be applied, which was proposed by Wilcoxon in 1945 (Wilcoxon, 1945). In this test, the Null Hypothesis (H<sub>0</sub>) maintains that the mathematical expectations of both populations are the same. The samples can be of different size. It does not require any type of assumption about the distribution of the samples and therefore it can be used with discrete or ordinal variables like the rest of the non-parametric tests.

The results of the Mann-Whitney U test are shown in Fig. 4 where we can see that in all cases the decision is to keep the Null Hypothesis, this implies that there is no significant change in the means of the post-pandemic courses. regarding pre-pandemic courses. Consequently, the pandemic has not influenced the opinion of the students regarding the subject according to the evaluation that has been carried out with the SEEQ questionnaire.

Finally, Fig. 5 shows a graph where the means of each of the categories evaluated for the two groups of data that we have sectioned from the pre-pandemic and post-pandemic academic courses are compared. Although, as we have shown with the Mann-Whitney U test, the mean difference does not have a significant value and the null hypothesis that the change is not significant must be accepted, it is important to show that it has improved (we insist, not significantly from statistical form) but that the change has been towards improvement.

## CONCLUSIONS

In this work, the opinion of the students of the Information Security subject of Computer Engineering and Telematics Engineering at the University of Extremadura from the 2012-13 academic year to the 2021-22 academic year has been analyzed through the validated questionnaire SEEQ (Matés & Bouzada, 2010). This is a total of 10 academic courses, of which

the first 8 belong to the pre-pandemic period of the COVID-19 pandemic, and the last two to the post-pandemic period.

The main objective was to find out if there has been a change in the perception that students have of the teaching-learning process. In the first place, it can be concluded that there is a change in perception. That this change is positive in all categories, except the category of "Interaction in the group" which has a decrease of 0.0038. However, it has been shown that all changes are not statistically significant. Therefore, the first conclusion is that there is no significant change in the perception that students have of the teaching-learning process in the post-pandemic period compared to the pre-pandemic period.

A second conclusion, but also very important, is that the mean of all the categories is above the mean of the Likert scale whose numerical values are between 1 and 5, therefore, the mean would be 2.5 and yet all the categories are above 3.3, including several above 4, a very high value. Thus, these results encourage the teaching team of the subject to continue improving, and self-assessing themselves with the SEEQ questionnaire, which is allowing us to measure said improvements and modifications in the subject.

## THANKS

Our thanks to all the students who have taken the Information Security subject at the University of Extremadura, and who have dedicated part of their time to answering the evaluation questionnaire for the subject once the entire teaching-learning process has been completed.



## Summary of hypothesis tests

	null hypothesis	Proof	Sig. <sup>a,b</sup>	Decision
1	The distribution of Media_Learning is the same between categories of 0 No 1 Yes.	Mann-Whitney U test for independent samples	,542	Keep the null hypothesis
2	The distribution of Medium_enthusiasm is the same between categories of 0 No 1 Yes	Mann-Whitney U test for independent samples	431	Keep the null hypothesis
3	The distribution of Media_Organization is the same between categories of 0 No 1 Yes	Mann-Whitney U test for independent samples	,798	Keep the null hypothesis
4	The distribution of Mean_interaction is the same between categories of 0 No 1 Yes	Mann-Whitney U test for independent samples	,842	Keep the null hypothesis
5	The distribution of Media_Attitude_personal is the same between categories of 0 No 1 Yes	Mann-Whitney U test for independent samples	,972	Keep the null hypothesis
6	The distribution of Mean_Exams is the same between categories of 0 No 1 Yes	Mann-Whitney U test for independent samples	,253	Keep the null hypothesis
7	The distribution of Media_Bibliography is the same between categories of 0 No 1 Yes	Mann-Whitney U test for independent samples	,193	Keep the null hypothesis
8	The distribution of Media_Vision_General is the same between categories of 0 No 1 Yes	Mann-Whitney U test for independent samples	,097	Keep the null hypothesis

a. The significance level is .050

b. Asymptotic significance is shown

Figure 4. Mann-Whitney U test.

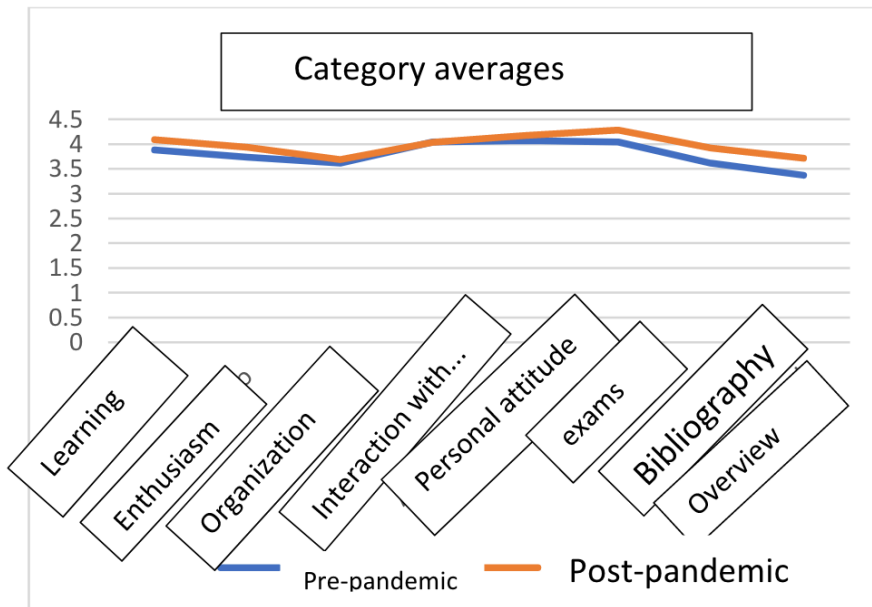


Figure 5. Category averages for pre-pandemic courses and post-pandemic courses.

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Evaluation table *				
Change Requests / Corrections / Enhancements Noted by Reviewers	Change			Comments
	Yes	No	Partial	
Reviewer 1. APA Standards	X			
Review 2. Vision Figure 2	X			
REvsior 2. Add more qualitative		X		It is not possible to do it in no time
Reviewer 2. APA Standards	x			
Reviewer 3. APA Standards	x			
Reviewer 4. APA Standards and	x			

\* This grid is intended to record chapter change/correction/enhancement requests, flagged by reviewers on the NTQR platform in OJS. The authors must mark the requests requested and inform if the changes were made, justifying in the “Comments” in case they have not been made or only partially.