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Effects of COVID-19 on the Perception of Virtual Education in University Students in Ecuador; Technical and Methodological Principles at the Universidad Técnica Particular de Loja

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Abstract: The confinement and migration from face-to-face to open access, online or blended/hybrid education modality caused because of the coronavirus crisis has forced a readaptation of education with enormous deficiencies at all levels. This work analyzes the viewpoint of a group of students from the Universidad Técnica Particular de Loja (Ecuador) regarding the current state of emergency from a descriptive and correlational quantitative methodological conception, based on the application of an instrument made up of six thematic blocks: socio-demographic situation, use of ICT, importance of ICT, methodology, didactic techniques, and study modality. The main results show that students are not yet convinced that a virtual modality is better than face-to-face. However, there are groups that value positively the use of ICTs mainly for recalling information, self-learning, and motivation. The techniques most valued by students are the traditional ones: teacher explanation and individual work. However, they give a low value to individualization as a methodological principle under which these techniques are based.

Keywords: COVID-19; virtual education; face-to-face education; methodology; ICT; didactic techniques; higher education

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1. Introduction

The COVID-19 pandemic has caused an unprecedented crisis in all areas. Since its onset, more than 1.5 billion students worldwide have been affected by the closure of institutions and the educational changes they had to face [1] as they moved in a short transition period from face-to-face to online or blended/hybrid education. Academic institutions focused on face-to-face education models had to face several challenges in this transition, among others, adjusting a fully online model that responds to careers in the area of engineering that are traditionally developed in face-to-face environments [2].

Recent research shows some effects of this scenario. Abreu [3], Camacho et al. [4], and Rogero-García [5] highlight the digital divide, an unprepared teaching staff for this new normality, and the increase in inequalities in learning. To this must be added the differences in resources, materials, and technological infrastructure of families, which negatively affect the educational development of students [6,7], manifestations of inequity and social exclusion [8,9].

However, not everything is negative; virtuality has allowed innovation and the search for ways to reach students. The studies by Cleland et al. [10] and Zapatería [11] agree in stating that university education, faced with this crisis, has been able to put into practice and develop various alternatives for adapting to the new online training requirements. In addition, this modality offers a flexible teaching model [12].

Likewise, virtual education is not new. In the United States, almost all states offer some type of online training [13], distance and virtual education is growing exponentially in Latin America [14], and in the United Kingdom, there are fully virtual schools with fully defined organizational structures [15]. Since the 1990s, particular models and methods have been established to ensure the quality of virtual education [16].

However, despite the previous experience that certain countries had, the pandemic has brought great challenges to those who are part of this process. Both students and teachers must develop digital knowledge and skills, responsibilities, ethical practices, and a high level of criticality to take advantage of the potential of online learning [17] to, therefore, deepen the models, methodologies, strategies, resources, and tools that promote the management of teaching and learning.

With this background, this research seeks to know the effects of the COVID-19 pandemic on virtual university education in Ecuador, based on the perceptions of students in the areas of Engineering, Communication, and Education at the Universidad Técnica Particular de Loja. The starting hypothesis is to verify if there is a statistically significant relationship between the importance and valuation of ICT, methodology, and didactic techniques implemented in this modality of studies.

1.1. The Role of ICT in Today's Educational Process

During the last decade, online education has become a viable model in higher education in all fields and areas, such as social, technical, biological, and administrative, at undergraduate and graduate levels [18]. However, the training in engineering careers in this modality is still a challenge, although some of the experiences show that a pedagogical proposal supported with an adequate use of technological platforms enabled a satisfactory trajectory of the virtual teaching–learning process in engineering career subjects in times of isolation [19].

Authors such as Van de Heyde and Siebrits [20] and Área Moreira et al. [21] describe some characteristics of the implementation of TEL (Technology-Enhanced Learning) in educational institutions as important, among them the 'reusability' that generates this type of transformation, the universality of the process, its capacity for expansion and openness, its aptitude for formalization, and the verified usefulness.

What is demonstrated in these contributions is the susceptibility to change in the educational methodological approach, with the use of the Internet and its digital tools and virtual connection, which as a vehicle for training and participation allows making technological knowledge visible, increasing this knowledge, providing the necessary infrastructure, and creating a specific culture [22].

From a holistic view, the proposal of an interdisciplinary approach in TEL research suggests several ad hoc benefits because it implies effective collaboration between interdisciplinary teams, education, pedagogy, computer science, design, and media technology [23,24], which consequently allow the application of methodological principles of participation, individualization, interrelation, motivation, and applicability in education in virtual classrooms.

In addition to sharing specific knowledge, there is the possibility that experts and professionals in training in the broad field of engineering, directly related to the operation of Information and Communication Technologies, can meet the training and educational production needs of other branches of knowledge such as education and communication, generating an option to incorporate TEL practices that are pedagogically sound.

1.2. Virtuality. Different Perceptions of the Actors of the Higher Education System

Research on learning enhanced by the development of Information and Communication Technologies (ICT) suggests the handling of broad and diverse concepts: infrastructure, systematic processes, human–digital perspective, and the perceived usefulness or possibility of use and consumption of these enriched environments [25]. Their perceived benefit and performance are always described in the context in which they are imple-

mented [26,27]. In terms of a sectional view, from the field of knowledge in which the experiences are recorded, especially since the imminent transformation of education to the virtual format, the changing technological adoption is also susceptible to comparisons rather than irreconcilable differences.

Downie et al. [28] point out that it is important to consider that models of technology application to support learning always suggest implicit improvement [29]. However, the ways of perceiving that 'improvement' in the educational dynamics are crucially different among the users of the educational system. The usefulness perceived by students is linked more to evaluative purposes. Teachers, on the other hand, visualize TEL in higher education linked to the development of their digital skills, specifically in didactic techniques that support classroom teaching [30]. In other words, teachers should be trained in alternative methods to overcome the loss of physical interaction [9] and respond to the demands of the current moment [31], strengthening teaching and learning strategies for the effectiveness of virtuality through forums, explanations, small group work, individual work, exhibitions, debates, tasks and projects, simulations, and action models, etc. [32].

In addition, several studies show that among the main positive points of the virtual modality, in times of pandemic, pointed out by students are having classes at home, a new way of distributing time to mix production, study or entertainment activities, use of mobile devices with access to multimedia teaching materials, information anywhere and anytime, interaction with peers and experts, learning from various sources, and incorporation of new technological tools that enable different modalities and dynamics of class [19]. Likewise, according to teachers, the forced migration to virtual learning environments had the access to classes as a positive aspect; however, they also express their distrust in relation to the effectiveness of student learning. Therefore, an online teaching and learning system in the long term requires training and confidence of teachers in the model for better performance [33].

On the other hand, the negative assessment of virtual teaching by some experts is explained by the inverse relationship perceived between dedication to study and academic performance, and mainly by the lack of adaptation of teachers to this new system [34,35].

1.3. Methodological Principles and Didactic Techniques to Complement Virtuality

It is important to highlight that the possibilities of ICT in education from the perspective of Díaz Barriga [36] are based on the following aspects: creation of learning environments for interaction and interrelation between students and teachers, for the development of cognitive and socio-affective skills in interaction with others through group work and in complex learning situations that facilitate the transfer of knowledge, to motivate learning, and modify new attitudes. In this same line, and from a constructivist approach, cognitive development with technological mediation occurs within a system of activities or strategies supported by digital and technological resources that constitute cultural tools for learning [37], favoring practices and facilitating the best presentation of contents, transfer of knowledge, access to information, and clarification of concepts, among others [38].

It is worth mentioning that the implementation of technology-mediated education and TEL is worth learning as it provides new opportunities for university students. In addition, the growing access to the Internet, mobile devices, and social networks has revolutionized communication processes and has democratized access to information and the creation of content for education [39]; however, the incorporation of new technological resources does not ensure the success of the educational process without didactic planning of the actions to be developed and the way in which these new resources are configured and used [40].

In this perspective, the new social, economic, and environmental scenarios brought by the pandemic demand paradigm shifts in terms of the education of people, requiring critical, creative, reflective entities with a high spirit of teamwork to be integrated into a society that is constantly changing and dynamic. In this context, educational trends in virtual education are moving toward new pedagogical models and methodological principles that seek to articulate participation, individualization, applicability, interrelation,

previous knowledge, cooperation, motivation for reflection, and decision making oriented toward intellectual, social, personal, and human growth in relation to the society [41].

So far, innovations have been evidenced in the use and execution of visual multimedia and its platforms [42], the occupation of virtual reality spaces [43], and the adoption of immersive images and interactive support elements [44] to promote self-assessment tools and educational guidance. All this, from the conception of these elements as advanced spaces and tools, and with the vision of users of professionals in training in these areas [45], attached to the demanding learning environments of the 21st century.

Related to this perspective, works such as those of Martínez-Arias and Parra-Valcarce [46], Tomé-Fernández et al. [47], Expósito et al. [48], and Hodges et al. [49] show the role in e-learning teaching in higher education, to enrich the capacity and skills of use of different digital media systems, taking advantage of their multimedia, hypertext, and interactivity characteristics, which, as a further aim, should provide key notions to effectively solve complex problems in the field of ICT.

Regarding the incidence of gender in the use of technology, the differences between men and women tend to disappear; the lines that, with the appearance of technology in the educational process, were visible, tend to blur as shown by the research of Torres-Diaz et al. [50] in a study with 16,546 surveys of university students in Ecuador.

With the panorama of a constant and disruptive acceleration in technological educational models, Al-Ataby [51] recommends a critical approach when addressing the implications of virtual educational practices and their impact, marked by the dissimilarity caused by the demographic and access gap [52,53]. However, these distinctions are those that can offer strengths not only through the combination between online learning and face-to-face environments but from the amalgamation of other didactic techniques specific to the specialties in Engineering, Communication, and Education which can offer solutions consistent with the needs of current higher education.

Linked to this last point, not little has been achieved in terms of instructional design, which has been fostered by disruptive innovation in technology and the interdisciplinary approach [54], based on the connotation of fostering dialogue and communication among the users of these virtual systems [55,56]. Some examples of the usefulness of this scenario are cultural tools, adaptive intelligent tutoring systems, avatars, embodied interaction, augmented cognition, personal learning environments, virtual objects, online communities, adaptive support, simulation, and collaborative technology, which ultimately ensure learning in virtual platforms when applied as didactic techniques in the classroom [57].

2. Materials and Methods

It is a quantitative, field, cross-sectional, exploratory, descriptive, and correlational study [58].

This research seeks to know the effects of the COVID-19 pandemic on virtual university education in Ecuador, based on the perceptions of students in the areas of Engineering, Communication, and Education at the Universidad Técnica Particular de Loja. The starting hypothesis is to verify if there is a significant statistical relationship between the importance and valuation of ICT, methodology, and didactic techniques used by university students.

2.1. Population and Sample

Information was collected from a group of 268 students of Communication, Education, and Engineering of the Universidad Técnica Particular de Loja during the study period October 2021 to February 2022. The students were randomly selected with a gender distribution of 48.5% women and 51.5% men. In this section, it is necessary to consider that the number of students sampled does not allow us to generalize the results; however, it presents an overview of the institutional reality and, on that basis, outline possible scenarios to expand the research.

2.2. Instrument and Procedure

In this case, the sample survey technique was used in the form of a self-administered questionnaire, which guaranteed the anonymity and confidentiality of the participants. The questionnaire of Fandos Garrido [59] was used, which consisted of 6 parts: identification data, classroom-virtual training, design of the course or training module, course development, attitude and skills developed in the course, and evaluation of the training received.

However, due to the objective and context of the study, the questionnaire was adapted by selecting 14 questions related to the sociodemographic situation, use and importance of ICT, methodology, didactic techniques, and study modality (Table 1). It was distributed to the participants through the Google Forms platform.

Question division.

Table 1. Questionnaire structure.

Questionnaire Questions	Number of Items
Identification data	4
Use of ICT	11
Assessment of subjects	5
Evaluate activities	13
Training activities	7
Materials for the development of the subjects	6
Weight of the activities in the subject	7
Methodological principles	7
Teaching techniques	9
Development of the subject	30
Developing the course in virtual, hybrid, or distance mode	7
Importance of the subjects	6
Overall assessment of the subjects	6

Students were categorized according to the valuation assigned to variables: based on the valuation of subjects, based on the valuation of ICT, based on the importance of methodological principles, and based on the importance of didactic techniques. The k-means method was used for this purpose.

The classification of students based on the assessment of ICT was carried out in two stages. In stage one, the principal components method was applied to a set of 11 variables. This procedure generated three components as a result: advantages of ICT, ICT results, and ease of teamwork. These three components explain 90.8% of the variance of the data and were taken as variables to perform a subsequent cluster analysis. For the cluster analysis process, the k-means method was used.

Chi square was used to determine the relationships between age, sex, and perception of technology classification. A multinomial logistic regression was used for the relationship between the variables, the levels of the relationship between the methodological principles and the classification of the perceptions regarding technology. The independent variable was the classification of perceptions regarding the technology, which has three categories: positive results, low valuation, and high rating. The dependent variable was the classification based on the evaluation of the methodological principles which has three categories: low, medium, and high assessment.

3. Results

A total of 268 surveys were conducted among students of the Universidad Técnica Particular de Loja. A total of 48.5% were women and the remaining 51.5% were men. The age distribution of the students is as shown in Table 2.

Table 2. Age distribution of students.

Range	Percentage
17–20	10.8%
21–24	19.4%
25–28	15.7%
29–31	13.4%
32–35	16.4%
36–39	9.0%
40–43	7.8%
44–47	4.5%
48–51	1.5%
44–47	1.5%

3.1. Ranking Based on the Assessment of Subjects

Cluster analysis was applied to categorize the students according to their assessment of the subjects they received. The resulting groups are shown in Figure 1. A total of 9% gave a low rating, 32% a medium rating, and 59% a high rating, with respect to prior information, clarity of learning outcomes, student needs, interest, and whether the course was better organized compared to the face-to-face modality.

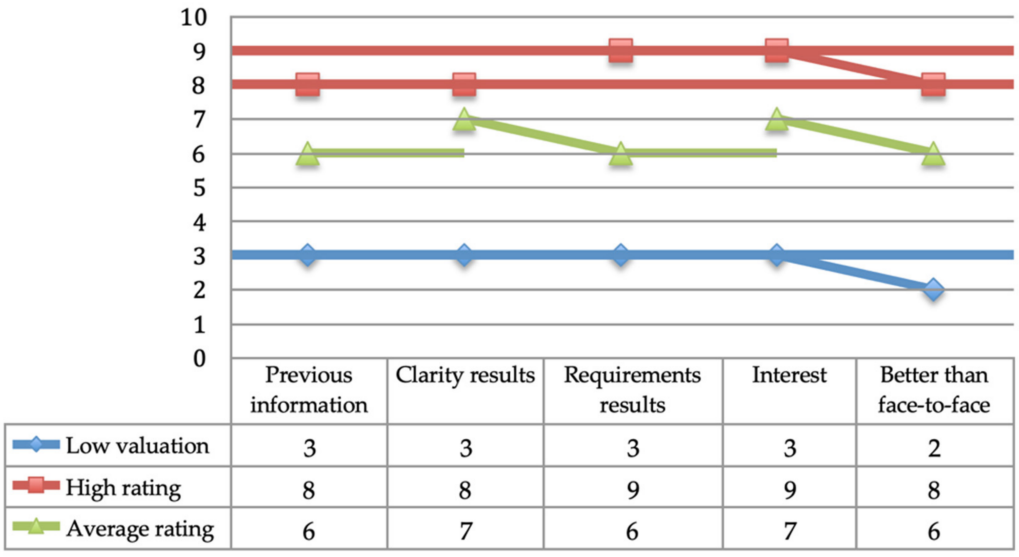


Figure 1. Assessment of the subjects.

3.2. Classification Based on ICT Assessment

A categorization was made of the valuation that students give to ICT (Table 3); this valuation was subjected to a principal components analysis that allowed reducing the size of the construct while maintaining an explanation of variance of 90.83% with three components to which a description (name) was assigned according to the variables that comprise it. One aspect to highlight is the lower valuation given to the variable that measures whether online or virtual classes are better than face-to-face classes.

Table 3. ICT assessment.

	Components		
Variables	**Advantages of ICT**	**ICT Results**	**Facilitate Teamwork**
Create Modify New Attitudes	0.773	0.46	0.288
Facilitate Transfer Knowledge	0.723	0.371	0.514
Best Presentation Contents	0.709	0.462	0.441
Propitiate Relationships Student–Professor	0.709	0.376	0.49
Clarify Abstract Concepts	0.702	0.555	0.302
Demonstrate Simulated Experiences	0.641	0.571	0.375
Access More Information	0.609	0.466	0.544
Easier To Remember Information	0.478	0.774	0.351
Facilitates Self-study Individualizes Teaching	0.444	0.686	0.494
Motivate Learning	0.475	0.683	0.478
Facilitate Teamwork	0.368	0.385	0.813

The three components were used as input variables to categorize students with the following results:

The 1.4% of students is called 'the positive results' group (group 1); these students are characterized by giving a markedly positive evaluation to the results of using ICTs. However, they give a markedly low evaluation to the remaining variables. A total of 78.3% belong to 'the high valuation' group, which has a uniformly positive valuation in all variables. Finally, the remaining 20.14% belong to 'the low valuation' group, which is characterized by having a higher rating in the advantages than in the rest of the variables (See Figure 2).

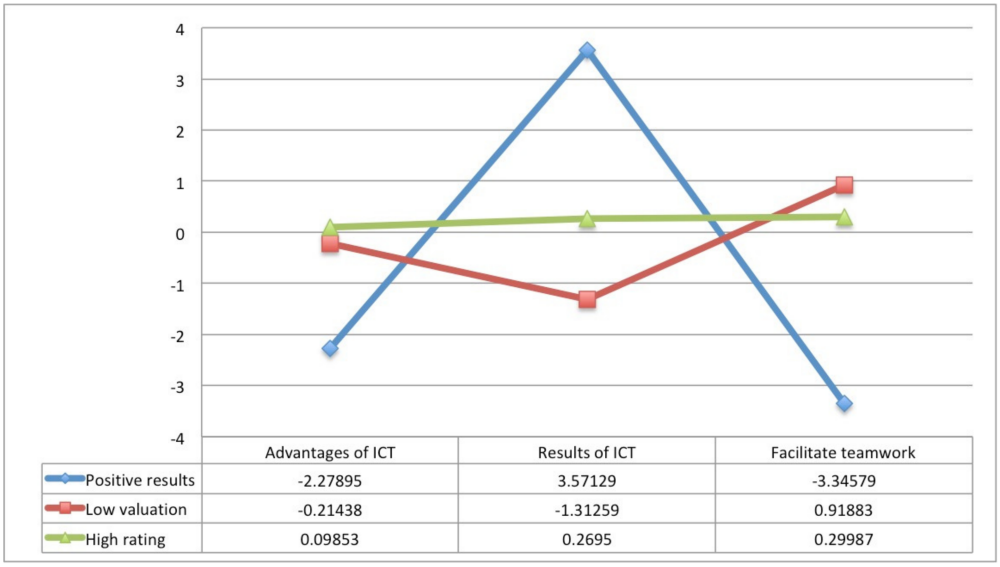
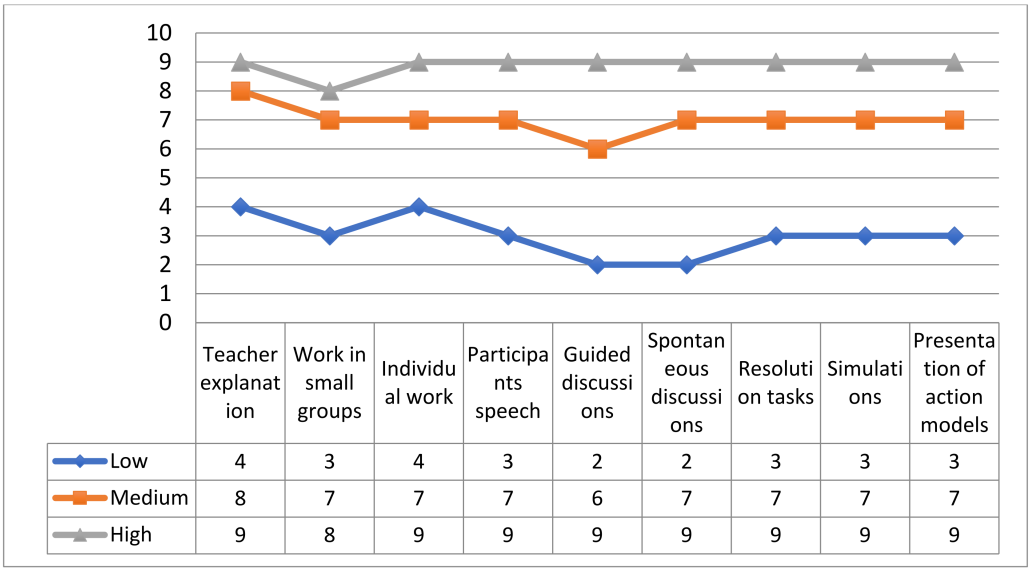


Figure 2. Classification based on ICT-related components.

3.3. Classification Based on the Evaluation of Didactic Techniques

In this classification, students were categorized based on the importance they give to the different didactic techniques used in the subjects. These techniques are represented by the variables shown in Figure 3 below.



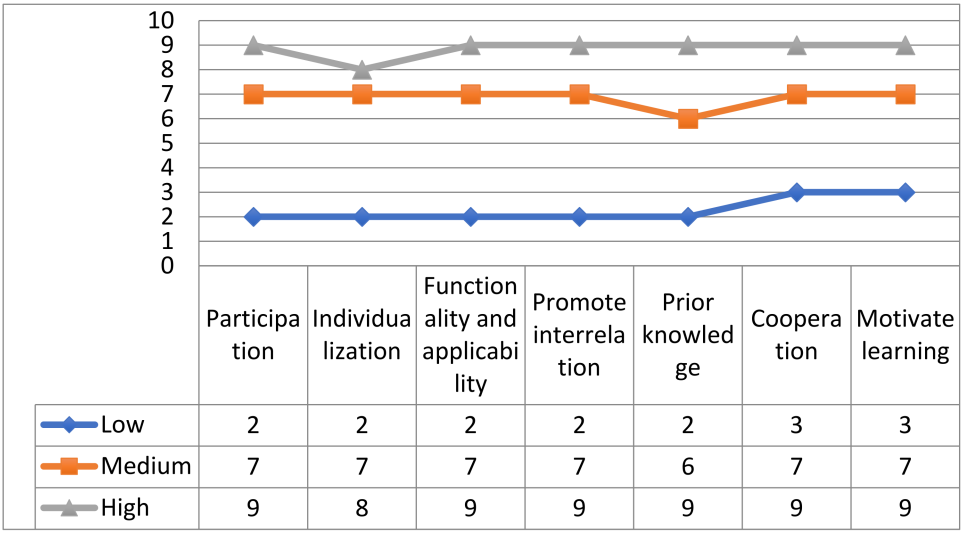
	Teacher explanation	Work in small groups	Individual work	Participants speech	Guided discussions	Spontaneous discussions	Resolution tasks	Simulations	Presentation of action models
Low	4	3	4	3	2	2	3	3	3
Medium	8	7	7	7	6	7	7	7	7
High	9	8	9	9	9	9	9	9	9

Figure 3. Assessment of didactic techniques.

There are three resulting groups: low score—representing 5% of students, this group gives a low score to all the didactic techniques; average valuation—this group represents 29% of students and the valuations given are at an intermediate level in all the variables measured; high value—this group represents 66% and values positively all the didactic techniques.

3.4. Classification Based on the Assessment of Methodological Principles

A final classification relates to the methodological principles that students rated on a scale of 0 to 9. These principles can be seen as variables in Figure 4.



	Participation	Individualization	Functionality and applicability	Promote interrelation	Prior knowledge	Cooperation	Motivate learning
Low	2	2	2	2	2	3	3
Medium	7	7	7	7	6	7	7
High	9	8	9	9	9	9	9

Figure 4. Assessment of methodological principles.

The assessments divide students into three groups:

- Low rating, 4% of the students assign a low rating to all variables.
- Average valuation, 18% of students assign an average valuation to all the variables analyzed.
- High rating, 78% of the students assign the highest ratings to the different methodological principles.

3.5. Relations

3.5.1. Age and Sex

A significant relationship was found between the value given to ICT and age ($x^2 = 32.3$; $p < 0.05$), in which the value given to technology has a direct relationship with age, that is, as the student advances in age, they tend to give greater importance to technology. The classification based on the importance of ICT does not depend on the student's sex.

No significant relationship was found between sex and age with the evaluation of the subjects, methodological principles, or the evaluation of didactic techniques.

3.5.2. Importance of ICT and Methodological Principles

A multinomial logistic regression was applied in which the dependent variable is the valuation (low, medium, high) given to the methodological principles and the independent variable is the importance students give to ICT. A significant incidence was found in this relationship. The model explains 17.8% of the variance (Table 4).

Table 4. Parameter estimates.

		B	Typical Error	Wald	gl	Sig.	Exp (B)	95% Interval for Exp (B)	
								Lower Limit	Upper Limit
	Intersection	1.748	0.195	80.652	1	0.000			
Under	[ICTRating = 1] [ICTR Rating = 1	2.441	1.240	3.874	1	0.049	11.484	1.010	130.519
	[ICTRating = 2] [ICTR Rating = 2	1.214	0.362	11.229	1	0.001	3.366	1.655	6.846
	[ICTRating = 3] [ICTR Rating = 3	0 [b]			0				
Medium	Intersection	5.182	1.003	26.701	1	0.000			
	[ICTRating = 1] [ICTR Rating = 1]	5.182	1.734	8.934	1	0.003	178.000	5.953	5322.604
	[ICTRating = 2] [ICTR Rating = 2	3.894	1.079	13.014	1	0.000	49.103	5.920	407.284
	[ICTRating = 3] [ICTR Rating = 3	0 [b]			0				

[b] This parameter has been set to zero because it is redundant.

The probability of belonging to the group that gives low importance to the methodological principles with respect to the group that gives high importance is 11.4 times greater when the student belongs to the 'positive results' group with respect to the 'high valuation' group; this can be interpreted as a greater probability (11.4 times) of belonging to the group that gives low value to the methodological principles when belonging to the group that gives higher value only to the results presented by the ICT.

The probability of belonging to the group that gives low importance to methodological principles with respect to the group that gives high importance is 3.36 times greater when the student belongs to the 'low value' group with respect to the 'high value' group. Likewise, this can be interpreted as the greater probability (3.36 times) of belonging to the group that gives low importance to methodological principles when the student belongs to the group that gives low importance to ICT.

The probability of belonging to the group that gives medium importance to the methodological principles with respect to the group that gives high importance is 178 times greater when the student belongs to the 'positive results' group with respect to the 'high valuation' group; this can be interpreted as a greater probability (178 times) of belonging to the group that gives medium value to the methodological principles when belonging to the group that gives higher value only to the results presented by the ICT.

The probability of belonging to the group that gives medium importance to methodological principles with respect to the group that gives high importance is 49 times higher when the student belongs to the 'low value' group with respect to the 'high value' group. The interpretation given indicates that there is a greater probability (3.36 times) of belonging to the group that gives medium importance to methodological principles when the student belongs to the group that gives low importance to ICT.

Regarding the students' perception of studying in a virtual versus face-to-face modality, they prefer the latter, despite positively valuing the use of ICTs mainly for recalling information, self-learning, and motivation. This may be because the teaching techniques used by professors are still traditional.

4. Discussion

A classification was developed based on the valuation given to the subjects. This classification divided the students into three groups: advantages of ICT, ICT results, and facilitate teamwork. In these groups a marked difference between them can be highlighted. Something that calls attention is that, as a common factor in all groups, the valuation given to the variable that measures 'a virtual modality is better than a face-to-face one' is found to be lower. This variable has the lowest valuation, which clearly indicates that students are not convinced that a technology-mediated modality is better than a face-to-face one, and this is corroborated with what the researchers Pérez-López and Cambero Rivero [34] state. In other words, the university must move toward more collaborative and student-centered models.

Technology will always be a way or a bridge that facilitates processes. In this work, the valuation that students give to technology is evaluated, these valuations divide students into three groups, and two of them present uniform behavior, high valuation and low valuation; however, there is a group that mainly values the facilities provided by technology to remember information, for self-learning, and for motivation.

The qualification of the didactic techniques divides the students into three groups. The evaluation of each of the techniques within each group is uniform; however, it stands out that the directed debates and the spontaneous debates are the ones that have a lower importance according to the students' criteria. Small group work is in the same situation. The techniques with the best valuation are the teacher's explanation and individual work; regarding the teacher's work and, more specifically, the explanation given by the teacher to the contents, the students' preference reinforces the idea of necessary training of teachers for long-term teaching events as pointed out by Andrade et al. [33].

To answer why the teacher's explanation and individual work have a higher grade, it is necessary to delve into the analysis, starting from the question: are these techniques not the most traditional ones? If the answer is yes, and if technologies provide advantages that improve both teaching and learning, then we are faced with a contradiction that may have many causes. Initially, these results would be in contradiction with those reported by Trigueros et al. [19] who highlight several positive aspects of a technology-mediated modality that do not reflect the results of this work.

A classification was developed based on the importance that the student gives to the methodological principles. In this classification, the most important group, due to the number of students counted in it, has a low valuation of individualization as a characteristic. The group of medium valuation has the characteristic of giving a lower valuation to previous knowledge. The valuation of the methodological principles allows highlighting that there are principles that receive less importance, individualization and previous knowledge, and those that receive greater valuation, motivating learning and cooperation. Here, we find a coincidence with the approaches of Chen-Quesada et al. [39] who point out both motivation and cooperation among the principles that articulate technology-mediated learning.

Of the four classifications developed, only age, and not gender, has an impact on the classification based on the valuation given to ICT; the remaining classifications do not show

any dependence on these variables. This coincides with previous studies by Torres-Diaz et al. [47] where gender tends to present less incidence on the way in which technology is used by university students in Ecuador.

Regarding the dependence of methodological principles on the importance of ICT, it should be noted that the more important a student considers technology, the higher the value they give to methodological principles, which supports what Nichol [52] pointed out regarding the promotion of methodological principles such as dialogue and communication as the basis of the educational process.

5. Conclusions

What ultimately underlies, according to the results of the research, is the roots of a traditional paradigm based on the teacher's explanation and individual work, which must give way to other more collaborative and student-centered models. The closure of face-to-face classrooms serves as an opportunity for this change once the technological barrier that hindered the use of digital technologies by teachers and students has been overcome. This is a more flexible model [44]. However, the transition to comprehensive digitization will only be possible if it is accompanied by an institutional strategy that produces a transformation in the model involving students and teachers.

The digital gaps based on gender or age tend to disappear. In this work, no incidence of gender was found on the valuation of technology; with respect to age, it persists with significant but low values. This is far from the findings on the digital divide that, at the time, defined this concept.

Regarding the importance that students give to the methodological aspects of the training process, this importance tends to increase as the importance they give to technology.

For future research, it is recommended to delve deeper into the topic of virtual versus face-to-face, to break down and expand the variables that can explain more clearly the preferences of students and especially the advantages of this mode of study. The objective of this article is none other than to present, by means of empirical evidence, a diagnosis with lights and shadows on the virtual teaching performed during the confinement and that may serve other universities to face the challenges of COVID-19.

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