2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #39338

Work in Progress: Influence of COVD-19 in Cultural Dimensions in Civil Engineering Students in

Daniel Cartuche
Dr. Miguel Andres Guerra, Universidad San Francisco de Quito USFQ

MiguelAndres is an Assistant Professor in the Polytechnic College of Science and Engineering at Universidad San Francisco de Quito USFQ. He holds a BS in Civil Engineering from USFQ, a M.Sc. in Civil Engineering in Construction Engineering and Project Management from Iowa State University, a Ph.D. in Civil Engineering with emphasis in Sustainable Construction from Virginia Tech, and two Graduate Certificates from Virginia Tech in Engineering Education and Future Professoriate and from USFQ in Structures for Construction Professionals. MiguelAndres's research includes Architectural and Civil Engineering Project Management, Sustainable and Resilient Urban Infrastructure, and the development of engineers who not only have strong technical and practical knowledge but the social awareness and agency to address global humanitarian, environmental, and social justice challenges. For him, social justice is a concept that should always be involved in discussions on infrastructure. Related to STEM education, Miguel Andres develops disruptive pedagogies for STEM courses as a tool for innovation, and assessing engineering students' agency to address climate change. Currently, MiguelAndres is working on a framework to support and conduct undergraduate research.

Dr. Homero Murzi, Virginia Polytechnic Institute and State University

Work in Progress: Influence of COVD-19 in Cultural Dimensions in Civil Engineering Students in Ecuador

Daniel Cartuche[1], MiguelAndrés Guerra[2*], Homero Murzi[3]

[1] Undergraduate student, Universidad San Francisco de Quito USFQ, Colegio de Ciencias e Ingenierías, Departamento de Ingeniería Civil, Casilla Postal 17-1200-841, Quito 170901, Ecuador.

[3] Assistant Professor, Universidad San Francisco de Quito USFQ, Colegio de Ciencias e Ingenierías, Departamento de Ingeniería Civil, Casilla Postal 17-1200-841, Quito 170901, Ecuador.

[3] Assistant Professor, Virginia Tech, Department of Engineering Education, Blacksburg, VA-USA.

* Correspondence: MiguelAndrés Guerra, MAGuerra@usfq.edu.ec.

Abstract

This study focuses on exploring how civil engineering students perceive the dimensions of culture proposed by Hofstede and how the Covid-19 pandemic altered these cultural dimensions. Hofstede proposes five measurable dimensions which are individualism, power distance, uncertainty avoidance, masculinity, and long-term orientation. Data were collected from 139 civil engineering students 39 in the year 2020 and 100 in the year 2022 to separate into pre- and post-Covid-19groups and make comparisons with each other. The groups are Ecuadorian civil engineering students at Universidad San Francisco de Quito, a private liberal arts university considered to be the best university in Ecuador. The survey was translated into Spanish to better understand the users. The results supply relevant information about how students perceive aspects of culture and differences that were created by Covid-19.

Introduction

Culture plays an important role in shaping our identities and how we interact with the world around us [1]. For Hofstede culture is what we call unwritten rules about how to be a good member of society or a group [2]. In recent years, there has been an increased focus on understanding the role of culture in engineering education, particularly in the United States. [3][4]-[5]. This is understandable, given that engineering is a global profession [6] and culture can affect how we learn, work, and communicate with others. There is a growing body of engineering education research that focuses on understanding engineering culture. Although culture is a complex phenomenon [7]-[8], understanding aspects of it, especially at the disciplinary level, is important for finding ways to improve engineering education in general.

Understanding how engineering students form their identity as professionals help us to develop pedagogies that enable students to become successful professional engineers within their field, enhancing important soft skills such as teamwork, creativity, problem-solving, and adaptive experiences [3]. Understanding the divisions of culture in engineering education gives us the ability to understand how students interact with their fellow students and authority figures such as professors or deans, how they learn and understand within their respective discipline, how they develop the necessary skills to apply in their careers, and how they operate across disciplinary boundaries [9].

However, these skills that are sought to be understood may be affected due to factors external to the academic responsibility on the part of educational institutions [10]. In

recent years the pandemic Covid-19, has revolutionized many aspects of the world at large, among these, education [11]. Due to various restrictions, remote or online education was a drastic change adopted by all students, so face-to-face interaction was greatly reduced [12],[13]. It is argued that analyzing this factor Covid-19, can provide us with a better understanding of important cultural changes in engineering students in recent years.

In Ecuador, research on the understanding of cultural traits within education in engineering disciplines is taking its first steps, however, there is still not much information on the subject. Ecuador is a developing country so the advancement of technologies has boosted the requirement of qualified personnel in technical knowledge [14], which is why engineering is an important field within the country, considered a driver of innovation [9].

The purpose of this study is to understand how civil engineering students in Ecuador distinguish different cultural dimensions associated with their discipline and to determine if the Covid-19 pandemic altered their cultural perceptions, affecting their learned soft skills. In this study we applied five cultural dimensions proposed by Hofstede Individualism, power distance, uncertainty avoidance, masculinity, and long-term orientation [15], to explain how students develop their skills. To obtain the necessary information, a valid survey was conducted, modified, and proposed by Sharma who reconceptualizes Hofstede's factors establishing greater validity and reliability [16], this survey was divided into five sections of eight questions each, about Hofstede's five dimensions. Data collection was conducted at the Universidad San Francisco de Quito, a private liberal arts university considered the best university in Ecuador [17], based only on engineering students.

Background

Hofstede's conceptualization of the dimensions of national culture was introduced based on a study conducted in the 1960s through a survey of IBM employees in more than 50 countries [18]. The author was able to develop dimensions that allowed him to characterize individuals on a spectrum with two opposite poles based on their beliefs, it was then possible to group users with similar characteristics under the same type of culture [9]. Hofstede and Minkov [19] through their research defined culture as a "system of shared meanings that may be unique to a particular society or group of societies".

In this research, we will make use of Hofstede's dimensions, which in an original study yielded four dimensions of culture that distinguish countries from each other [9]: Individualism, which is the capacity to belong to a group and to work collectively. Power distance reflects the relationship between dependence and the degree to which groups can accept an unequal distribution of power. Uncertainty avoidance considers how individuals cope with uncertainty. And masculinity assesses the emotional roles among members of society and estimates how much a society is driven by competition and success [20]. However, through new research in 23 countries, Hofstede added a fifth dimension called long-term orientation that reflects the encouragement of future reward-oriented activities [21],[22].

During the last decades, Hofstede's dimension theory has been used in several studies to understand cultures in different environments, so its effectiveness has been confirmed [9], a characteristic that allows confidence in its use to study cultures in the academic disciplines of engineering in the context of Ecuador.

The cultural context in Ecuador

Using Hofstede's online tool [23], it was possible to obtain the national values of the cultural dimensions in Ecuador and to be able to make a first analysis, the virtual tool allows us to make a comparison with a country, in this case, the United States, a country where more research has been done on cultures based on Hofstede's theory [3]-[5]. Figure 1 shows the representation of Hofstede's five dimensions with updated data for the country under study.

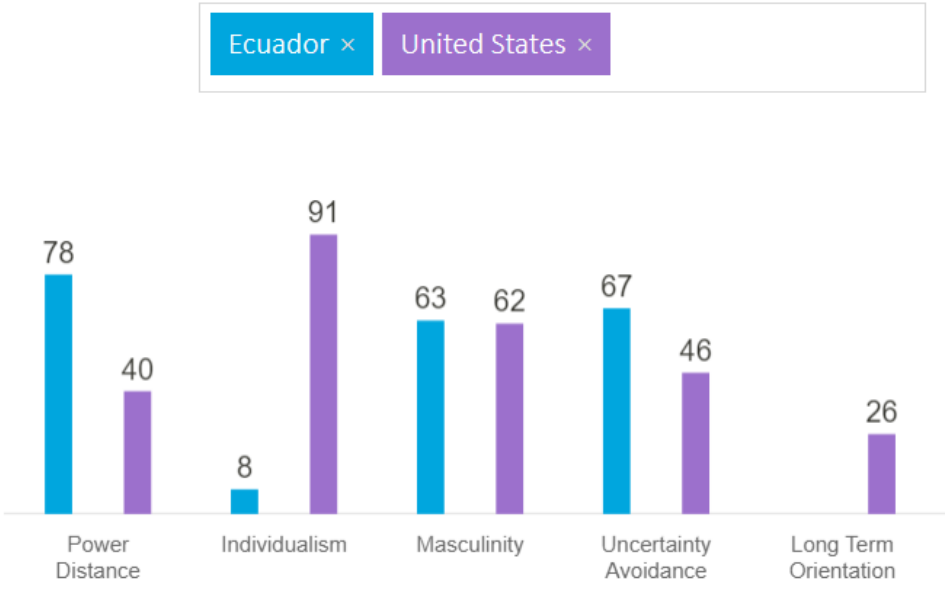


Figure 1. Comparison of countries between Ecuador and the United States according to Hofstede [23].

Based on Figure 1, we can see that Ecuador is a country that is characterized by being not very individualistic, so collectivism and teamwork are part of its culture, making group membership important for the country's inhabitants [23]. On the other hand regarding the power distance, it talks about the fact that individuals within societies are not equal and members accept the inequality of this power, in Ecuador the power distance is accepted within their culture and is related to race and social classes so that people who people of local indigenous races or lower social classes feel inferior to others and are accepted with a fact of life [23].

Masculinity, on the other hand, refers to societies driven by competition, leaning towards high scores related to the male gender, while in societies with values of caring for others and quality of life, it is related to the female gender and leans towards low values within this spectrum. In Ecuador, there is a society oriented to competitiveness and success and together with the high value of collectivism it is understood that

competitions are generally between groups, so that individuals in society seek to belong to groups that generate status and rewards based on their performance, this characteristic also contradicts the stereotype of Latin America as people who avoid hard work [23].

Uncertainty avoidance refers to how society deals with the uncertainty of its future, indicating its score to the extent that members of the culture avoid ambiguous or unknown situations. Ecuador scores above average on this dimension, making them a country with a culture that avoids ambiguity, religion, and customs fairly respected within a group and social conservatism prevails [23].

Long-term orientation describes a time horizon in a culture so that societies with high scores tend to be thrifty people with investment intentions, linearly assume time and focus on the future instead of the present, while societies with low scores within the spectrum tend to assume time circularly and seek immediate rewards [24]. Ecuador does not currently have a score on this scale, so it is not possible to perform a macro analysis of the country; however, it opens the door to future research with updated data on this dimension.

COVID-19 Context

With the appearance of the Covid-19 virus at the end of 2019 in the city of Wuhan - China [25], countries were forced to seek alternatives to prevent the spread of the virus and to protect the health of each of its inhabitants, several measures were applied in all institutions including educational institutions, which were forced to migrate their face-to-face educational model to an online or remote model to protect the health of their students and proliferate the teaching and learning process [26]. Covid-19 has been the biggest challenge that educational systems have faced in recent years [10], [11], although technology offered tools that allow continuous communication during this process of isolation [26], the abrupt migration overnight from the traditional system to the remote system, generated little preparation time and training for student and teacher in the new digital technologies, and even though according to studies students have a greater acceptance of new technologies, student participation in online learning remains unexplored [27]. In addition to these challenges, research shows that online education was quite hampered by network problems, energy, inaccessibility, and unavailability [28], factors that in the reality of Latin America were more noticeable. Regarding engineering, it is said that the downloadable digital material was to some extent beneficial for learning, but it cannot be replaced by the face-to-face environment that allows association with laboratory equipment and field trips that provide a direct approach to the area of study [29], [30], [31], from this deduction doubts and concerns were born by students about the lack of practical training within their areas of study [32].

The Covid-19 pandemic has changed the lives of the general population including students in particular aspects, among them are students who were in the transition stage starting their university studies (Post pandemic students) and students who were interrupted in the middle of their process (Pre pandemic students), however, both groups were separated from their social groups and were in stressful situations due to uncertainty in education [11], [33], these changes negatively affected the mental health

and socialization of users [34], factors that have an impact on possible changes in terms of the culture of post-pandemic and pre-pandemic groups.

Institutional Context

The present research was conducted at the Universidad San Francisco de Quito USFQ, the first liberal arts university in Latin America located in the capital of Ecuador, Quito. It was founded in 1988 and was recognized by the Ecuadorian government in 1955 [9],[35]. According to the QS University Ranking, USFQ is ranked #1 in Ecuador and #60 in Latin America [19]. The university has minority programs and awards scholarships to more than one hundred students from ethnic groups each year. According to CEAACES, USFQ is one of the three institutions in the country that provides quality education and has 51 bachelor's degrees, a mass of 15 master's programs, and currently, a doctoral program taught in Spanish with English language options [35],[17]. It has 250 international research agreements and 114 international exchange programs with more than 24 countries. USFQ enrolls around six thousand students each year and supplies approximately 500 professionals during the year [36]. Finally, USFQ is the only university in the world that has a campus in the Galapagos Islands and the Tiputini Amazon Rainforest, allowing students to share experiences with researchers from all over the world [17].

Methodology

The research method used for data collection was based on the survey modified by Sharma [16], the same that was collected quantitatively to measure the five cultural dimensions of Hofstede in the civil engineering major at Universidad San Francisco de Quito USFQ. The latest Hofstede studies add a sixth dimension, however, due to the collection of data from earlier dates the study focuses only on the five main ones described above. The survey was administered online with the Qualtrics platform obtaining data from civil engineering students. The objective of the research was to collect data obtained at the beginning of 2020 when the Covid-19 pandemic was not yet present in Ecuador and data from the year 2022 when the on-site return to educational facilities took place. Using these data, a comparative analysis was made between pre-pandemic and post-pandemic students. Although USFQ students have an adequate level of English, in order to avoid confusion, the first step was to make an adequate translation into Spanish. The translation was validated by the researchers using several native Spanish speakers and was then provided to the study groups. Once the translation was confirmed, it was converted into an online version.

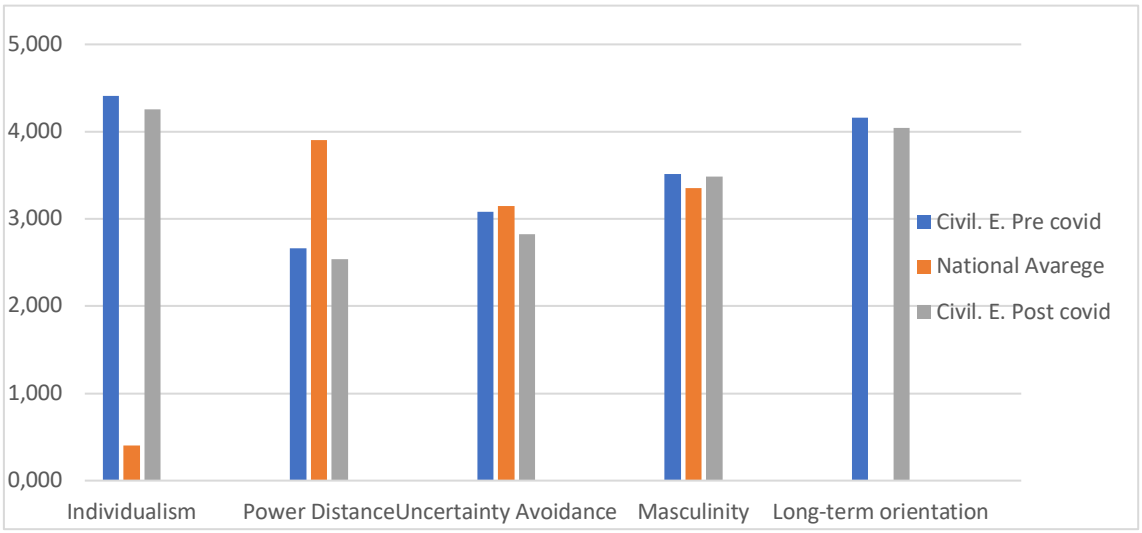
The objective of the research was to collect data obtained at the beginning of the year 2020 when the Covid-19 pandemic was not yet present in Ecuador and data from the year 2022 when the face-to-face return to the educational sites took place. With these data, a comparative analysis was made between pre-pandemic and post-pandemic students. The data were processed and managed in Qualtrics, then classified in Excel, and finally analyzed in SPSS software. The analysis was mainly based on a t-student distribution to find significant differences between the results with a p-value of 0.005. The survey was based on five sections of eight multiple choice questions to obtain a better approach by the respondents and represent each of Hofstede's dimensions, a scale of 1 to 5 was defined being 1 strongly disagree and 5 strongly agree, in the case of individualism a user with a score of 5 would mean he/she has a strong inclination

towards individualism while a score of 1 would mean a greater tendency towards collectivism, this same philosophy is applied in the five study dimensions; individualism, power distance, uncertainty avoidance, masculinity, and long-term orientation. To confirm the quality of the research, it was based on earlier studies conducted by one of the authors. Content validity was discussed and determined by the researchers in consensus.

Results and Discussion

Figure 2 shows the detail of the arithmetic means of the civil engineering students by the group for each of the dimensions of culture proposed by Hofstede. The results obtained using SPSS software show means with a maximum value of 5 and a minimum of 1, i.e., the higher the score, the greater the tendency of the study group to the dimension described. In addition, the national means of the Hofstede online tool are represented to have a visual perspective between the USFQ civil engineering students pre and post-pandemic and the national means.

Figure 2. National averages vs. Civil engineering averages at USFQ



As a first analysis and based on the national averages of the Hofstede online tool [23], we can find differences between civil engineering students in general and the national averages. The dimension with the most difference is individualism, according to the data in Figure 2 civil engineering students at Universidad San Francisco de Quito tend to a high level of individualism, a factor that goes against the great collectivism that characterizes the national averages of Ecuador.

In power distance, we can observe the difference between the students of the educational institution of study and the national averages so that in Ecuador the acceptance of power inequality is accepted, and the relationship between bosses and employers is not collaborative. At USFQ we can observe an average score within this dimension, giving us to understand that the USFQ community allows an environment where collaboration between students and professors is greater, without leaving aside the mutual respect between groups, this difference in contour with the national averages may be due to the liberal internal policies that characterize USFQ.

These variations in national averages can be explained by Sharma, who suggests that cultural dimensions can be dynamic because they are linked to the context in which they are measured [36],[16].

As for the other dimensions, there are no relevant differences that can be analyzed in-depth, and in the case of long-term orientation, since there is no national average, it is impossible to analyze it; however, it opens the way for new research to measure this dimension based on updated data in the dimension.

Analysis of civil engineering students Post- and Pre-Covid-19

In the research conducted, the aim is to understand how the Covid-19 pandemic affected students who were one of the most affected groups forced to make drastic changes in their educational process [11]. The pandemic opened the way to new technologies and teaching methodologies that could trigger changes in the culture of students. It is expected to find differences between students who were interrupted in their traditional educational processes due to the pandemic and students who entered their university studies already remotely considered as post- Covid students.

A t-test was performed with $\alpha = 0.05$, and it was determined if there were significant differences based on the p-value assigned. Table 1 shows the results obtained using the SPSS computer program, with the samples and the means of each study group about their cultural dimension, in addition to the significance values, marked with red those differences that are represented in each dimension.

Table 1: Comparison of Hofstede's dimensions between civil engineering students' Pre-pandemic and Post-pandemic.

Dimension	Grupo	N	Mean	Significance
Individualism	ICV 2020	39	4,40980	0,02000
	ICV 2022	100	4,25268	
Power Distance	ICV 2020	39	2,66255	0,20800
	ICV 2022	100	2,54140	
Uncertainty Avoidance	ICV 2020	39	3,08196	0,03000
	ICV 2022	100	2,82370	
Masculinity	ICV 2020	39	3,51419	0,73300
	ICV 2022	100	3,48598	
Long-term orientation	ICV 2020	39	4,16163	0,30400
	ICV 2022	100	4,04240	

We begin with the individualism dimension, which has a mean of 4.41 for pre-pandemic and 4.25 for post-pandemic students, with a p-value of 0.02 showing a significant difference between the study groups, however, both groups are within the individualistic zone of the spectrum. Continuing with power distance, a mean of 2.66 was collected for pre-pandemic students and 2.54 for post-pandemic students, with a p-value of 0.208, indicating that there is no significant difference, however, based on their means it is possible to perform an analysis, on the other hand, it is likely that through a more conservative statistical analysis, it is possible to find significance in this dimension. As for uncertainty avoidance, the means were 3.08 for pre-pandemic students and 2.823 for

post-pandemic students, two means that do reflect a significant difference with a p-value of 0.03. On the other hand, masculinity reflected means within the male spectrum of the spectrum with means of 3.51 for pre-pandemic students and 3.48 for post-pandemic students. The differences are not significant, but analysis can be made based on their means. Finally, with a long-term orientation, the means reached a p-value of 0.304, a value that reflects that there are no significant differences, the means for this dimension were 4.16 and 4.04 for pre-pandemic and post-pandemic students respectively, as well as the power distance dimension, a more conservative analysis could reflect significant differences in this dimension due to its relatively low p-value.

It is important to emphasize that post-pandemic students are students who have so far received most of their studies remotely or online and pre-pandemic students are students who started their studies regularly and were interrupted in the middle of their process by social isolation.

Individualism represents the degree of preference for teamwork and group membership in a society. In the educational context, individualistic people tend to be students who prefer individual work rather than collective work and seek their benefit [37]. Based on the results in Table 1, we observe that both groups score high on the spectrum of individualism, with pre-pandemic students having a higher mean generating a significant difference with post-pandemic students. However, it is interesting to note that students who had their studies in a face-to-face manner surrounded by their social groups have a higher level of individualism, this may be mainly due to the traditional education methodologies that have been used in most educational institutions.

Although Civil Engineering is a career that within the USFQ encourages teamwork through study groups for practical activities such as laboratories, students were more inclined to individual work [38], [39]. On the other hand, post-pandemic students, even though they were students who were separated from their social groups, have a lower mean within this dimension, characterizing them as individuals with a preference for collective work about pre-pandemic students, this variation may be because they are young people who are entering their university studies, they look for a way to belong to their social groups, With these students who kept their studies online, the need to return to campus and have the opportunity to form social groups lasted during the time of social distancing, a factor to which no one was accustomed and mainly this group who did not have ties in the new educational establishment in this case USFQ.

The expected data were opposite to those found since it was believed that pre-pandemic students would have a lower inclination towards individualism due to the contact between people they maintained in their daily lives and that their university activities in general were centered on social groups to which they sought to belong. On the other hand, with post-pandemic students, a greater inclination toward individualism was expected because with isolation they had to adapt to individual work and little socialization with the outside world. Further research should be conducted to determine the reason for these changes based on the results obtained.

Based on Table 1, we can see that the difference between the two study groups in **Power Distance** is not significant; however, some variations can be analyzed based on the Covid-19 context. The power distance refers to the acceptance of power inequality that a group maintains in society so having a high score in this dimension represents

groups that live with power inequality as a normal aspect of their lives, and there may be traits of inferiority within their culture; on the other hand, a negative score would indicate the opposite.

In the educational environment, hierarchies within an educational institution are mainly marked by the interaction between teacher and student. The policies of the Universidad San Francisco de Quito allow the distance of power to be less perceptible than in other universities in the country, however, respect among members of the community is always well established, generating empathy and trustworthiness, factors that in turn reduce student dropout [40].

Based on the results of the pre-pandemic civil engineering students we can observe a slightly higher average with the post-pandemic civil engineering students, this factor can be understandable due to the new methodologies adopted during the pandemic. With traditional face-to-face education, it is common to observe the superior entity at the front of the room imparting their knowledge to their students, associating being in front of the room as a position of power, since the person in that position must be heard by the rest. On the other hand, with online education, there was no such position associated with power, so it is understandable to observe a reduction in this dimension, since being all behind a screen, one can sense a greater equality in terms of the positions of all the people within that social group. It can be added that power distance is also associated with the measure of collaboration between study members, so with pre-pandemic students we can argue that collaboration was slightly lower due to personal aspects of everyone such as nerves, participating or collaborating required a greater predisposition on the part of the student. With the online classes, participation was easier, so collaboration and interaction were more accepted by the students. These results were expected for the reasons explained above.

Due to the low level of p-value in this dimension, it can be argued that there is a difference that can be further studied in subsequent research thus opening the door for future research.

Uncertainty avoidance defines how a group deals with uncertainty, i.e. how they react to the unknown. A high score on this dimension indicates that the study group has a greater aversion to the unknown and a lower score is equivalent to an acceptance of risk. In addition, a high score on this dimension is related to attachment to traditions and structured situations, while groups with lower scores represent individuals with the capacity to accept new ideas and innovation.

About Table 1 we can observe that both groups are slightly above average within this spectrum, however, the pre-pandemic civil engineering students have a higher mean, establishing a significant difference based on the p-value obtained through the computational analysis.

In the field of education about civil engineering, a higher than average level of uncertainty avoidance is expected because as engineers we are subject to the design of structures based on pre-established standards that set a course to be followed based on previous studies so that the use of new construction methods or design methods are avoided at least at the undergraduate level.

With a p-value of 0.03 the difference between the two study groups falls within the range of significance, we can argue that the Covid-19 pandemic was a factor that could affect the culture of the students in this dimension. The pre-pandemic students have been traditionally going through their preparation process without prolonged interruptions that prevent the continuation of their studies, so the uncertainty in their obligations was not much of a consideration. On the other hand, for students who were forced to change suddenly in their education model, change and adaptation of new ideas is something they accepted in that period, this event could indirectly make students more susceptible to change and better able to adapt to new models that allow them to continue with their daily activities.

Masculinity refers to groups that are characterized by having roles of competition and success, in this way they are more materialistic, and their score is 5, in the case of low scores, it is related to feminism and their role is centered on care, empathy, emotions, human interaction among other aspects.

Table 1 reflects averages that are more in the male range than the female, and the difference between the groups is insignificant according to the statistical analysis, we can see that they are quite similar, although the pre-pandemic engineers very slightly exceed the average of the post-pandemic engineers. Therefore, it is possible to argue that the Covid-19 pandemic did not cause alterations in the perception of the culture of the study subjects within this dimension of culture.

Within the educational environment, civil engineering is a technical career in which the works produced are seen in a more objective way, which makes them more susceptible to this assertive role characteristic of the masculinity dimension. During the Covid-19 pandemic, the focus on education in this aspect has not changed because the designs and calculations performed still had the same objective, which is their functionality, for this reason, it can be argued that social distancing and remote education were not caused for the alteration of the perception of the culture of civil engineering students of the Universidad San Francisco de Quito USFQ in the dimension of masculinity.

Long-term orientation tells us about the quality of the members of society to perform activities or have virtues that seek a reward in the future. Thus, groups with scores close to 5 are characterized by having habits of perseverance and thrift; on the other hand, scores close to 1 represent groups with more traditionalist habits focused on the present. This dimension has a difference between the study groups with a p-value of 0.30, as well as the power distance dimension, there is a difference that can be further analyzed, and in the case of using more conservative statistical analysis may provide a significant difference. This result encourages further studies focused on this dimension of culture.

The pandemic although statistically does not cause a significant alteration between both study groups, we can analyze the difference in their means. Both groups are trending at five within the dimension analyzed which corroborates with the civil engineering education provided by USFQ which is focused on training engineers who focus on the future, valuing today's sacrifice for tomorrow's reward, this approach has not changed during the Covid-19 pandemic, so we found no significant differences. However, the pandemic as we know mentally altered the students so that motivation decreased and fatigue increased factor that could reduce the way of thinking ahead the students, for this reason, the decrease in the means of the Post Covid-19 group who maintained their

studies remotely. However, further study is needed on the factors that may have affected the students in this cultural dimension.

Conclusions

The purpose of the research was to understand the cultural dimensions of civil engineering students at Universidad San Francisco de Quito and to determine whether the Covid-192019 pandemic generated changes in students' perceptions of culture. The study was based on Hofstede's theory of cultural dimensions with modifications proposed by Sharma. From the results obtained in general (Figure 2) we could find that even though the sample were Ecuadorian students, there were large differences in certain cultural dimensions with Hofstede's national averages. Although no statement can be made about the difference with the national averages, these data corroborate Sharma's statement that perceptions of culture vary according to the context in which they are measured [16]. It can be inferred that within the institutional context and based on the liberal policies of the university these cultural dimensions can change national averages, as an example in the dimension of power distance, the collaboration between student and professor is more established than with other institutions in the country. This definition can explain the great difference between civil engineering students of the Universidad San Francisco de Quito in the dimension of individualism and power distance with Hofstede's national averages.

Both groups lean towards individualism with high scores in this spectrum, suggesting that civil engineering students tend to be more individualistic. This characteristic is largely due to the way of education existing in the educational institution, since at the beginning of their university studies the civil engineering program focuses on more individualistic learning with exact science subjects such as physics, calculus, and chemistry, among others, evaluating students individually. Team projects are promoted at higher levels. However, the evaluation of students is still largely individual. This important finding allows for recommending the incentive for collaborative work, since engineering in general is not an individual field and requires the association between engineers and other professionals for problem-solving and project development, so teamwork is important in the field of civil engineering. Both groups also have an intermediate score in terms of power distance, we can conclude that it is related in the same way as individualism with the educational institution. USFQ is characterized by its liberal policy where it promotes an environment of equality among its community, a factor that is reflected in its power distance score.

In the comparative analysis between pre-pandemic and post-pandemic students, the SPSS statistical program found significant differences based on a p-value of 0.05, these dimensions of culture are individualism where the result was quite interesting, placing pre-pandemic engineers in a more individualistic position than post-pandemic students. It would be expected that pre-pandemic students, being individuals who had a traditional education and being people who belonged to social groups, their level of collectivity would be higher than students who due to social distancing have not been able to make use of the facilities and therefore not have the opportunity to socialize with others. However, the results were the opposite, and it can be concluded that in post-pandemic students the need to belong to social groups and to seek collectivity among fellow students increased during the two years of confinement.

Another significant difference is the avoidance of uncertainty, it was concluded based on the results that the pandemic allowed the students to adapt to new changes, this changed the culture in the group and allowed them to accept uncertainty and avoid traditionality. The pandemic altered the culture of civil engineering students to the point of forming groups that prefer mild collectivism compared to pre-pandemic students and a greater acceptance of uncertainty compared to pre-pandemic students. The Covid-19 pandemic caused several changes in students of all majors in all educational institutions, both mentally and socially [34]. Identifying the cultural dimensions in these students allows us to determine the variations that this event may have caused and thus develop pedagogical interventions to strengthen education and collaborative work in civil engineering. In this way, future collaborations for different engineering disciplines can be fostered.

This study is considered relevant to better understand the role of the Covid-19 pandemic in the perception of civil engineering cultures. It is planned to continue with the research and collect data from other engineering fields that will allow us to identify the perceptions in their areas and look for differences between them, in addition, it is aspired to collect information in different countries to report on the main differences and similarities between countries based on the theory of Hofstede's dimensions.

References

[1] J. Namenwirth y R. Weber, «Ph (1987) Dynamics of Culture», *Boston MA Allen Unwin*.

[2] G. Hofstede, «Cultural dimensions», *Www Geert-Hofstede Com*, 2003.

[3] H. Murzi y J. M. Cruz, «Measuring disciplinary perceptions of engineering from a cultural lens: a validation of an instrument in a research technical university», *J. Educ. Cult. Stud. 4 1*, p. 19, 2019, doi: https://doi.org/10.22158/jecs.v4n1p19.

[4] H. Murzi *et al.*, «Cultural dimensions in academic disciplines, a comparison between Ecuador and the United States of America», en *2021 ASEE Virtual Annual Conference Content Access*, 2021.

[5] C. J. McCall, D. R. Simmons P.E., y L. D. McNair, «Disciplinary Influences on the Professional Identity of Civil Engineering Students: Starting the Conversation», *ASEE Conf.*, 2016, [En línea]. Disponible en: https://peer.asee.org/26850

[6] A. S. Patil, «The global engineering criteria for the development of a global engineering profession», *World Trans. Eng. Educ.*, vol. 4, n.º 1, pp. 49-52, 2005.

[7] B. Fredrik, «The analysis of culture in complex societies», *Ethnos*, vol. 54, n.º 3-4, pp. 120-142, 1989.

[8] C. lee, *That complex whole: Culture and the evolution of human behavior*. Routledge, 2019.

[9] M. Guerra, H. Murzi, J. C. Woods, Jr, y A. Strandberg, «Understanding Students' Perceptions of Dimensions of Engineering Culture in Ecuador», *ASEE Conf.*, jun. 2020, doi: 10.18260/1-2--35429.

[10] M. A. Guerra y C. Gopaul, «IEEE Region 9 Initiatives: Supporting Engineering Education During COVID-19 Times», *IEEE Potentials*, vol. 40, n.º 2, pp. 19-24, 2021, doi: 10.1109/MPOT.2020.3043738.

[11] S. J. Daniel, «Education and the COVID-19 pandemic», *PROSPECTS*, vol. 49, n.º 1, pp. 91-96, oct. 2020, doi: 10.1007/s11125-020-09464-3.

[12] J. D. Chertoff, J. G. Zarzour, D. E. Morgan, P. J. Lewis, C. L. Canon, y J. A. Harvey, «The Early Influence and Effects of the Coronavirus Disease 2019 (COVID-19) Pandemic on Resident Education and Adaptations», *Focus Data Distill.*, vol. 17, n.º 10, pp. 1322-1328, oct. 2020, doi: 10.1016/j.jacr.2020.07.022.

[13] C. Senior, C. Howard, E. Stupple, y R. Senior, «Student Primacy and the Post Pandemic University», *Front. Educ.*, 2021, doi: https://doi.org/10.3389/feduc.2021.712767.

[14] F. Molina-Granja, L. Barba-Maggi, L. Molina-Valdiviezo, y W. Bustamante-Granda, «Demand and employability study of the data science engineering career in Ecuador», en *2022 17th Iberian Conference on Information Systems and Technologies (CISTI)*, 2022, pp. 1-5. doi: 10.23919/CISTI54924.2022.9820496.

[15] G. Hofstede, «Dimensionalizing Cultures: The Hofstede Model in Context», *Online Read. Psychol. Cult.*, 2011, doi: https://doi.org/10.9707/2307-0919.1014.

[16] P. Sharma, «Measuring personal cultural orientations: scale development and validation», *J. Acad. Mark. Sci.*, vol. 38, pp. 787-806, 2010.

[17] QSTopUniversities, «Universidad San Francisco de Quito (USFQ)», *Top Universities*, 2022. [En línea]. Disponible en: https://www.topuniversities.com/universities/universidad-san-francisco-de-quito-usfq

[18] E. Murzi y G. Homero, «Understanding Dimensions of Disciplinary Engineering Culture in Undergraduate Students», *Va. Tech*, 2016, [En línea]. Disponible en: http://hdl.handle.net/10919/71775

[19] M. Minkov y Geert Hofstede, «Cultural differences in a globalizing world», *Emerald*, 2013.

[20] A. Khalouei, «Levels of Analysis and Hofstede's Theory of Cultural Differences: The Place of Ethnic Culture in Organizations», *Int. Proc. Econ. Dev. Res.*, vol. 11, 2011, [En línea]. Disponible en: https://www.academia.edu/7853209/Levels_of_Analysis_and_Hofstedes_Theory_of_Cultural_Differences_The_Place_of_Ethnic_Culture_in_Organizations?auto=citations&from=cover_page

[21] M. Minkov y G. Hofstede, «Hofstede's Fifth Dimension: New Evidence From the World Values Survey», *J. Cross-Cult. Psychol.*, vol. 43, n.º 1, pp. 3-14, 2012, doi: 10.1177/0022022110388567.

[22] G. Hofstede, *Cultures and Organizations: Software of the Mind (side 25, 26, 53, 84, 113, 166)*. New York: McGraw-Hill. Fundet i: Peng, Mike & Meyer, Klaus (2016 …, 1997.

[23] Hofstede Insights, «COUNTRY COMPARISON». 2022. [En línea]. Disponible en: https://www.hofstede-insights.com/country-comparison/ecuador,the-usa/

[24] E. Tarapuez Chamorro, «Las dimensiones culturales de Geert Hofstede y la intenciÃ³n emprendedora en estudiantes universitarios del departamento del QuindÃ\-o (Colombia)», *Pensam. GestiÃ³n*, pp. 60-90, jul. 2016.

[25] T. Singhal, «A Review of Coronavirus Disease-2019 (COVID-19)», *Indian J. Pediatr.*, vol. 87, n.º 4, pp. 281-286, abr. 2020, doi: 10.1007/s12098-020-03263-6.

[26] C. M. Toquero, «Emergency remote education experiment amid COVID-19 pandemic», *IJERI Int. J. Educ. Res. Innov.*, n.º 15, pp. 162-176, jul. 2020, doi: 10.46661/ijeri.5113.

[27] S. Z. Salas-Pilco, Y. Yang, y Z. Zhang, «Student engagement in online learning in Latin American higher education during the COVID-19 pandemic: A systematic review», *Br. J. Educ. Technol.*, vol. 53, n.º 3, pp. 593-619, 2022, doi: https://doi.org/10.1111/bjet.13190.

[28] E. M. Onyema y N. C. Eucheria, «Impact of Coronavirus pandemic on education», *J. Educ. Pract.*, vol. 11, n.º 13, pp. 108-121, 2020.

[29] J. Acosta y M. A. Guerra, «Validating Guerra's Blended Flexible Learning framework for Engineering Courses», en *2022 ASEE Annual Conference & Exposition*, 2022.

[30] H. Velásquez, M. Guerra, y M. Jimenez, «Exploring Interdisciplinary Contributions to More Sustainable Solutions in the Built Environment and Infrastructure Development Students», en *2022 ASEE Annual Conference & Exposition*, 2022.

[31] A. Bao, «Implementing Digital Learning to Enhance Post-Pandemic Civil Engineering Teaching», *2022 ASEE Annu. Conf. Expo.*, 2022, [En línea]. Disponible en: https://pesquisa.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov/resource/pt/covidwho-2044969

[32] S. Asgari, J. Trajkovic, M. Rahmani, W. Zhang, R. C. Lo, y A. Sciortino, «An observational study of engineering online education during the COVID-19 pandemic», *Public Libr. Sci. San Franc. CA USA*, 2021.

[33] N. Granja, V. Guerra, y M. A. Guerra, «Give me a coffee break! Pilot study on improving exam performance and reducing student stress», en *2022 ASEE Annual Conference & Exposition*, 2022.

[34] E. Mushtaha, S. A. Dabous, I. Alsyouf, A. Ahmed, y N. R. Abdraboh, «The challenges and opportunities of online learning and teaching at engineering and theoretical colleges during the pandemic», *Ain Shams Eng. J.*, vol. 13, n.º 6, p. 101770, 2022, doi: https://doi.org/10.1016/j.asej.2022.101770.

[35] A. Velasco, M. Valencia, S. Morrow, y V. Ochoa-Herrera, «Understanding the limits of assessing sustainability at Universidad San Francisco de Quito USFQ, Ecuador, while reporting for a North American system», *Int. J. Sustain. High. Educ.*, 2018.

[36] J. Ubidia, M. Guerra, V. Viteri, y H. Murzi, «Understanding Student's Perceptions of Cultural Dimensions in construction majors: Deconstructing barriers between architecture and civil engineering students», *2022 ASEE Annu. Conf. Expo.*, ago. 2022, [En línea]. Disponible en: https://peer.asee.org/40612

[37] C. Ubidia, M. Guerra, V. Guerra, y C. Gallardo, «Work in Progress: Collaborative Environments in Architecture and Civil Engineering Education–Case Study», en *2022 ASEE Annual Conference & Exposition*, 2022.

[38] M. Guerra y T. Shealy, «Teaching user-centered design for more sustainable infrastructure through role-play and experiential learning», *J. Prof. Issues Eng. Educ. Pract.*, vol. 144, n.º 4, p. 05018016, 2018.

[39] M. A. Guerra y Y. Abebe, «Pairwise Elicitation for a Decision Support Framework to Develop a Flood Risk Response Plan», *ASCE-ASMEJournalofRiskandUncertaintyinEngineeringSystems*, jul. 2018, doi: 10.1115/1.4040661.

[40] M. E. Mariño, C. Ubidia, y M. Guerra, «Work in Progress: Designing a First-Year Hands-on Civil Engineering Course to Reduce Students Dropout and Improve the Overall College Experience», *2022 ASEE Annu. Conf. Expo.*, 2022.