

# Analysis of women's participation in STEM careers pre- and post- pandemic COVID - 19

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## Abstract

The Covid-19 pandemic impacted the world's population in different sectors: trade, agriculture, transportation, health, and education, among others. The article is focused on the educational sector, at the higher education level, which generated a series of adverse effects such as loss of learning, school dropout, and social, emotional, and psychological problems, still, at the same time the pandemic generated positive changes to the current educational system such as the restructuring of educational policies that support the flexibilization of different study modalities, teaching methodology, adaptation of new technologies, among other changes that allowed to prepare all the actors involved (teachers, students, parents) in the teaching-learning process. Therefore, the participation of women and men is presented and analyzed through enrollment statistics of some STEM careers of the participating universities during and post-pandemic in the period of 2019 - 2022 in relation to gender inequality in the Salvadoran context. In addition, some projects and strategies that seek to support the reduction of university desertion by women in El Salvador are presented. For the development of this work, the collaboration of some foundations in El Salvador related to the promotion of projects and strategies that promote the insertion of women in STEM careers was requested. At the same time, the participation of public and private universities in El Salvador, which offer the different STEM careers selected for the study, was also requested. Finally, the study raises a new question about the phenomenon of exponential increase hypothetically linked to the teaching modality observed in university enrollment statistics.

## Keywords

El Salvador, gender, equality, pandemic, Covid-19, women, STEM.

## 1. INTRODUCTION

The educational crisis caused by Covid-19 brings with it huge challenges, but it also presents an unprecedented opportunity for the educational systems of Latin America and the Caribbean: the opportunity to carry out structural reforms, to transform themselves from the root. Returning to the classroom and re-establishing the situation quo before the onset of the pandemic is neither feasible nor desirable. It is possible to give continuity to many innovations and to the growing flexibility developing before the emergency among all educational system players [1].

As a result of the aforementioned, the research is focused on the statistics of men and women university students in the period 2019 - 2022, in order to know if the pandemic generated a decrease in enrollment figures as well as to make visible the gender inequality in STEM careers, or at least it is the substantiated speculation that is expected to be validated through the findings exposed in the different sections of the article.

## 2. BACKGROUND

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Pandemics have a negative effect on all sectors: health, industry, agriculture, and education, among others. The current research is focused on the educational sector, therefore, a series of topics have been broken down to explain the relationship with gender inequality in education.

## **2.1. IMPACT OF COVID-19 PANDEMIC ON EDUCATION SECTOR**

In 2020, Latin America and the Caribbean had the longest school closures, with an average of 158 days without classes, affecting more than 160 million students in the region. By mid-2021, more than 100 million students are present in education systems that are only partially open, about 60 million are in fully closed systems, and less than 1 million are in fully open systems [4].

In the rest of the world during the first quarter of 2020, on-site classes were suspended and education came to a standstill. This forced shutdown not only caught education systems off guard but also presented them with a seemingly almost impossible demand: to keep education alive while schools were closed, implementing different distance learning modalities for which they had never really prepared.

So education systems around the world reacted in different ways, using a variety of distance education tools, from using educational platforms to simpler tools such as instant messaging applications for smartphones and even photocopying, distributing materials, and making phone calls.

This created an additional challenge: unequal access to connectivity, equipment, and educational materials. It also highlighted the unequal conditions in which students are living and able to study at home, as well as the support they may receive from their families.

Thus, despite all efforts, the pandemic has resulted in a major educational loss. Much of the knowledge that students should have acquired during the 2020 and 2021 school years was simply not achieved or was achieved in a very partial and uneven manner.

Based on an OECD study, for a high percentage of students, learning appears to have been almost non-existent. For example, it cites early tracking from an online mathematics teaching application in several U.S. school districts, which suggests that learning declined sharply during the crisis, especially in schools in low-income areas. In the same way, evidence from Germany shows that the time children spent on school activities was cut in half by the pandemic, with 38% of students spending no more than two hours a day studying and 74% spending less than four hours a day. Meanwhile, time spent on entertainment - watching television or playing computer or cell phone games - increased to more than five hours a day.

An estimated proportion of children in low- and middle-income countries who are unable to read and understand simple text by the end of primary school could increase from 51% to 62% as a consequence of the pandemic. Additionally, the proportion of lower secondary school children below the minimum level of achievement, as measured by PISA international test scores, could increase from its current level (55%) to 71% [3].

## **2.2. COVID-19 PANDEMIC AND GENDER INEQUALITY IN EDUCATION**

As close to 1.2 billion school-aged children are still affected by school closures and face the reality of distance learning in the midst of the COVID-19 pandemic, UNICEF warns that inherent inequalities in access to tools and technology could exacerbate the global learning crisis.

"Access to technology and materials needed to continue studying while schools are closed is remarkably unequal. Similarly, children who do not have adequate help to study at home have hardly any resources to facilitate their education. Providing a diversity of educational tools and expanding internet access for every school and every child is critical," said Robert Jenkins, UNICEF's Chief of Education. "Before COVID-19, education was already in crisis. Now we are facing a deepening and potentially even more divisive education crisis." [8].

The pandemic intensified gender gaps already existing in education and employment. Economic crisis resulted in a significant increase in the risk of dropout and a substantial increase in the proportion of young people excluded from the education system and the labor market, particularly for women and the most vulnerable sectors (the poor and young people located in rural areas). The percentage of women who are neither studying nor gainfully employed continues to be between 9 and 23% higher

than that of men in the same 20-24 age group. In the labor markets, there is a similar initial impact on both genders, but the recovery is much faster for men.

Before the pandemic, the time spent on household chores by women doubles from age 14 to 18. With the 2020 quarantines, this increased even more. The number of hours spent on housework increased by 18% for women and only 2% for men. This inequity has repercussions on the time they can devote to study, significantly reducing their school results. For many girls and adolescents, especially in rural areas, their natural role is based on a combination of work in the home and external demands, which is what they have always seen reflected in the women in their families and communities. [9].

### **2.3. PROGRAMS SUPPORTING WOMEN'S EDUCATION DURING PANDEMICS**

Muchas Más is a foundation that provides access to education to Salvadoran girls and young women in order for them to be able to pursue higher education in their chosen field, have access to dignified jobs and income, become economically autonomous, and develop their own life projects.

This foundation has created a strategy for the period 2021 - 2025 in which the central axis of the intervention of Muchas Más is providing access to higher education and the knowledge and exercise of rights from a feminist perspective. Experience has taught that, in order to break the intergenerational cycle of poverty and to be masters of their lives, it is key to develop strategies that address and sustain their needs in an integral manner, both academic and formative as well as economic, psychological, and relational. In 2021-2025, the program will continue to provide personalized scholarships for young women to access high school and university studies, strengthening the focus on STEM careers, with the aim of helping to break gender gaps in these areas and expand decent work opportunities for girls.

Muchas Más Beat: This is the chapter of BeatsByGirlz in El Salvador. The Project aims to contribute to the prevention of school dropouts, the development of digital skills in the context of COVID-19, and bringing technology in a friendly way through music and music through technology [10].

## **3. METHODOLOGY**

The type of research is documentary - field, the research design is quantitative and the scope of the study is descriptive.

1. Materials and methods: Some of the techniques for the collection of quantitative data: request for data from the participating institutions in virtual/presential mode, making use of software that facilitates data collection.
2. Population: the Higher Education Institutions (HEI) of El Salvador, are composed of 24 universities, 11 specialized institutes, and 6 technological institutes, but for the research, a profile was made that highlights some of the HEI, the study populations is made up of 6 universities, 5 private and 1 public; Finally, with regard to the population of STEM careers, those registered at the national level according to the Ministry of Education - MINED were taken into account. When applying the criteria of the profile created, the population was reduced to 8, those careers with the highest demand at the national level according to MINED statistics.
3. Sample: The sample for the study population of the HEIs was obtained through non-probabilistic sampling by quotas; subsequently, the sample for the study population of the institutions and STEM careers was obtained through non-probabilistic sampling by convenience.
4. Criteria for obtaining the sample of Higher Education institutions
  - Academic offer of STEM careers
  - Linkage with promotional projects in STEM/ICT training areas
  - Central geographic area

5. Criteria for obtaining the sample of the 6 STEM programs
  - Highest student demand according to statistics from the Ministry of Education - MINED.
  
6. Criteria for obtaining non-educational institutions participating in the study
  - Being a non-educational institution
  - Linkage with projects, policies, promotion strategies in STEM/ICT training.
  - Geographic area Central

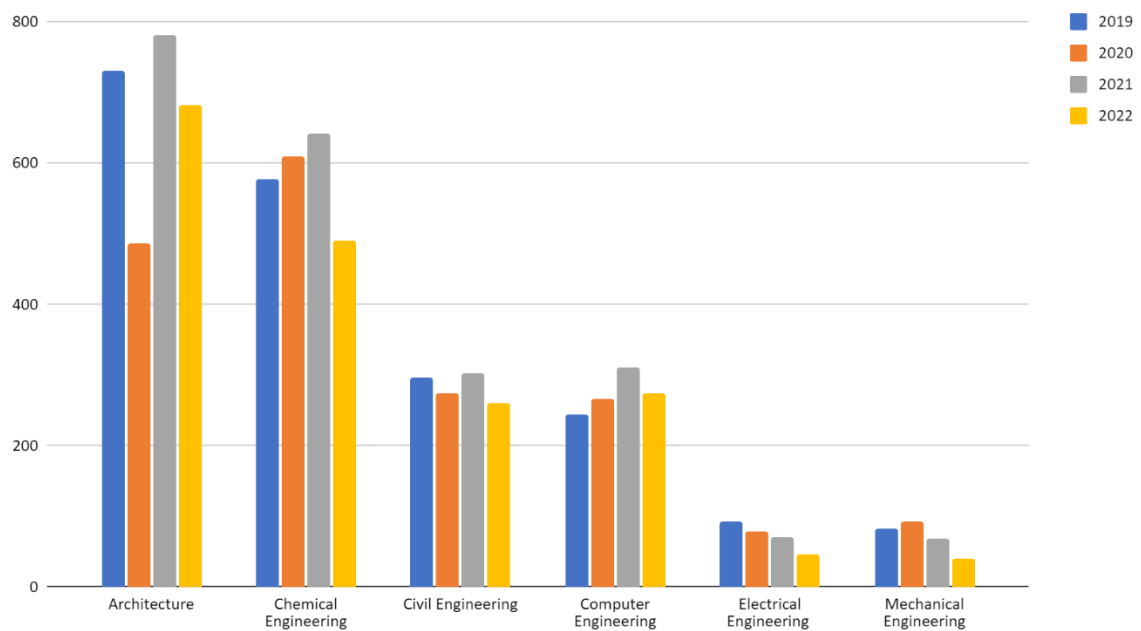
## 4. RESULTS

### 4.1. STATISTICS OF WOMEN BY STEM CAREER PRE- AND POST PANDEMIC COVID- 19, - UNIVERSIDAD CENTROAMERICANA JOSÉ SIMEÓN CAÑAS (UCA)

**Table 1**

Enrollment record by female gender for the 2019 - 2022 period - UCA

Careers	2019	2020	2021	2022
Architecture	731	487	780	682
Civil engineering	296	274	303	261
Electrics engineering	93	79	71	46
Informatics engineering	244	266	310	275
Mechanical engineering	83	92	68	40
Chemical engineering	577	609	642	490



**Figure 1:** Enrollment statistics - UCA

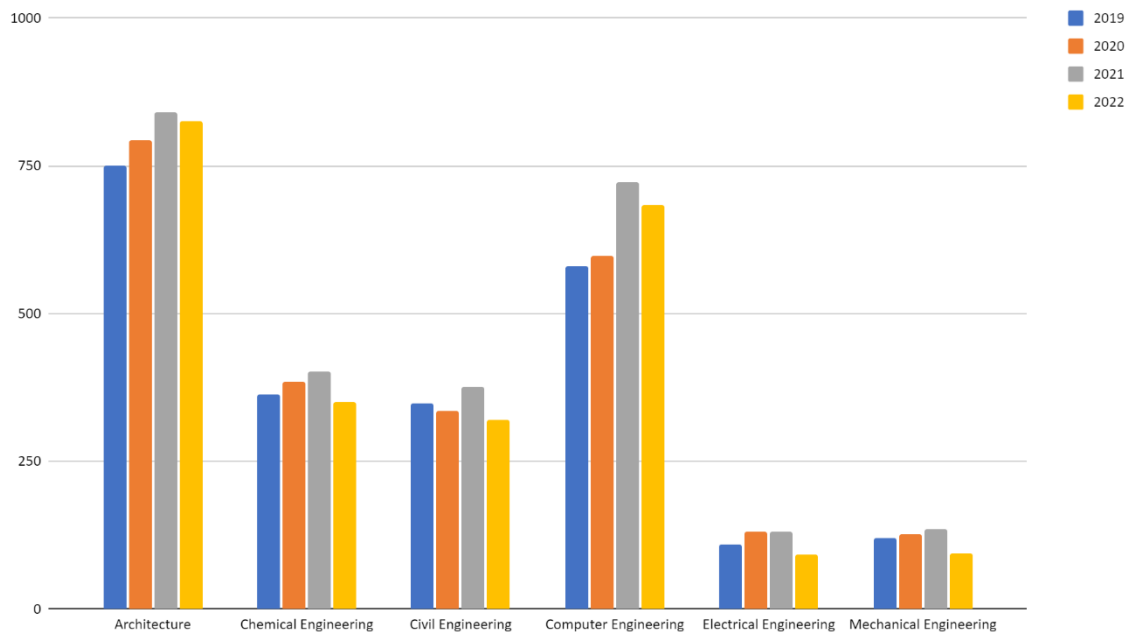
Figure 1 shows statistics corresponding to the Universidad Centroamericana José Simeón Cañas, which reflects the number of female students enrolled in the period 2019 - 2022, for some STEM careers. In the period of 2019 - 2022 the careers with the highest demand for enrollment by young women: Architecture careers 13.25%, 8.83%, 14.14%, 12.37%; career Chemical Engineering 12.75%, 13.46%, 14.18%, 10.83%; Civil Engineering career 12.80%, 11.85%, 13.10%, 11.18%; Mechanical Engineering career 14.12%, 15.65%, 11.56%, 6.80%; Electrical Engineering career 15.25%, 12.95%, 11.64%, 7.54%, and Computer Engineering career 17.63%, 19.22%, 22.40%, 19.87%.

## 4.2. STATISTICS OF WOMEN BY STEM CAREER PRE- AND POST PANDEMIC COVID- 19, - UNIVERSIDAD DE EL SALVADOR – FACULTY OF ENGINEERING AND ARCHITECTURE (UES -FIA)

**Table 2**

Enrollment record by female gender for the 2019 - 2022 period -UES - FIA

Careers	2019	2020	2021	2022
Architecture	751	793	840	826
Civil engineering	347	334	376	319
Electrics engineering	581	597	722	684
Informatics engineering	110	130	130	92
Mechanical engineering	119	126	135	95
Chemical engineering	362	384	402	351



**Figure 2:** Enrollment statistics - UES - FIA

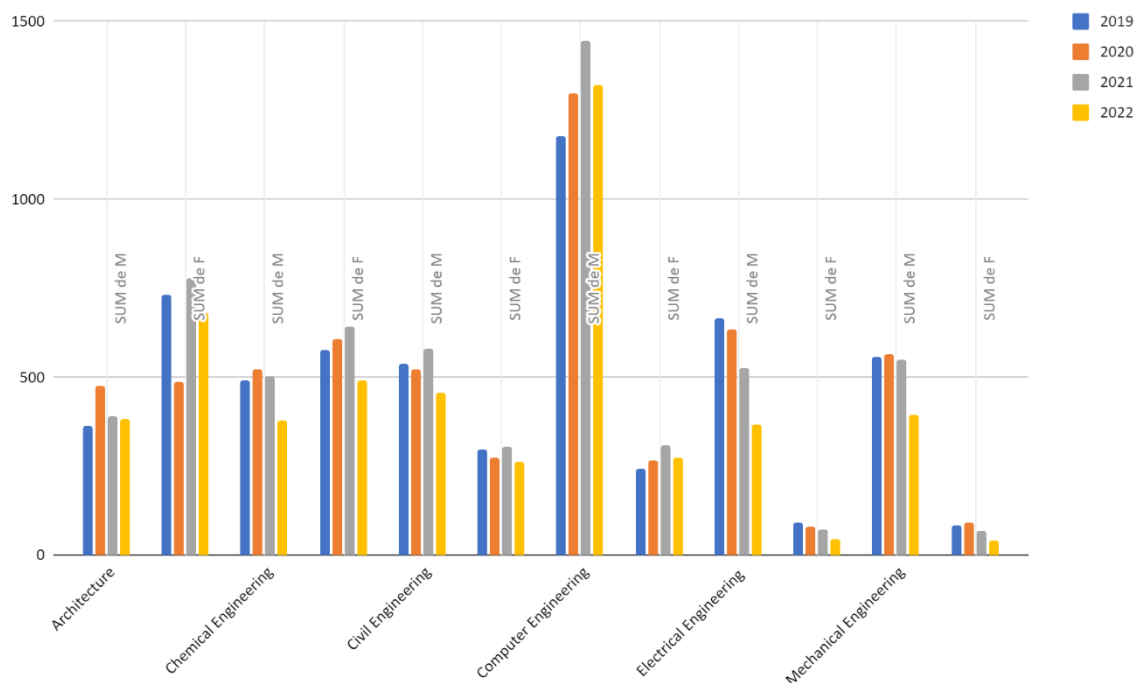
Figure 2 shows statistics corresponding to the University of El Salvador, Faculty of Engineering and Architecture - FIA, which indicates the number of female students enrolled in the period 2019 - 2022, in some of STEM careers. In the period of 2019 - 2022 the careers with the highest demand for enrollment by young women: the career of Architecture 9.69%, 10.24%, 10.84%, 10.66%; the career of Computer Systems Engineering 10.21%, 10.49%, 12.69%, 12.02%; Civil Engineering 10.32%, 9.93%, 11.18%, 9.49%; Chemical Engineering 10.57%, 11.21%, 11.74%, 10.25%; Electrical Engineering 11.62%, 13.73%, 13.73%, 13.73%, 9.71%; Mechanical Engineering 12.43%, 13.17%, 14.11%, 9.93%.

### 4.3. COMPARATIVE STATISTICS BY GENDER OF STEM CAREERS PRE- AND POST PANDEMIC COVID - 19, - UNIVERSIDAD CENTROAMERICANA JOSÉ SIMEÓN CAÑAS (UCA)

**Table 3**

Enrollment record by gender for the period 2019 - 2022 - UCA

Year	4.3. Comparative statistics by gender for the period 2019 - 2022											
	Architecture		Civil Engineering		Electrics Engineering		Informatics Engineering		Mechanical Engineering		Chemical Engineering	
	M	F	M	F	M	F	M	F	M	F	M	F
2019	364	731	536	296	665	93	1178	244	556	83	491	577
2020	475	487	521	274	633	79	1297	266	566	92	523	609
2021	392	780	582	303	527	71	1446	310	549	68	503	642
2022	381	682	458	261	366	46	1323	275	395	40	377	490



**Figure 3:** Enrollment statistics by gender - UCA

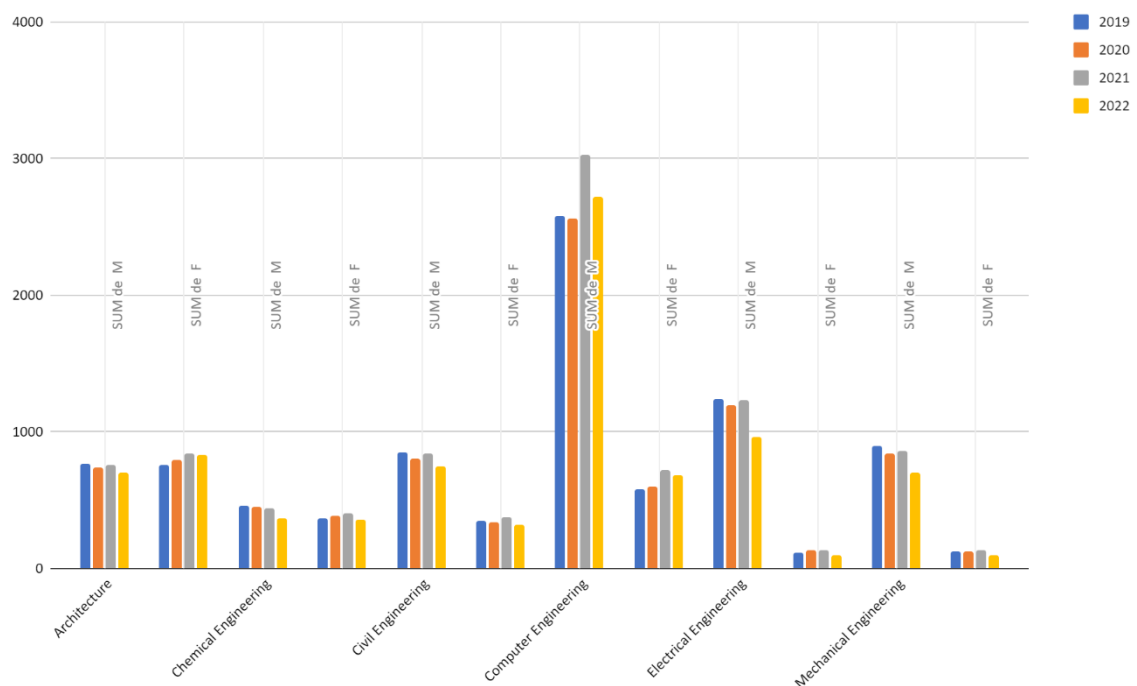
Figure 3, shows statistics corresponding to the Universidad Centroamericana José Simeón Cañas, which reflects a comparative of enrollments by gender in the period 2019 - 2022, for some of STEM careers, the Architecture career - female 27.28%, 18.17%, 29.10%, 25.45% - male 22.58%, 29.47%, 24.32%, 23.64%; Chemical Engineering career - female 24.89%, 26.27%, 27.70%, 21.14% - male 25.92%, 27.61%, 26.56%, 19.90%; Civil Engineering major - female 26.10%, 24.16%, 26.72%, 26.72%, 23.02% - male 25.56%, 24.85%, 27.75%, 21.84%; Mechanical Engineering major - female 29.33%, 32.51%, 24.03%, 14.13% - male 26.91%, 27.40%, 26.57%, 19.12%; Electrical Engineering career - female 32.18%, 27.34%, 24.57%, 15.92% - male 30.35%, 28.89%, 24.05%, 16.70% and Computer Engineering career - female 22.28%, 24.29%, 28.31%, 25.11% - male 22.46%, 24.73%, 27.57%, 27.57%, 25.23%.

#### 4.4. COMPARATIVE STATISTICS BY GENDER OF STEM CAREERS PRE- AND POST PANDEMIC COVID - 19, - UNIVERSIDAD DE EL SALVADOR – FACULTY OF ENGINEERING AND ARCHITECTURE (UES - FIA)

**Table 4**

Enrollment record by gender for the period 2019 - 2022 – UES - FIA

Comparative statistics by gender for the period 2019 - 2022												
Year	Architecture		Civil Engineering		Electrics Engineering		Informatics Engineering		Mechanical Engineering		Chemical Engineering	
	SUM de M	SUM de F	SUM de M	SUM de F	SUM de M	SUM de F	SUM de M	SUM de F	SUM de M	SUM de F	SUM de M	SUM de F
	2019	766	751	850	347	2579	581	1238	110	894	119	459
2020	734	793	800	334	2561	597	1189	130	842	126	444	384
2021	758	840	839	376	3027	722	1230	130	861	135	441	402
2022	700	826	744	319	2721	684	957	92	698	95	361	351



**Figure 4:** Enrollment statistics by gender – UES – FIA

Figure 4 shows statistics corresponding to the University of El Salvador, Faculty of Engineering and Architecture - FIA, corresponding to the number of female students enrolled in the period 2019 - 2022, in some of STEM careers. In the period of 2019 - 2022 the careers with the highest demand for enrollment by young women: Architecture career - female 23.40%, 24.70%, 26.17%, 25.73% - male 25.90%, 24.81%, 25.63%, 23.66%; Computer Systems Engineering major - female 22.48%, 23.10%, 27.94%, 26.47% - male 23.69%, 23.52%, 27.80%, 24.99%; Civil Engineering major - female 25.22%, 24.27%, 27.33%, 23.18% - male 26.29%, 24.74%, 25.95%, 23.01%; Chemical Engineering major - female 24.15%, 25.62%, 26.82%, 23.42% - male 26.92%, 26.04%, 25.87%, 25.87%, 21.17%; Electrical Engineering major - female 23.81%, 28.14%, 28.14%, 28.14%, 19.91% - male 26.83%, 25.77%, 26.66%, 20.74%; Mechanical Engineering major - female 25.05%, 26.53%, 28.42%, 20.00% - male 27.13%, 25.55%, 26.13%, 26.13%, 21.18%.



## 5. DISCUSSION AND CONCLUSION

Figures 1 - 2 show statistics of the female gender in STEM careers (Architecture, Civil Engineering, Computer Engineering, Chemical Engineering, Mechanical Engineering and Electrical Engineering) of the participating universities (Universidad Centroamericana José Simeón Cañas and Universidad de El Salvador) for the research, In 2020, when the pandemic was officially declared, there is an exponential increase compared to 2019, however, many universities start their academic semester in March or February, it is estimated that students were already enrolled for the first semester, which was switched from on-site to virtual mode of study; For the year 2021 the virtual study modality continued, trying little by little to incorporate academic activities in a blended learning manner in this year can also be seen in graphs 1 - 2 the increase in enrollments, despite the high rate of increase in the year 2022 a new phenomenon is presented the accelerated decrease for private and public universities in STEM careers, the research assumes that the change of modality from virtual to face-to-face, violence against women, stereotypes among other causes are considered to affect enrollments by the female gender.

Figures 3 - 4 show comparative statistics by gender of STEM careers (Architecture, Civil Engineering, Computer Engineering, Chemical Engineering, Mechanical Engineering, and Electrical Engineering) of the participating universities (Universidad Centroamericana José Simeón Cañas and Universidad de El Salvador) for the research, in which the relationship of gender inequality in education can be visualized, however, the same situation is visualized for both genders: an exponential increase in 2020 and 2021, but in 2022 there is an accelerated decrease in enrollment statistics, so the research considers a new research question: Does the type of study modality influence the selection of university careers in STEM field?

## 6. PROPOSAL

The current study proposes the design and development of a virtual platform that functions as an observatory in which universities can add their enrollment statistics, graduates, by gender, and residential area, among others, where the platform is public to monitor events such as the exponential increase and decrease that may occur in a degree program and evaluate the context that the country of El Salvador is experiencing at that time, while it can be used by universities to generate new strategies for attracting students or the generation of new careers or the improvement of curricula.

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