Analysis of the Academic Performance of Mechanical-Electrical Engineering Students during the COVID-19 Pandemic: A Case Study in a Private University in Peru

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Abstract—**The COVID-19 pandemic, brought with a number of problems in different sectors, one of the most affected was the education sector, especially in engineering programs, since these have a practical nature and need laboratories to consolidate meaningful learning. In many cases, the virtualization generated some anomalous behavior in the academic indicators that could be used for the analysis of the successes and errors that could lay the foundations for a modern education in engineering careers. The main objective of this research is to analyze the average academic performance per course of a mechanical-electrical engineering program, for which some data was taken from 2018 to 2021. To explain the behavior of the curves, a qualitative survey was applied to 357 students. Three academic indicators are used in the study: grades average, "not pass" rate, desertion rate. The results of the analysis showed that in the first period of the year 2020 (starting period of confinement) they presented very different parameters from those already known in previous years, which could be based on three main causes. The first was due to the full-time dedication of the students to carry out their academic activities, the second is based on the proper technology, resources and strategies adopted by the university and finally, the economic aid from the Peruvian government.**

Index Terms—**Academic performance, COVID-19, desertion, engineering education**

I. INTRODUCTION

The global public health crisis caused by the COVID-19 virus has forced the closure of face-to-face universities, changing education traditional approaches in search of new teaching and learning possibilities [1]. Universities have experienced an unprecedented mass "migration" from face-to-face education to online education, following government demands for uninterrupted teaching and learning, which is why most universities have opted for online education [2].

In a short time, millions of members of the university community began teaching in front of a computer screen, and students at home took online courses [3]. This sudden change, in the way teachers delivered instruction, combined with the health threats and economic consequences of the pandemic, created a singular demanding situation that forced the implementation of new methodologies so that engineering students perform the simulation of certain industry processes for their professional training [4].

In Peru, where the predominant teaching modality in universities is face-to-face, the Supreme Decree (N° 044-2020-PCM) was promulgated declaring a State of National Emergency due to the serious circumstances that affect life as a result of the outbreak of the COVID-19 in an attempt to control the spread of the virus forced all face-to-face universities to move to online teaching, which required changing teaching methods and resources to adapt them to distance education [5].

On March 11, 2020, the Government decided to reschedule the start of classes in public and private educational institutions of basic education, which generated an alert for higher education, applying social confinement 5 days later. Causing mostly unprepared higher education instructors to suddenly make necessary changes and adjustments [6].

Developing countries, such as Peru, are far behind in transforming their educational structures to adapt to virtual learning [7]. The educational system has been severely affected by COVID-19 in schools, colleges and universities. Like other disciplines, the teaching and learning of mechanical-electrical engineering has also been affected, forcing changes in teaching methodologies, tools and infrastructure [8].

Universities in Peru through the National Superintendence of Higher University Education (SUNEDU) contemplated policies to switch to online education, but at the beginning of the pandemic, educational institutions in mechanical-electrical engineering had little preparation. This has raised several critical concerns about how this forced and unplanned educational transition to online education has influenced the views of teachers and students and the adoption of online learning in engineering education [9].

The present work seeks to analyze the average academic performance per course of a professional school of the specialty mechanical engineering, and how has this been affected due to the confinement? For which, data was taken from 2018 to 2021 in order to view data behavior before, at the start of, and during the COVID-19 pandemic, exploring students' online experiences.

II. METHODOLOGY

The study uses a population of 357 students of the

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mechanical-electrical engineering career. Two different data sources are used in this study: the data of the average grade of three units per course, the “not pass” rate and the desertion rate of the courses; the second data source contains the answers to a questionnaire applied to the students. The qualitative survey asked the students about aspects such as: type of study financing, type of company in which they work, study conditions, family burden and satisfaction with virtualization. All the students of the career, participated in the survey.

III. Results

Before the pandemic, in the first three semesters of the career, the desertion rate was high, for example in the academic semester 2019 period 2. Fig. 1 shows a high percentage of desertion and “not pass” rate, and a low-grade average in the courses of Statics, Electromagnetism and Electrical Circuits, courses that belong to the first, second and third academic semesters respectively. This is explained, since the disciplines present a higher requirement to pass and the student could have the possibility to quit the career and chose another career since they have not achieved to pass many courses yet, likewise, the cost of the monthly payments of the career which are above the regular basic average of a family income is another reason why students choose to give up the career because they do not have the expected results [10].

On the other hand, in the last semesters (courses such as: Machinery Design, Electrical Machines and Hydraulic Machines), the increase in the average grade is inversely correlated with the level of “not pass” rate and the desertion rate (Fig. 1) since the student gets used to the level of the academic demands of the courses, making students prefer to continue with the career rather than quit.

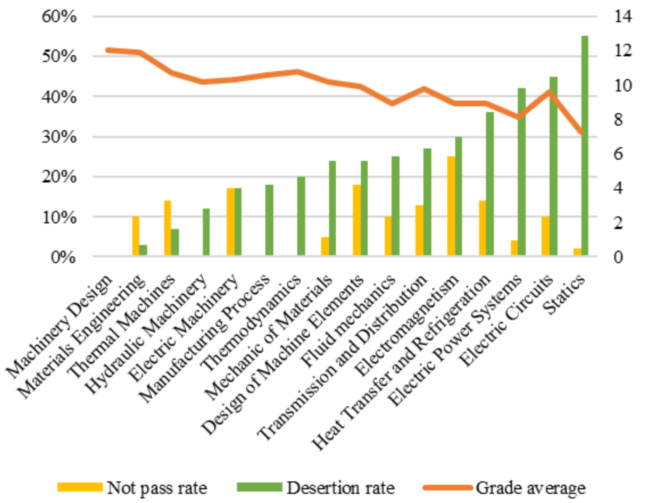

Fig. 1. Academic performance period 2, year 2019, by course, considering grade average, desertion rate and “not pass” rate.

In the beginning of the social confinement due to the COVID-19 Pandemic, in period 1 of the year 2020, the behavior of the three academic indicators was shown according to Fig. 2, the first semester courses continued to show a higher percentage of the desertion rate compared to the rest of the disciplines, but to a lesser extent, for example the statics course decreased from 55% (2019-II) to 12%, the electromagnetism course dropped from 30% (2019-II) to 8%, the same happened with the grade average for the first semester courses. Additionally, it is observed that there were zero cases of “not pass” students and also that the grade averages throughout that period turned out to be higher than the minimum passing grade.

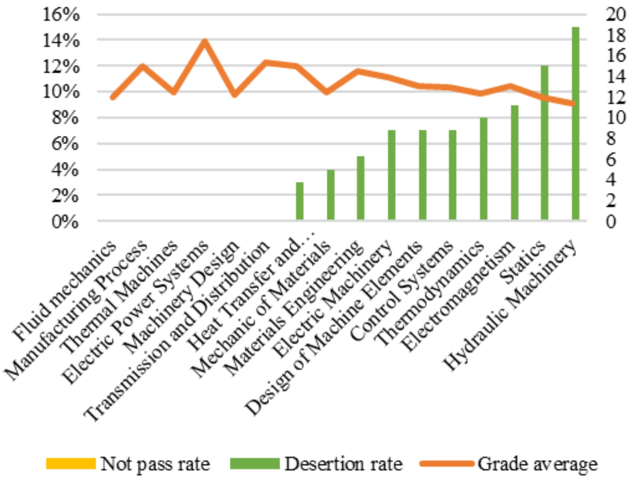

Fig. 2. Academic performance period 1, year 2020, by course, considering grade average, desertion rate and “not pass” rate.

In order to seek an explanation for this behavior, the average grades of nine courses with the highest credits of the career between the years 2018 and 2021 were taken (Fig. 3). Before the pandemic, during the first two years it has been observed that the behavior of the average grade of the nine courses remains constant. However, in period 1 of the year 2020 a differentiated change is shown, and in subsequent periods until period 2 of the year 2021 the trend stabilizes, even maintaining data similar to those of 2018 period 1.

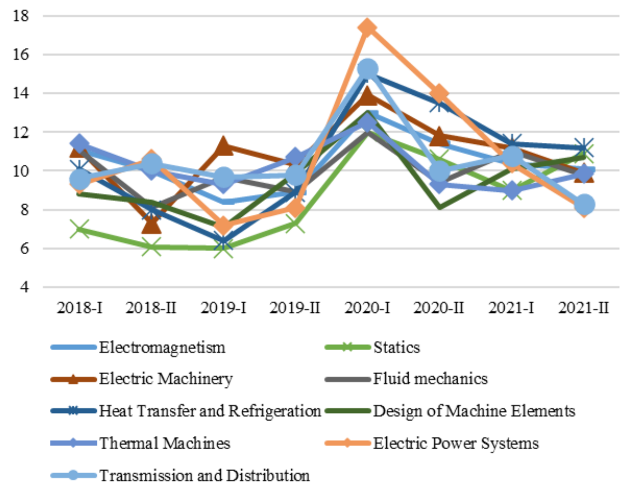

Fig. 3. Grade average of 9 courses during the years 2018 to 2021.

By the other hand, it is imperative to analyze the behavior of the “not pass” and desertion rate indicators throughout the years 2018 and 2021. Fig. 4 shows the average behavior of the rates of “not pass” and desertion per year, resulting in a regular behavior during the years 2018 and 2019. However in the 2020-I semester, when the confinement period begins, it means the total virtualization of the courses, a very significant decreased is observed, different to previous years, and so that they finally stabilize in subsequent periods.

To explain these results, a questionnaire was applied to 357 students belonging to the program of mechanical engineering. The answers to the questions provided are summarized in Fig. 5. Within the results, there are three main reasons why social confinement helped to improve the three analyzed indicators (grade average, “not pass” rate and desertion rate). The first has to do with the availability of students to dedicate exclusively to academic activities. The second is framed by the way in which virtualization has been handled by students and teachers during the pandemic. And the last one, due to financing to continue studying.

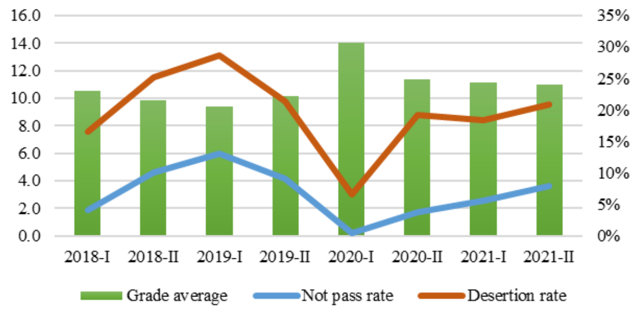

Fig. 4. Grade average, desertion rate, “not pass” rate by period during the years 2018 to 2021.

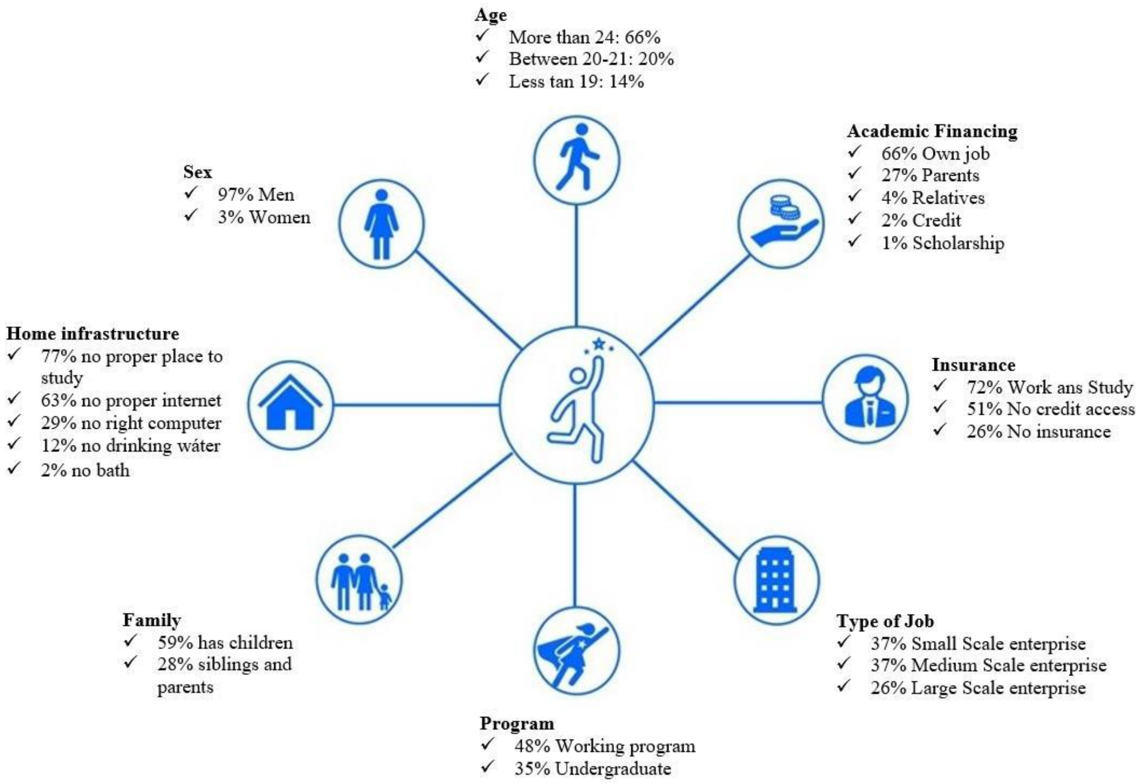

Fig. 5. Summary of the results of the survey of 357 students.

A. *Availability to Study*

The results of the survey showed that 66% of students financed their own studies, of which 95% belonged to small and medium sized companies, corresponding to 64% of students in the entire program. And others had financing associated with their parents, relatives, scholarships and educational credits.

On April 15, 2020, the Peruvian government issued emergency decree N° 038-2020, in order to face the economic emergency caused by the pandemic, trying to avoid the closure of companies and protect the integrity of the workers through remote work [11]. This decree provided for remote work, paid leave, and, exceptionally, the “perfect work suspension”, which consists in suspending the obligations of both the employer and the worker (remuneration and compliance with the working day) without break the employment relationship, which is recovered once the state of emergency is lifted [12].

To that end, employers should submit the application to the Ministry of Labor, duly substantiated. The Ministry of Labor and Employment Promotion (MTPE) reported that until March 31, 2021, more than 41,000 requests for “perfect work suspension” were made, of which some 32,000 companies were able to make it effective, which involves 303,194 suspended workers [13].

Thus, due to the national and global situation, many students stopped working due to the perfect work suspension. The students who obtained some type of financing dedicated themselves exclusively to studying, so the grades in that semester reflect good rates of academic performance [14].

B. *Online Learning*

Other results in Fig. 5, showed that 77% of students did not have a proper place to study, 63% did not have proper internet access and 29% did not have a proper computer. This is because after March 16, 2020, many students chose to travel with their families to spend confinement in different regions of the country. Therefore, in many cases they had to go through a period of accommodation in their homes in order to improve the conditions of their study space [15].

At the same time, one of the main problems encountered was the nature of the mechanical engineering courses. Most of them were carried out in parallel with the assistance of "physical" laboratories [16]. Since, it is especially important that mechanical engineering students acquire theoretical knowledge in the classroom, and laboratories are an effective means of providing practical knowledge and experience, and due to social isolation, access to them was impossible [17]. Thus, the university opted for virtualizing the laboratories using open license and paid applications and software (Fig. 6) for the use in virtual classrooms.

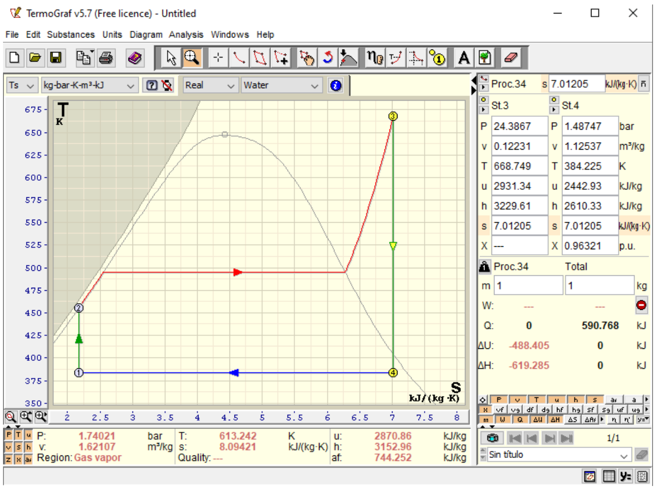

Fig. 6. Software used for the virtual teaching of the Thermodynamics course. (Source: TermoGraf v5.7) [18].

Virtual labs showed good results, mainly because students' lab experiences are often negatively affected by issues such as: limited lab time and equipment; a large number of students, which overloads the capacity of laboratories and reduces the opportunities for students to carry out experiments alone; lack of available space and insufficient number of teachers [19].

In this case, the simulators made the students improve and master some basic concepts of the hard sciences, which are part of the career, it also provided unlimited time of use and time availability that could be adapted to the student's availability, this being very beneficial [20].

For this reason, although the students mentioned that they did not have the best study conditions, the virtual laboratories and the teaching performance generated great acceptance by the students, which were reflected in the satisfaction survey. The five criteria that comprise in Fig. 7 show a positive response considering the attention and performance of teachers, the quality of online teaching, the quality of virtual laboratories and the availability of software.

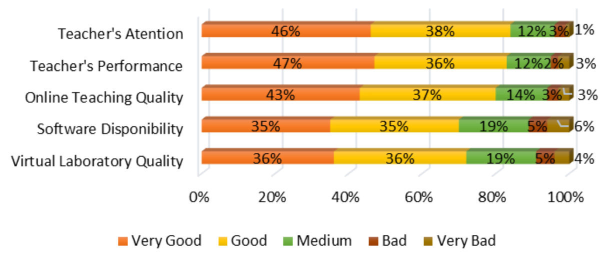

Fig. 7. Results of student satisfaction considering the quality of laboratories, virtual education and teaching performance.

C. Financing

As already mentioned, the economic resource influenced the level of student desertion, however, due to the actions of the Peruvian government through Emergency Decree 038-2020, it also considered economic support through state bonds, which they were made effective from time to time, also while the "perfect work suspension" was carried out, it was possible to access to some of the benefits of withdrawing money from the pension agencies [11].

For example, the provision of the AFP fund became effective, in which you could up to 25% of the pension funds. On the other hand, compensation for time of service (CTS) equivalent to a monthly remuneration could be requested during the period of the "Perfect work Suspension". And even a subsidy from ESSALUD, a worker of a micro or small company and with remuneration less than S/2,400, it was possible to access to the Emergency Social Protection Economic Benefit, equivalent to S/760 monthly for a period of three months [5].

Due to the aforementioned, it generated to financial aid for the student during the period of isolation in which, for the unemployed student, it was an opportunity to study exclusively.

D. Curve Stabilization

Finally, during the periods of 2020-I, 2021-I and 2021-II, Fig. 5 and Fig. 6 showed a stable trend for the three analysis indicators. Fig. 8 shows the academic performance of the students of period 2 of the year 2021, which shows a similar behavior in the academic performance of period 2 of the year 2019 comparing it in its three indicators.

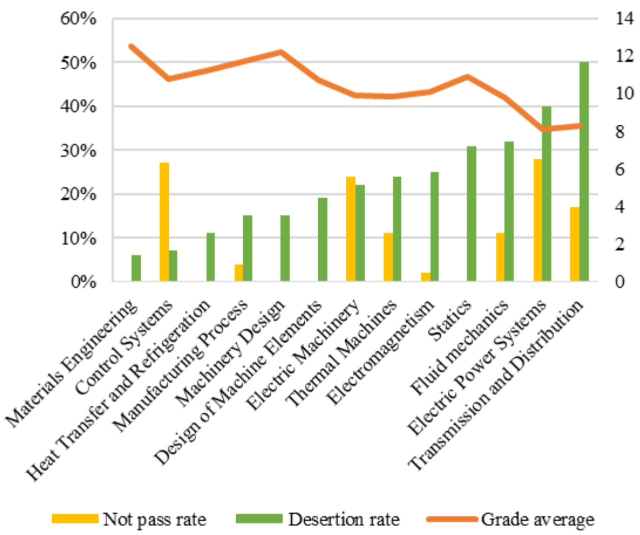

Fig. 8. Academic performance period 2, year 2021, by course, considering grade average, desertion rate and "not pass" rate.

This is explained through Fig. 9, in the April-May-June 2021 quarter, the Peruvian government changed some articles of emergency decree 038-2020, improving employment indicators at the national level. Compared to the semester of the previous year, it can be seen that the economically active population (EAP) increased by 46.3%, which is equivalent to 5,643,800 people. The urban area concentrates 77.6% of the country's EAP, that is, 13,837,600 people, compared to the same quarter of the previous year, it increased by 60.8% (5,229,900 people). Meanwhile, 22.4% of the EAP (3,987,400 people) is found in the rural area of the country, compared to the same quarter of the previous year, it increased by 11.6% (414,000 people) [13].

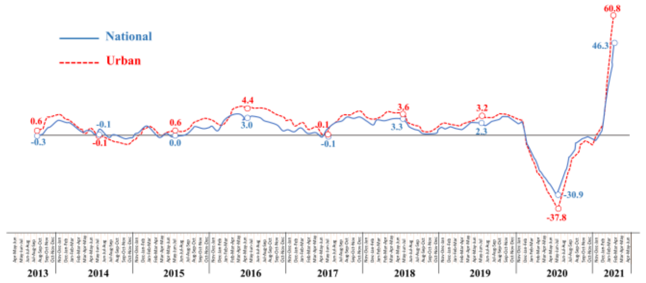

Fig. 9. Evaluation of the EAP at the national and urban levels for the quarter April-May-June 2021. (Source: INEI, 2021).

Also, in April-May-June 2021 (Fig. 10), the population employed in companies with 11 to 50 workers (medium-sized company) increased by 83.7% (528,900 people), followed by those employed in small economic units with 1 to 10 workers in 58.8% (4,653,100 people. When compared with a similar quarter of 2019, it showed different behavior, in those with 11 to 50 workers increased by 7.7%; while in small companies with 1 to 10 workers increased by 5.1%, 74.6% of the country's workers work in small companies with 1 to 10 workers, 6.9% in companies with 11 to 50 workers and 18.5% in companies with 51 or more. The micro and medium-sized companies, which are related to 64% of the Mechanical Engineering students, improved their employment values exponentially [13].

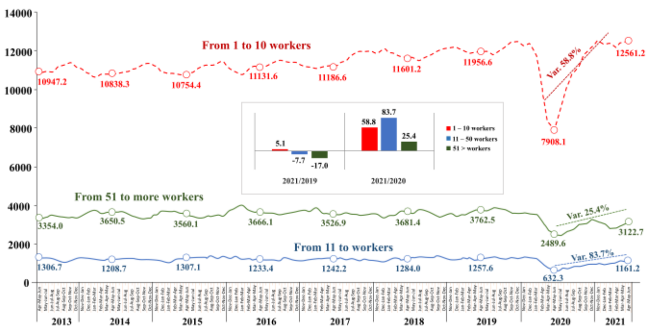

Fig. 10. Evaluation of the EAP by company size for the quarter April-May-June 2021. (Source: INEI, 2021)

IV. Conclusions

In the beginning of the COVID-19 pandemic, there is evidence of an increase in the grade average, a decrease in the desertion rate, and almost zero cases of "not pass" rate. This was based on three main causes. The first was due to the availability that the student had due to the economic situation in which the country was, the government ordinances through its policies made the students who worked (66%), mostly stop doing so. The second is based on the appropriate technology, resources and strategies adopted by the university in order to exchange the experience of physical laboratories for virtual ones. Likewise, the teaching performance showed good acceptance by the students, despite the fact that the teachers had to train in virtual teaching techniques quickly due to the drastic changes. Lastly, economic aid from the government in the form of state bonds, savings withdrawals, helped students to continue studying and dedicate themselves exclusively to it.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Carlos A. Alvarado-Silva conducted the research, analyzed the data and wrote the discussion of the results; Alex D. Tejeda-Ponce contributed with data collection through questionnaires; Bertha Ulloa-Rubio contributed to writing-review and project administration; Jorge A. Salas-Ruiz formulated the abstract and the contextualization of the problem; and Karina L. Gaytan-Reyna contributed with the methodology, elaboration of graphs and tables; all authors had approved the final version.

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