Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Procedia Computer Science 203 (2022) 508–513

Procedia Computer Science

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The 3rd International Workshop of Innovation and Technologies (IWIT 2022)
August 9-11, 2022, Niagara Falls, Ontario, Canada

Impact of COVID-19 on Students' Generic Skills – A Case Study in a University from a Developing Country

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Abstract

The education sector was considerably affected by the COVID-19 pandemic, risking the learning process and forcing governments to pull out contingency actions to ensure the students' development of generic and specific skills and guarantee education quality. These actions include the shift to online and hybrid (i.e., online and in-person) classes. This work assesses the pandemic effect on the generic skills of undergraduate students in a Colombian university. The study aims to determine the effect of COVID- 19 on the development of generic skills quantitatively. Two datasets were retrieved: *i)* A dataset with the scores obtained by the students in an institutional Generic Skills test and in the midterm tests; *ii)* A dataset with the students' scores in the Colombian standardized test for undergraduate students, called the *Saber Pro* test. Three analysis stages were performed: *i)* Univariate exploratory analysis; *ii)* Differential analysis to compare the No COVID vs. COVID scenarios; *iii)* A correlation analysis. Results showed that the scores of the Generic Skills and the Midterm tests increased significantly when comparing the two scenarios, except for the Written Communication. As for the *Saber Pro* test, only the scores for Written Comprehension, Quantitative Reasoning, and the global scores increased significantly. On the other hand, the correlation analysis showed a strong correlation only between the scores obtained at the Generic Skills and the *Saber Pro* tests for the English Proficiency skill. In addition, the analysis elucidated a weak correlation between the Generic Skills test's average and the Saber Pro's global score. Finally, the results prove that online education is a feasible alternative that offers students more flexibility to ensure the development of generic and specific skills.

Keywords: Digital education, remote learning, education quality, pandemic.

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10.1016/j.procs.2022.07.071

1. Introduction

The world witnessed an economic crisis caused by the COVID-19 pandemic, which has severely impacted the well-being of a large part of the world's population [1]. Widespread psychological distress related to the virus outbreak has been observed worldwide, resulting in problems for education. The COVID-19 crisis was one of the most discussed topics on social networks in 2020 and 2021 and has affected the classical educational paradigm worldwide [2]. This crisis has offered an opportunity to establish a path for introducing digital learning [3–5]. However, research indicates that skill development through online education is not as good as that of in-person learning [6–8]. Increasing the knowledge on education quality during the COVID-19 crisis allows for developing strategies to compensate for the pandemic's adverse effects and aid educators and students in assimilating such a transition.

Many recent studies have assessed the effects of the pandemic on university students. Most studies involve practical cases, either focusing on the situation experienced within a given institution or comparing how different institutions made changes in teaching methods in response to the pandemic. Some of these studies provide a first nationwide overview of many countries based on surveys directed to students to assess the transition to online or hybrid classes (i.e., mixing online and in-person classes) [9,10]. Colombia (South America) has implemented strategies such as the temporal suspension of classes, and a further shift to a remote-lecturing approach, via information and communication technologies [11].

Generic skills are those that can be applied across a variety of subject domains and require longer acquisition than dependent (subject area) skills. Once acquired, these skills remain throughout the individual's life, helping them succeed not only in their academic studies but also in their career and life [12]. Generic skills are a useful proxy for monitoring the quality of education [13]. According to the outlines set by the Colombian Institute for the Promotion of Higher Education (ICFES), generic skills include reading comprehension (RC), quantitative reasoning (QR), citizen skills (CS), English proficiency (EP), and written communication (WC) [14]. Intending to enhance the generic skills of its students, Universidad de la Costa, located in the city of Barranquilla, Colombia, has implemented a novel evaluation system. In this system, students must take a test each semester. The test, known as the "Generic Skills Test" (translated from Spanish) [15], features a questionnaire structure similar to that outlined by the ICFES for the Colombian standardized test for undergraduate students, known as *Saber Pro* [14]. Universidad de la Costa developed the Generic Skills Test taking the international Tuning Project as a reference [16].

Despite being designed and implemented before the onset of the COVID-19 outbreak in Colombia, the Generic Skills Test has worked as a reliable instrument to measure student performance before and after the pandemic. In this regard, two datasets were obtained: *i)* a dataset with results of the institutional Generic Skills Test, applied to Engineering students at the Universidad de la Costa, as well as semester-wise average scores obtained by the same students in the midterm tests; and *ii)* A dataset containing the results for the Colombian standardized test for undergraduate students, known as *Saber Pro* test. Both datasets span over the period 2018-2021. This research assesses the generic skills (RC, QR, CS, EP, and WC) of undergraduate students in a Colombian university. More specifically, the study focuses on quantitatively determining the effect of COVID- 19 on the development of generic skills.

The manuscript is organized as follows: Section 2 provides a detailed description of the methods implemented, section 3 presents the results, and section 4 addresses the conclusions and a brief discussion o future works.

2. Methodology

The methods to conduct the study comprise the following four stages: *i)* Data Gathering and Preprocessing; *ii)* Preliminary Data Analysis; *iii)* Differential Analysis; *iv)* Correlation Analysis. These stages are described in detail in subsections 2.1 – 2.4.

2.1. Data Gathering and Preprocessing

Data were retrieved from two different sources (as previously mentioned in Section 1): *i)* A dataset containing the results from an institutional Generic Skills Test applied to the Engineering students from Universidad de la Costa, as well as the semester-wise average scores the students obtained on the midterm tests; and *ii)* A dataset containing the results from the Colombian standardized test for undergraduate students, called the *Saber Pro* test. The data for both datasets extends over the 2018-2021 period.

The first dataset comprises the scores obtained by students on a test that evaluates five generic skills: Reading Comprehension (RC), Quantitative Reasoning (QR), Citizen Skills (CS), English Proficiency (EP), and Written Communication (WC). Furthermore, the dataset contains the average score obtained by each student on the Generic Skills. These skills are in line with directions issued by the Colombian Institute for the Promotion of Higher Education (ICFES) [14]. Additionally, this dataset contains each student's semester-wise midterm average scores, adding up to 27421 samples. The scores in this dataset have a range of 0-5.

The second dataset contains the yearly results obtained by engineering students on the *Saber Pro* test, the Colombian standardized test applied by the ICFES to undergraduate students. This test evaluates both generic and specific skills. As for the generic skills assessed by the *Saber Pro*, these match those evaluated by Universidad de la Costa's institutional Generic Skills test. On the other hand, the specific skills vary depending on the program each student is engaged in. Finally, the dataset contains 2242 samples and reports the global score obtained by each student, which is computed based on the scores for the generic and specific skills. Scores span a 0-300 range. For the analysis, aiming to make this dataset comparable to the first one, we have kept only the scores for the generic skills and those for the global score. The global score will somehow account for those specific skills, as it is computed with generic and specific skills scores.

2.2. Preliminary Data Analysis

Initially, we computed the following descriptive univariate statistics for the first dataset (Generic Skills Test's scores + Midterm Average scores): means, minimum and maximum values, standard deviations, medians, and quartiles. Means and standard deviations are tabulated, whereas the other statistics are presented using boxplots. All these statistics are calculated period-wise (i.e., semester-wise) for the generic skills' average and midterm average scores. A similar approach is used to conduct the preliminary analysis for the second dataset (*Saber Pro* test). The same descriptive univariate statistics are computed and reported for the global scores obtained by students in the *Saber Pro* test. However, as the test is applied yearly, statistics are calculated and reported on a yearly basis.

2.3. Differential Analysis

Given that the COVID-19 outbreak took place at the beginning of 2020, both datasets (Generic Skills + Midterms and *Saber Pro*) were split into subsets labeled as "No COVID" and "COVID" for the 2018-2019 and 2020-2021 periods, respectively. Further, normality is assessed for all variables comprising each subset using the Shapiro-Wilk test [17]. Moreover, we performed, for each dataset (Generic Skills + Midterms and *Saber Pro*), hypothesis-testing analysis to compare the variable-wise means using Welch's two-sample t-test [17]. These analyses allow comparing and elucidating statistically significant differences between results before and after the COVID-19 outbreak. Hence, they are a means to assess the impact of the pandemic on the students' generic skills development.

2.4. Correlation Analysis

We created a merged dataset containing the scores for all generic skills from Universidad de la Costa's Generic Skills test and the *Saber Pro* test. The pair-wise Pearson correlation coefficients were computed for all variables within the merged dataset. Additionally, we computed the Pearson correlation coefficient between the Generic Skills test's average score and the *Saber Pro*'s global score.

The methods described in this section were implemented in the software RStudio. The analyzed datasets and the implemented codes are freely available at https://github.com/iportnoy1/Datasets_and_Codes_Generic_Skills_-_Midterms_-_SaberPro_Scores_Unicosta.

3. Results

Results of the preliminary data analysis are summarized in Fig. 1. These results show that, after the COVID-19 outbreak, a rise in the scores of the Generic Skills test and the Midterms average. However, hypothesis tests must be conducted to assess whether these observed changes are statistically significant. For the *Saber Pro* test, on the other hand, the preliminary analysis does not show any evident changes between scores for the No COVID vs. COVID periods. Nevertheless, statistical significance is also to be assessed. Finally, the Shapiro-Wilk's normality test was

applied to every variable of both datasets, showing no rejection for the null hypothesis, i.e., all variables fit a normal distribution.

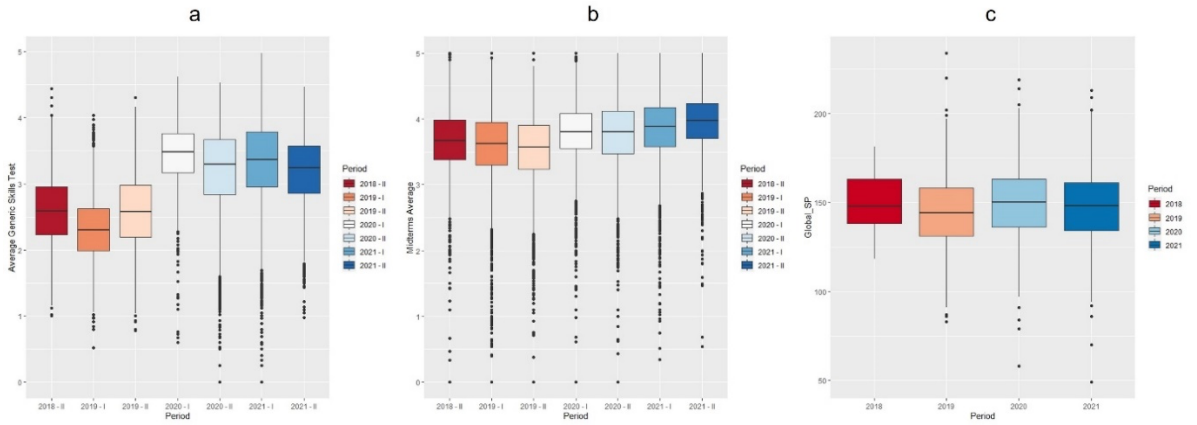

Fig. 1. Period-wise boxplots for the (a) Generic Skills Test's average scores, (b) Midterms Average, and (c) Global *Saber Pro* Test.

As for the differential analysis, results for the first dataset (Generic Skills + Midterms Average) are summarized in Table 1. Here, "_G" indicates scores are from the Generic Skills test. Results for the second dataset (*Saber Pro* test) are shown in Table 2. Here, "_SP" indicates scores are from the *Saber Pro* test.

Table 1. Mean comparison of the first dataset (Generic Skills + Midterms Average).

Statistic/metric	Scenario	Score					
		RC_G	QR_G	CS_G	EP_G	WC_G	Midterms Average
Mean	No COVID	2.30	2.52	2.39	2.33	2.82	3.58
	COVID	2.85	3.21	3.45	3.62	2.39	3.82
t-test's p-value		0	0	0	0	2.20×10^{-287}	5.25×10^{-294}

Table 2. Mean comparison of the second dataset (*Saber Pro* Test).

Statistic/metric	Scenario	Score					
		RC_SP	QR_SP	CS_SP	EP_SP	WC_SP	Global Score
Mean	No COVID	151.83	136.05	138.34	143.57	156.05	145.15
	COVID	156.64	142.93	138.49	145.32	156.31	147.92
t-test's p-value		2.09×10^{-4}	3.35×10^{-7}	0.92	0.18	0.84	2.56×10^{-3}

Differential analysis results for the first dataset (see Table 1) show every skill-wise score but the WC for the Generic Skills test applied by Universidad de la Costa exhibited a significant rise, as evidenced by the t-test. The same holds for the Midterms Average scores. On the other hand, results for the second dataset (see Table 2) show that scores for two out of three generic skills evaluated by the *Saber Pro* test exhibited a significant rise. These generic scores showing significant mean changes are the Reading Comprehension (RC) and the Quantitative Reasoning (QR). The Global Score also showed a significant increment when comparing the No COVID vs. COVID scenarios. It is worth mentioning again that the Global Scores are computed considering not only generic skills but also specific skills, which may vary depending on the programs to which students belong.

Finally, the correlation analysis results are displayed through a correlation plot in Fig. 2, where we observe that, for the No COVID scenario, the only strong positive correlation between corresponding skills evaluated by the Generic Skills and the *Saber Pro* tests takes place between EP_G and EP_SP, with a Pearson correlation coefficient of 0.69. All other pair-wise correlations are weak. This implies that the students' English proficiency performance for both tests shows a strong association.

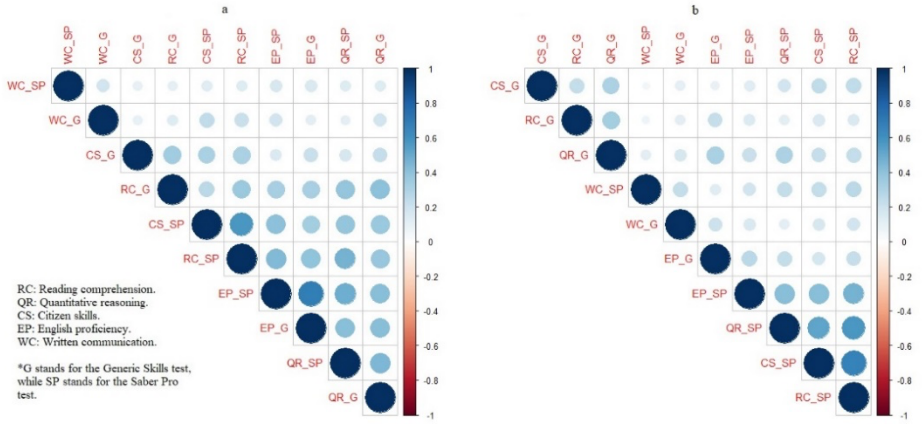

Fig. 2. Correlation structure for the (a) No COVID and (b) COVID scenarios.

On the other hand, for the COVID scenario, no strong pair-wise correlations occur between corresponding skills from both tests (Generic Skills and *Saber Pro* tests). Conversely, pair-wise strong/mild positive correlations only occur among some skills from the *Saber Pro* test, accordingly: RC_SP-CS_SP (0.67), RC_SP-QR_SP (0.57), and QR_SP-CS_SP (0.52). This implies no association between scores assessed by the Generic Skills test and those assessed by the *Saber Pro* test. Finally, we computed the Pearson correlation between the Generic Skills test's Average score and the *Saber Pro*'s Global score, obtaining a value of 0.44, which indicates a weak association between results obtained at both tests.

These results show that the strategies implemented to face the COVID-19 pandemic helped to ameliorate its impact on Universidad de la Costa's engineering students, setting out the path to the shift to digital transformation in undergraduate education. Such results show that, with the correct actions, online and hybrid education are feasible options to provide high-quality education while guaranteeing the students' development of generic skills.

4. Conclusions

This work conducted statistical analysis to characterize the impact of the COVID-19 on the performance of engineering students from Universidad de la Costa, located on the north coast of Colombia (a developing country). Performance was assessed through the scores obtained by students in three tests: *i)* An institutional exam called the *Generic Skills* test; *ii)* The midterms taken by students; and *iii)* The Colombian standardized test for undergraduate students, called the *Saber Pro* test. The analysis comprised three stages: *i)* Exploratory analysis using univariate descriptive statistics; *ii)* Differential to compare No COVID vs. COVID scenarios through univariate statistics; *iii)* Correlation analysis.

The exploratory analysis suggested a differential performance of students when comparing the No COVID vs. COVID scenarios. Therefore, the differential analysis was further performed. The differential analysis showed that the average in the Generic Skills and the Midterm tests increased significantly when comparing the two scenarios. Except for the Written Communication (WC), all the generic skills scores increased significantly. On the other hand, for the Saber Pro test, only the Written Comprehension (WC), the Quantitative Reasoning (QR), and the global scores increased significantly. The correlation analysis revealed a strong correlation between the scores obtained at both the Generic Skills and the Saber Pro tests for the English Proficiency (EP) skill only. Additionally, there is a weak correlation between the Generic Skills test's average and the Saber Pro's global score.

The results show that the strategies implemented by Universidad de la Costa to face the COVID-19 pandemic had a positive effect on the students' development of generic skills. Additionally, as the significant increment in the global Saber Pro test scores show, the specific skills were also enhanced thanks to Universidad de la Costa's digital education-oriented actions. Thus, results prove that online education is a feasible option that offers students more flexibility while guaranteeing a high-quality education.

Future works should focus on the development of innovative learning strategies for post-pandemic online programs. Additionally, the digital gap (i.e., the limited access to internet and computers) faced by students coming from different socio-cultural environments should be addressed to ameliorate the impact this factor has on the students' learning process.

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