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Assessment of the efficiency of graduate Programs (strictosensu) in Brazilian public universities in the context of the COVID-19 pandemic

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Abstract: The COVID-19 pandemic imposed significant challenges to the management, pedagogical organization, and mental health of the academic community in Brazilian universities, affecting all educational spheres. Among the main obstacles were limited access to technology and the internet, faculty overload, and difficulties in adapting to remote education. This study analyzes how master's programs at the State University of Mato Grosso (UNEMAT) and the Federal University of Santa Catarina (UFSC) adapted to the pandemic context, using Data Envelopment Analysis (DEA) to assess relative efficiency from 2017 to 2022. The results showed that, of the 15 UNEMAT programs analyzed, 6 (40%) maintained or improved their efficiency in the first year of the pandemic (2020). At UFSC, 26 out of 71 programs (36.6%) achieved more than 80% efficiency in 2020. Although not all students had full access to digital resources, the data suggest that factors such as rapid institutional reorganization, the use of digital tools, and, in some cases, the maturity and autonomy of graduate students contributed to maintaining efficiency. The findings demonstrate that the programs that best adapted to the pandemic scenario were able to optimize the management of available inputs and maximize outputs, even in the face of adversity.
Keywords: higher education; university management; data envelopment analysis (DEA); COVID-19 pandemic.

1 Introduction

The general objective of this study is to evaluate the academic efficiency of graduate programs (stricto sensu) at the State University of Mato Grosso (UNEMAT) and the Federal University of Santa Catarina (UFSC) in the context of the COVID-19 pandemic, using Data Envelopment Analysis (DEA) for the period from 2017 to 2022. Specifically, the study aims to: (i) compare academic efficiency levels before and during the pandemic; (ii) identify programs that maintained or improved their

performance during the pandemic period; (iii) indicate efficiency benchmarks that may support programs with lower performance; and (iv) contribute to the enhancement of university management in crisis contexts.

To contextualize the study, it is important to highlight the challenging scenario imposed by the COVID-19 pandemic, which affected various sectors of society, including Higher Education Institutions (HEIs). In an effort to contain the spread of the virus, measures such as mask-wearing, physical distancing, and the recommendation to avoid enclosed and crowded spaces were implemented, culminating in social isolation—a key strategy for protecting the population (WHO, 2022; Farias, 2020).

It is important to highlight that, due to the temporary closure of schools and universities, more than 90% of students worldwide were affected (UNESCO, 2020). In Brazil, the Ministry of Education (MEC) authorized the emergency replacement of in-person classes with remote activities delivered via digital platforms (Gusso *et al.*, 2020). Higher Education Institutions (HEIs) were abruptly forced to transition to emergency remote teaching, raising concerns about how to ensure the quality of this form of education (Gomes; Kretzmann; Pedroso, 2022).

In this context, the COVID-19 pandemic not only disrupted the academic calendar but also imposed operational challenges on HEIs. These challenges exposed and exacerbated long-standing weaknesses in student education, demanding urgent structural policies for digital inclusion and pedagogical practices focused on reading and writing (Saviani; Galvão, 2020).

This scenario brought about significant changes in the academic activities of undergraduate and graduate programs at HEIs, requiring rapid adaptations to ensure the continuity of educational processes, as well new approaches to organizing and managing human, technological, and financial resources (Gusso *et al.*, 2020). These transformations directly impacted the organizational structure of universities, their operational workflows, and academic outcomes (Andriola; Nogueira; Silva, 2024).

According to Cavalcanti and Guerra (2022), the absence of standardized guidelines affected approximately one million students at federal universities, whose academic activities were suspended at the beginning of 2020. Institutional responses varied depending on the management capacity of each institution. Vaz and Fossatti (2022) emphasize that, despite the challenges faced—especially in state universities—effective management strategies enabled the continuity of academic operations and

provided support to students and faculty. Complementarily, Corrêa *et al.* (2022) highlight that the joint efforts of students, tutors, and coordinators contributed to a positive pedagogical adaptation, even under continuous stress.

Therefore, the pandemic imposed significant challenges on academic performance, as traditional teaching and assessment methods proved insufficient to encompass the complexity of education in virtual environments (Cavalcanti; Guerra, 2022). Although many studies have focused on analyzing the qualitative impacts of this transition (Serra *et al.*, 2022; Luiz; Martins; Marinho, 2023; Mota-Passos *et al.*, 2023; Winters, 2023), particularly in relation to the student-teacher experience, the use of technology, and psychosocial issues, there remains a gap in quantitative analyses that explore objective indicators of performance and efficiency.

Thus, this study adopts a quantitative approach, using Data Envelopment Analysis (DEA) to estimate the relative efficiency of academic units. This methodology allows for measuring the efficiency of educational units based on the relationship between available resources (inputs) and the outcomes achieved (outputs), as highlighted by Muniz *et al.* (2022a). In the present study, this approach is applied to assess the performance of educational units, identifying good management practices and strategies for resource optimization. The aim is to support future strategies to strengthen more vulnerable academic units (Cavalcante; Andriola, 2012).

The article is organized as follows: Section 2 briefly reviews the literature on the challenges imposed by the COVID-19 pandemic in the university context and the importance of methodologies and metrics that quantitatively capture how these challenges affected academic efficiency; Section 3 presents the methodological aspects of the research; Section 4 presents the results and discussion; finally, Section 5 provides the concluding remarks.

2 COVID-19 and Efficiency Assessment in HEIs

With social distancing measures implemented to contain the spread of the coronavirus, Higher Education Institutions (HEIs) had to adapt to the adoption of remote teaching to mitigate pedagogical and health-related impacts (Gusso *et al.*, 2020; Mota-Passos *et al.*, 2023). This transition was supported by Ordinance No. 343 of March 17, 2020, issued by the Ministry of Education (Brasil, 2020), which authorized the adoption of remote teaching for the duration of the COVID-19 pandemic.

The shift to remote teaching led to changes in the dynamics of interaction among students, faculty, and staff (Teles; Gomes; Valentim, 2021; Souza *et al.*, 2022). The adoption of emergency remote teaching exposed the fragility of institutional strategies and deepened inequalities among students from different socioeconomic backgrounds (Saviani; Galvão, 2020).

This reality brought to light the challenges arising from the restrictions and the adaptive capacity of the university community. Recent studies conducted in HEIs have highlighted the lack of pedagogical support for faculty, student dissatisfaction and limited access to technology, resistance within academia to the non-presential model, and pedagogical limitations due to the quality of equipment and internet connectivity (Teles; Gomes; Valentim, 2021; Correa *et al.*, 2022). In addition, issues such as lack of motivation, difficulties with concentration, insomnia, anxiety, and depression have been reported among graduate students and faculty (Gusso *et al.*, 2020; Andriola; Nogueira; Silva, 2024).

The adaptations required to address the pandemic included measures aimed at ensuring the continuity of teaching activities through remote learning. Among these measures were the implementation of new academic management systems, technical-institutional planning, training of faculty in the use of digital tools, and the registration and unification of procedures (Cavalcanti; Guerra, 2022). Furthermore, as reported by Mélo *et al.* (2021), the pursuit of digital inclusion was a guiding principle for federal HEIs in responding to the pandemic context. Of the institutions surveyed, 73% opted to provide financial assistance for internet plans, 46% distributed SIM cards with mobile data, and 55% offered financial aid for the purchase of electronic devices for students in situations of socioeconomic vulnerability. The literature also points to adjustments and flexibilization of the academic calendar as measures to mitigate the impact on student education (Muniz; Muniz; Andriola, 2022b).

Despite the adaptation efforts described, the impacts on academic and institutional outcomes have been reported in several studies conducted in Brazilian HEIs. According to the study by Gusso *et al.* (2020), the abrupt transition to remote teaching led to an increase in dropout rates in undergraduate and graduate programs, particularly among students in vulnerable situations. This dropout was associated with emotional overload, technological difficulties, and the lack of an adequate home environment for studying. Complementarily, Corrêa *et al.* (2022) and Andriola (2025)

identified that the pandemic negatively affected students' well-being and academic adaptation, contributing to delays in course completion and a decline in scientific productivity in certain programs.

On the other hand, institutions with consolidated digital infrastructure and proactive institutional policies were able to mitigate some of these adverse effects. Behar *et al.* (2021) emphasize that prior use of digital platforms and faculty training contributed to maintaining the quality of education in HEIs. Similarly, Pacheco and Barcelos (2025) point out that measures such as support for remote teaching, participatory planning, and digital inclusion were essential to sustaining academic outcomes during the pandemic period. Thus, successful adaptation to the pandemic context has been associated with agile and innovative academic management in meeting the needs of the university community, through the adoption of strategic actions aimed at the efficient integration of resources and people (Souza *et al.*, 2022; Vaz; Fossatti, 2022; Andriola, 2025).

At this point, the planning and adoption of strategic actions require an understanding of the current situation through diagnostic assessments, which support decision-making by administrators and guide the organization in achieving its goals (Queiroz; Queiroz; Hékis, 2011; Andriola; Mc Donald, 2004). The implementation of diagnostics makes it possible to structure effective strategic planning and to define strategies that better prepare HEIs to cope with crises similar to the COVID-19 pandemic (Andriola, 2009).

The incorporation of evaluation results can generate learning and recommendations that enhance decision-making processes within educational organizations, allowing for more assertive interventions (Encinas, 2019). In this regard, Data Envelopment Analysis (DEA) has been used to assess efficiency in the use of resources (Alvarenga; Ohayon, 2021; Rodrigues, 2017; Muniz *et al.*, 2022).

DEA was developed based on the pioneering work of Farrell (1957), operationalized by Charnes, Cooper, and Rhodes (1978), and later refined by Banker, Charnes, and Cooper (1984). It is a non-parametric approach designed to estimate the relative efficiency of units known as Decision Making Units (DMUs), by evaluating the performance of these productive units in comparison to a reference partner (benchmark), considering multiple inputs and outputs. One of the main outcomes of this methodology is the estimation of an efficiency frontier that distinguishes the most

efficient units (score = 1) from the others (scale between 0 and 1), providing a comparative performance index.

The importance of DEA as a decision-support tool is emphasized in the literature (Chaves; Thomaz, 2008), as its application enables the analysis of alternative scenarios and the adoption of more effective management practices. Moreover, DEA presents advantages such as flexibility in handling multiple inputs and outputs, robustness in estimating relative efficiency, and independence from units of measurement (Souza Júnior; Gasparini, 2006).

Its application in the evaluation of efficiency within HEIs involves analyzing the performance of units based on the relationship between the inputs applied and the actual academic outputs delivered (Afonso; Santos, 2008). Encinas (2019) asserts that the focus of efficiency in HEIs lies in the relationship between outputs generated and inputs used, which is achieved when inputs are adequately managed to produce a given quantity of outputs.

Thus, in models that assess institutional capacity to convert resources into educational outcomes, inputs may include: structural aspects, variables related to the student body (such as admissions and enrollments), or other variables that influence the allocation of resources within the institution (De Witte; López-Torres, 2017; Corrêa *et al.*, 2022). Outputs may include: the number of graduates, graduation rates, scientific production (such as articles, books, and conference papers), as well as impact indicators like extension projects, patent registrations, or institutional partnerships (Afonso; Santos, 2008). In evaluating the efficiency of graduate programs, indicators related to academic performance and scientific output may also be considered (Andriola; Nogueira; Silva, 2024; Corrêa *et al.*, 2022).

Analyzing efficiency through DEA based on HEI variables makes it possible to determine the level of efficiency or inefficiency of a unit, as well as to identify the variables that led to these results (Alvarenga; Ohayon, 2021). This process allows for a better understanding of the factors contributing to inefficiency, the identification of best management practices from the most efficient units, and the development of targeted interventions to improve the performance of less efficient ones (Cook; Tune; Zhu, 2014; Cavalcante; Andriola, 2012).

3 Methodological Aspects of the Study

In this study, the productive units (DMUs) represent the graduate programs (stricto sensu) of the State University of Mato Grosso (UNEMAT) and the Federal University of Santa Catarina (UFSC), whose academic efficiency in the pre-pandemic period (2017–2019) and during the pandemic (2020–2022) was estimated using DEA. This characterizes the research as a longitudinal study of both ex-ante and ex-post-facto nature (Andriola; Soto, 2002). The selection of these two universities stems from the fact that two doctoral students on the project's technical team are staff members at these institutions, which facilitated access to the data necessary for achieving the research objectives.

The definition of the periods 2017–2019 (pre-pandemic) and 2020–2022 (pandemic) aligns with the timeline of the COVID-19 health crisis, with 2020 marking the beginning of social distancing measures and the emergency shift to remote learning. The former time frame captures efficiency in a stable context, while the latter reflects the programs' adaptation to the new reality imposed by the pandemic.

The data were obtained from the graduate studies offices of the respective institutions, thereby ensuring their validity and reliability. These were complemented with information available on public platforms and through direct contact with program coordinators. Programs that did not meet the required temporal coverage were excluded from the analysis. In total, 71 programs from UFSC and 15 from UNEMAT were analyzed, totaling 86 DMUs. The inputs considered for the analysis are detailed in the Table 1.

Table 1 – Variables Selected for the Model

Tipo	Variable	Description
Input	Available Slots	Number of slots made available annually
Input	New Enrollments	Students who started the program
Input	Enrolled Students	Total number of students with active enrollment
Input	Granted Scholarships	Number of scholarships awarded
Output	Graduates	Number of students who completed the program
Output	CAPES Rating[1]	CAPES Rating

Source: The authors.

[1]CAPES (Coordination for the Improvement of Higher Education Personnel) is a Brazilian federal agency responsible for evaluating and accrediting graduate programs. The CAPES Rating is a national performance indicator that assesses the quality of stricto sensu graduate programs on a scale from 1 to 7, with higher scores indicating greater academic excellence.

The selection of the elements presented in Table 1 followed the recommendation of Nunamaker (1985), which suggests that the number of variables should not exceed one-third of the total number of DMUs analyzed. Since the six variables correspond to 1/12 of the total 86 DMUs analyzed, it is appropriate to apply DEA using the BCC-O model. The estimations were carried out using DEA-Solver software (professional version 7.0) developed by the multinational company SAITECH.

For the analysis of results, priority will be given to metrics such as the average efficiency score per program and per institution, as well as the identification of benchmarks—units that achieve full efficiency and can serve as references for others. This approach aims to facilitate understanding of best management practices and variations in performance over time.

It is important to note that this research adopts a predominantly quantitative approach, focused on the analysis of relative efficiency through the DEA technique. No primary qualitative data were collected from the graduate programs analyzed, such as interviews or questionnaires. Therefore, the understanding of specific strategies adopted by each program during the pandemic is addressed indirectly and exploratorily, based on evidence available in the literature and the secondary data used.

4 Main Results

This section presents the results of the relative efficiency analysis of graduate programs, based on the scores obtained through the DEA model. The aim here is not to detail the adaptation strategies implemented by HEIs during the pandemic, nor to conduct a direct analysis of indicators such as dropout rates, scientific productivity, or quality of education. Although these dimensions are relevant, they fall outside the scope of this study, which focuses on measuring efficiency based on academic inputs and outputs.

With regard to the graduate programs (stricto sensu) at UNEMAT, the analysis of efficiency scores indicates that, compared to 2019—the last year prior to the pandemic—40% of the DMUs maintained or increased their efficiency in 2020, sustaining consistent performance in 2021. On the other hand, 13% of the programs showed efficiency gains in 2020 but experienced a decline in the following year, while

33% recorded a drop in 2020 but recovered in 2021. Only 13% of the DMUs maintained low scores in both pandemic years (2020 and 2021), as detailed in Table 2.

Tabela 2 – DMUs UNEMAT[2]

N°	DMUs	2018	2019	2020	2021
1	Mestrado Acadêmico em Ciências Ambientais	0,8896	0,9766	1	1
2	Mestrado Acadêmico em Ecologia e Conservação	1	1	1	0,8509
3	Mestrado Acadêmico em Linguística	1	0,7803	0,6858	0,8275
4	Mestrado Acadêmico em Estudos Literários	1	0,5702	0,5527	0,681
5	Mestrado Acadêmico em Educação	0,9936	0,8733	1	1
6	Mestrado Acadêmico em Ambiente e Sistemas de Produção Agrícola	0,6845	1	0,6375	0,6343
7	Mestrado Acadêmico em Genética e Melhoramento de Plantas	0,9168	0,8286	0,7445	0,5417
8	Mestrado Acadêmico em Biodiversidade e Agroecossistemas Amazônicos	1	1	1	0,9465
9	Mestrado Acadêmico em Ensino de Ciências e Matemática	1	0,4347	0,5875	0,8548
10	Mestrado Acadêmico em Geografia	0,7108	0,9859	0,8111	0,5584
11	Mestrado Acadêmico em Letras	0,9065	1	0,9768	0,9651
12	Mestrado Profissional em Letras	1	1	1	1
13	Mestrado Profissional em Ensino de História	1	0,5106	0,4074	1
14	Mestrado Profissional em Matemática em Rede Nacional	1	0,4815	0,999	1
15	Mestrado Profissional em Ensino de Biologia em Rede Nacional	1	1	1	1

Source: The authors.

[2]The names of the programs (DMUs) are presented in their original form, as officially designated by Brazilian institutions.

These results suggest that, despite the adversities imposed by the pandemic — such as the abrupt shift to remote teaching and increased workload for faculty (Gusso *et al.*, 2020; Andriola; Nogueira; Silva, 2024) — a significant portion of the programs managed to preserve or recover their efficiency levels. This performance may be associated with factors such as institutional response capacity, minimal digital infrastructure, and coordination between administration and faculty, as also discussed by Corrêa *et al*. (2022) and Behar *et al.* (2021).

Table 2 illustrates the evolution of efficiency of UNEMAT's DMUs, highlighting the Mestrado Profissional em Ensino de Biologia em Rede Nacional e o Mestrado Profissional em Letras, both of which achieved 100% efficiency across all evaluated years (2018 to 2021). The resilience of these programs is remarkable, especially given the impact caused by the abrupt transition from in-person to remote teaching, which required urgent pedagogical and administrative reconfigurations.

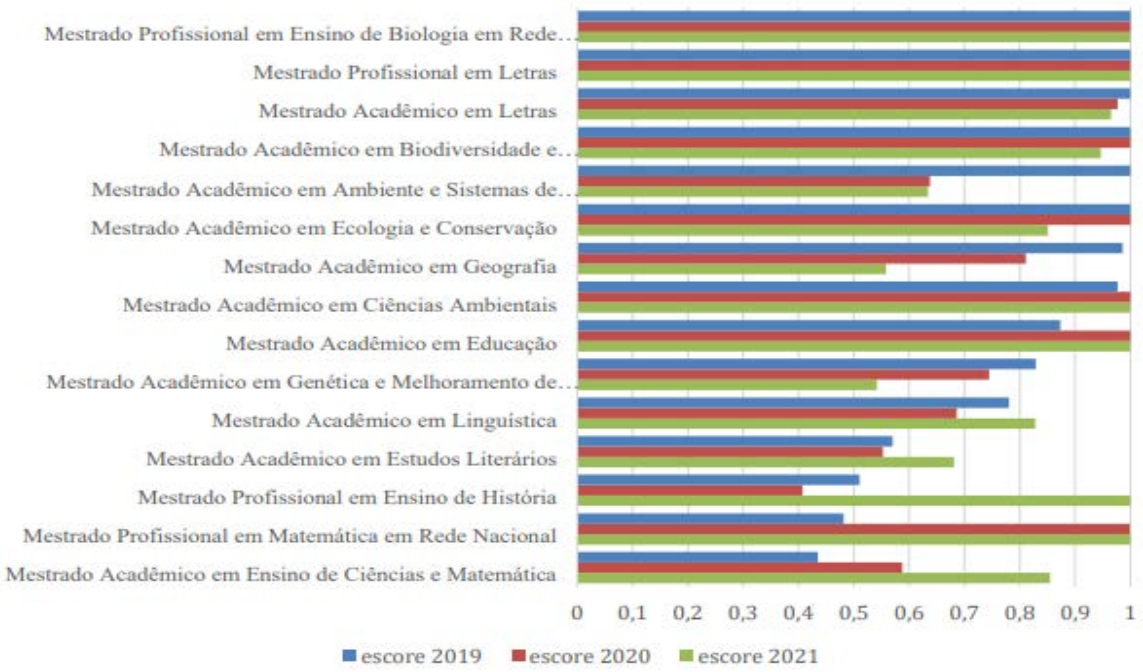
According to Batista and Schuhmacher (2022), this context demanded institutional reorganization, the reformulation of instructional strategies, and the overcoming of challenges related to digital infrastructure and faculty training in educational technologies. The maintenance of efficiency in these DMUs suggests a robust institutional capacity to manage inputs and outputs even under public health pressure.

On the other hand, programs such as the Mestrado Acadêmico em Ecologia e Conservação and the Mestrado Acadêmico em Biodiversidade e Agroecossistemas Amazônicos achieved maximum scores in the pre-pandemic years and in 2020 but experienced declines between 5% and 15% in 2021. Programs like the Mestrado Acadêmico em Ciências Ambientais, the Mestrado Acadêmico em Educação, and the Mestrado Profissional em Matemática da Rede Nacional improved their efficiency indices in 2020 and maintained strong performance in the following year.

These distinct patterns reflect structural inequalities and variations in the response capacity of institutions and programs. Nunes and Souza (2024) argue that, despite adaptation efforts, digital exclusion worsened during the pandemic, affecting the continuity and quality of educational processes. Darcoleto and Flach (2020) also point out that pedagogical reinvention in times of crisis required both technological and affective mediation to sustain engagement with students, which may have favored more structurally established programs.

These results are illustrated in Figure 1, which shows the evolution of DMU efficiency scores between 2019 and 2021.

Figure 1 – Performance of UNEMAT DMUs



Source: The authors.

The analysis of Figure 1 reveals distinct patterns in the behavior of UNEMAT's DMUs during the pandemic. Five programs maintained high and stable efficiency scores throughout the entire pandemic period (2020 and 2021), demonstrating strong performance even in the face of adversity. Four DMUs showed recovery in the second year of the pandemic following an initial decline in 2020, suggesting a capacity for progressive adaptation. Another three maintained stable performance during the period, but with consistently low scores, indicating persistent structural limitations. Additionally, some units presented low efficiency levels across the entire time series analyzed (2019 to 2021), as is the case of the Mestrado Acadêmico em Linguística, Mestrado Acadêmico em Estudos Literários, Mestrado Acadêmico em Genética e Melhoramento de Plantas, Mestrado Acadêmico em Ensino de Ciências e Matemática and Mestrado Acadêmico em Geografia, which require attention from institutional management.

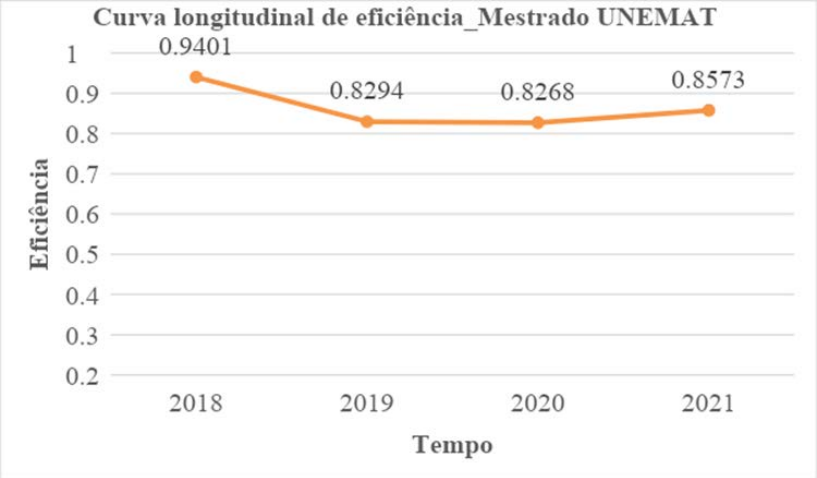
According to DEA principles, DMUs with low efficiency should model themselves after those with optimal performance, using them as benchmarks to guide improvement efforts. The DEA model also allows for generating projections regarding

the adjustments needed to achieve higher efficiency—such as increasing scientific output or improving graduation rates—but due to the scope limitations of this study, such projections will not be individually detailed here.

The information obtained through DEA application is particularly useful for university management, providing an objective diagnosis of the units requiring intervention. One illustrative example is the Mestrado Profissional em Ensino de História, which recorded the lowest efficiency score in 2020. To reach satisfactory levels, the program would need to increase its academic productivity, particularly in terms of the number of graduates. Its suggested benchmarks are the Mestrado Profissional em Letras and Mestrado Profissional em Ensino de Biologia, both of which achieved maximum scores (1.0), standing out as references of excellence within the UNEMAT context.

Finally, the overall average of DMU scores was calculated to represent the longitudinal performance of UNEMAT's master's programs, as shown in Figure 2. Based on the DEA model adopted and the selected indicators, the results suggest that, on average, the pandemic did not cause a significant decline in the relative efficiency of the programs analyzed.

Figure 2 – Longitudinal Performance of UNEMAT's DMUs



Source: The authors.

Although the public health crisis imposed numerous challenges on higher education institutions, the data presented in Figure 2 indicate that UNEMAT's graduate programs demonstrated institutional resilience and a certain capacity for adaptation, maintaining efficiency levels close to those observed in the years preceding the crisis.

These results provide reflections on the performance of master's programs, highlighting the importance of performance analysis as a management tool and a mechanism for continuous improvement. Such reflections may support the development of strategies aimed at enhancing the results of lower-performing units.

It should be noted, however, that these results refer exclusively to the parameters considered in the quantitative modeling and do not encompass other relevant impacts, such as those of a psychosocial, pedagogical, or structural nature. In fact, the pandemic scenario affected higher education across the country at all academic levels, as it led to the suspension of in-person classes at both public and private universities. As a result, several challenges emerged, notably: "a) lack of psychological support for faculty; b) decline in the quality of education; c) increased workload for professors; d) student dissatisfaction; and e) limited (or nonexistent) access to essential technologies by students" (Gusso *et al.*, 2020, p. 4).

With regard to UFSC, Table 3 presents the results of the DEA analysis (BCC-O model) applied to 71 graduate programs at UFSC, covering the period from 2017 to 2022.

Table 3 – Longitudinal Performance of UFSC's DMUs

		Pré-Pandemia			***Pandemia***		
Nº	**DMU**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
1	Administração (acadêmico)	0,7865	1	0,9661	1	0,642	0,7732
2	Administração Universitária (profissional)	1	1	1	1	0,9412	0,9681
3	Agroecossistemas (acadêmico)	1	0,7254	0,7143	0,805	0,8158	0,7941
4	Antropologia Social (acadêmico)	0,8913	1	1	0,971	0,8739	0,9808
5	Aquicultura (acadêmico)	0,9083	0,8815	0,8571	0,896	1	1
6	Arquitetura e urbanismo (acadêmico)	0,7996	0,7722	0,7495	0,795	1	0,8614
7	Biologia Celular e do Desenvolvimento (acadêmico)	0,7214	0,6773	0,665	0,578	0,5783	0,9483
8	Bioquímica (acadêmico)	1	1	1	1	1	0,9777
9	Biotecnologia e Biociências (acadêmico)	0,7896	0,7627	0,8395	0,737	0,7143	0,9155
10	Ciências dos Alimentos (acadêmico)	1	0,9677	1	0,874	1	0,9241
11	Ciência e Eng. de Materiais (acadêmico)	1	1	1	1	1	1
12	Ciências da Reabilitação (acadêmico)	0,5169	0,5429	0,8213	0,832	0,568	0,6165
13	Ciências Médicas (acadêmico)	0,8384	1	0,8415	0,953	0,8	1
14	Contabilidade (acadêmico)	0,8281	0,7143	0,8302	0,954	0,8287	0,811
15	Design (acadêmico)	0,9577	0,9209	0,9224	0,880	0,9493	1
16	Direito (acadêmico)	1	0,9912	1	0,919	1	1
17	Direito (profissional)	0,8000	1	0,9846	1	0,8800	1
18	Ecologia (acadêmico)	0,7669	0,7762	0,8684	0,729	0,8641	1
19	Economia (acadêmico)	0,975	0,8605	0,9682	0,828	0,9289	0,9946
20	Ecossistemas Agrícolas e Nat. (acadêmico)	0,681	0,628	0,777	0,665	0,5926	0,8134
21	Educação (acadêmico)	0,7521	1	1	1	0,8161	0,7408

22	Educ. Científica e Tecnológica (acadêmico)	0,8906	0,8571	0,8594	0,909	0,8571	0,9131
23	Educação Física (acadêmico)	1	1	1	1	1	1
24	Energia e Sustentabilidade (acadêmico)	0,7253	0,7228	0,6731	0,705	0,7094	0,742
25	Enfermagem (acadêmico)	0,8758	0,9844	1	1	0,978	0,9408
26	Engenharia Ambiental (acadêmico)	0,87	0,8743	0,8819	0,904	0,9109	0,9466
27	Engenharia Civil (acadêmico)	1	1	1	0,871	0,8857	1
28	Engenharia de Alimentos (acadêmico)	1	1	1	1	1	1
29	Engenharia de Produção (acadêmico)	0,8571	1	0,8804	0,857	0,9245	0,9091
30	Eng. de Sistemas Eletrônicos (acadêmico)	0,7196	0,5391	1	0,501	0,4699	0,5556
31	Eng. Transp. e Gestão Territorial (acadêmico)	0,579	0,6872	0,7981	1	0,7348	0,5572
32	Eng. e Ciências Mecânicas (acadêmico)	0,4641	0,5687	0,7522	0,930	0,8652	0,6249
33	Eng. e Gestão do Conhecimento (acadêmico)	1	1	1	1	1	1
34	Engenharia Elétrica (acadêmico)	1	1	1	1	1	1
35	Engenharia Mecânica (acadêmico)	1	1	1	1	1	1
36	Engenharia Química (acadêmico)	1	1	1	1	1	1
37	Ensino de Biologia (profissional)	0,8	0,7835	1	0,910	1	0,9485
38	Ensino de Física (profissional)	1	0,8205	0,8632	0,978	1	0,8
39	Ensino de História (profissional)	1	0,7677	0,7207	0,675	1	1
40	Estudos da Tradução (acadêmico)	0,8571	0,8602	0,8613	0,986	0,8603	0,9424
41	Farmácia (acadêmico)	0,7663	0,9484	0,8533	0,749	0,8485	0,7973
42	Farmacologia (acadêmico)	0,9375	1	0,9623	0,882	1	0,931
43	Farmacologia (profissional)	1	1	1	1	1	1
44	Filosofia (acadêmico)	1	1	1	1	1	1
45	Física (acadêmico)	0,7718	1	0,7555	0,807	0,9387	0,7692
46	Gestão do Cuidado em Enf. (profissional)	1	1	1	1	1	1
47	História (acadêmico)	0,758	0,9424	0,725	0,918	0,8177	1
48	Informática em Saúde (profissional)	0,800	1	0,8725	1	1	0,800
49	Inglês: Linguísticos e Literários (acadêmico)	0,7554	0,7143	0,7482	0,784	0,8141	0,7657
50	Jornalismo (acadêmico)	0,7535	0,7781	0,6451	0,571	0,6711	0,7086
51	Letras (profissional)	0,6891	0,8704	1	1	1	1
52	Linguística (acadêmico)	1	1	0,8729	0,857	0,8907	0,8571
53	Literatura (acadêmico)	0,7871	0,7956	1	0,749	0,8905	0,7143
54	Matemática (profissional) – Florianópolis	1	0,9794	0,9564	1	1	1
55	Matemática Pura e Aplicada (acadêmico)	0,8085	0,7489	0,7813	0,714	0,7494	0,8405
56	Métodos e Gestão em Avaliação (profissional)	1	0,6458	1	1	1	0,4291
57	Multicêntrico - Ciências Fisiol. (acadêmico)	1	0,9999	0,8922	1	0,7743	1
58	Nutrição (acadêmico)	0,7684	0,7092	0,5714	0,603	0,6163	0,5783
59	Oceanografia (acadêmico)	0,6658	0,7203	0,8305	0,820	0,5834	0,7069
60	Odontologia (acadêmico)	0,8976	0,7143	0,7143	0,831	0,8448	0,8377
61	Perícias Criminais Ambientais (profissional)	1	0,4902	0,5556	1	0,8613	1
62	Propriedade Intelectual e Inov. (profissional)	0,8	1	1	1	1	0,8
63	Psicologia (acadêmico)	0,7573	0,8745	0,8106	1	0,784	0,8346
64	Química (acadêmico)	1	1	1	1	1	1
65	Recursos Genéticos Vegetais (acadêmico)	0,8972	0,8727	0,9314	1	0,9778	1
66	Relações Internacionais (acadêmico)	0,7417	1	0,7814	0,571	0,6851	0,6577
67	Saúde Coletiva (acadêmico)	0,9259	0,8571	0,8571	0,869	0,9811	1
68	Saúde Mental e Atenção Psicos. (profissional)	0,677	1	0,7131	0,612	0,8143	1
69	Serviço Social (acadêmico)	1	1	0,8646	0,752	0,7143	0,7732
70	Sociologia Política (acadêmico)	0,7683	0,8896	0,7942	1	1	1
71	Tec. Info. e Comunicação (acadêmico)	0,6103	0,9073	0,932	0,997	0,9415	0,7222

Source: The authors.

As shown in Table 3, some programs maintained 100% efficiency—represented by a score of 1—throughout the six years evaluated. These include: Ciência e Engenharia de Materiais (academic), Educação Física (academic), Engenharia de Alimentos (academic), Engenharia e Gestão do Conhecimento (academic), Engenharia Elétrica (academic), Engenharia Mecânica (academic), Engenharia Química (academic), Farmacologia (professional), Filosofia (acadêmica), Gestão do Cuidado de Enfermagem (professional), and Química (academic). The Bioquímica program (academic) also stands out for maintaining maximum efficiency from 2017 to 2021. In 2022, although it did not reach the efficiency frontier (with a score of 0.9777), the DMU still achieved a very high level of efficiency.

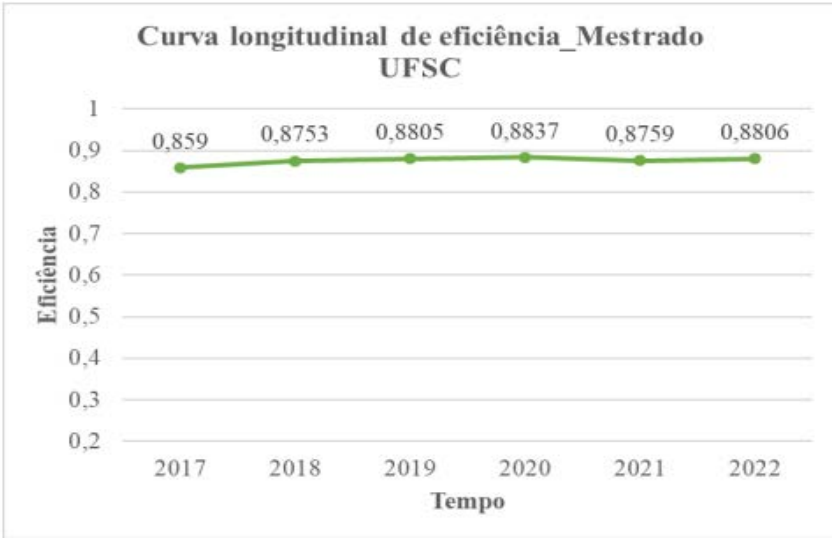
On the other hand, some DMUs displayed behavior contrary to expectations: although they recorded lower efficiency scores during the pre-pandemic period (2017–2019), they reached maximum productivity during the pandemic years (2020–2022). This was the case for the Mestrado Profissional em Letras, the Mestrado Profissional em Matemática – Florianópolis Campus, and the Mestrado Acadêmico em Sociologia Política, all of which demonstrated significant capacity to adapt to adverse conditions.

This performance may be associated with the reconfiguration of teaching practices, reorganization of faculty work, and more efficient use of available institutional resources, as discussed by Batista and Schuhmacher (2022), who highlight the importance of faculty autonomy and institutional flexibility as critical factors for sustaining teaching during times of crisis. It is worth noting that, according to the logic of Data Envelopment Analysis, units initially classified as inefficient can achieve better results by using efficient DMUs—referred to as benchmarks—as references, and by adjusting inputs and internal management processes.

According to the data in Table 3, a significant number of DMUs reached efficiency scores close to or equal to 1, that is, 100% relative efficiency under the adopted model. Even among those that did not reach the efficiency frontier, many programs demonstrated satisfactory results. In quantitative terms, 20 DMUs surpassed 80% efficiency in 2017; the same number was recorded in 2018, followed by 27 in 2019, 26 in 2020, 29 in 2021, and 24 in 2022. These data suggest that, based on the criteria and variables defined in the DEA model, the average performance of the programs remained relatively stable during the pandemic period.

This finding does not imply an absence of impacts but may indicate the presence of institutional resilience mechanisms that, as argued by Gomes, Kretzmann, and Pedroso (2022), enabled many programs to maintain productive levels by adapting academic and operational strategies to emergency remote teaching. Figure 3 illustrates this trend, presenting the overall average efficiency scores across the analyzed time series.

Figure 3 – Longitudinal Performance of UFSC's DMUs



Source: The authors.

As illustrated in Figure 3, the overall average academic efficiency of UFSC's master's programs did not show a significant decline in scores during the pandemic period. This indicates that the institution adapted to the pandemic context in a way that ensured its graduate programs continued to offer teaching, research, and extension activities in a manner comparable to the pre-pandemic period.

It is important to clarify that, although some master's programs experienced a reduction in inputs and even outputs over time, the DEA model identifies best practices within each specific context (period/year) when making comparisons. This may help explain why certain programs were able to maintain their efficiency over time or even justify why units that were previously inefficient succeeded in increasing their productivity during this period.

5 Conclusions

The results of this study show that the stricto sensu graduate programs at UFSC and UNEMAT demonstrated the capacity to adapt to the pandemic, maintaining, on average, relatively stable levels of technical efficiency during the years 2020 to 2022. The efficiency scores obtained through Data Envelopment Analysis (DEA), using the BCC-O model, indicate that, in both institutions, the programs managed to maintain or even improve their efficiency during the pandemic period.

These findings are supported by the literature, which points to relative success in the virtualization of teaching (Luiz; Martins; Marinho, 2020) and institutional management (Lessa *et al.*, 2022), primarily driven by the efforts of organizational actors. The importance of such actors is especially evident in the significant intra-institutional variations observed among DMUs. Although the overall average efficiency remained stable, some programs experienced substantial performance losses during the pandemic years, while others showed notable recovery or even increased productivity—indicating that institutional efficiency was not homogeneous and largely depended on internal resource management and the innovation capacity of faculty and administrators (Barbosa *et al.*, 2022; Lessa *et al.*, 2022).

In general, in cases where academic efficiency increased suggests sound resource management at the program level (inputs), whether material or human, resulting in the delivery of outcomes (outputs) even under unfavorable conditions. In this context, although the quantitative data analyzed do not allow for identification of the causes of positive results, the literature indicates that factors such as the use of innovative pedagogical practices (Fiorese; Trevisol, 2021), prior familiarity with digital technologies and virtual learning environments (Behar *et al.*, 2021), as well as structured institutional support, may have contributed to institutional adaptation.

Beyond internal institutional factors, it is important to consider that external elements may also have influenced the efficiency outcomes observed. Specific institutional policies—such as the creation of remote teaching support centers, participatory planning, and digital inclusion initiatives—were fundamental in sustaining academic activities at many institutions (Pacheco; Barcelos, 2025; Barbosa; Costa; Hecksher, 2023). Moreover, financial support directed at students through student assistance programs, emergency scholarships, and retention initiatives played a

crucial role in supporting students in vulnerable situations (Santos *et al.*, 2023; Unicamp, 2021).

Although not directly measured in this study, these elements are consistent with findings in the literature on higher education during the pandemic (Zawacki-Richter *et al.*, 2022) and help explain the results observed, while also informing strategies to maintain or restore strong performance among DMUs. Overall, the applied model made it possible to identify patterns of academic performance before and during the pandemic, revealing the adaptive capacity of several DMUs while also highlighting structural weaknesses in others. The general objective of the study was achieved by successfully evaluating and comparing the efficiency of the programs during the pre-pandemic and pandemic periods, generating diagnostic information to support organizational planning and strategic decision-making in university management. As such, this study contributes to the literature on institutional evaluation in times of crisis.

Despite these promising results, it is essential to acknowledge the limitations of the DEA methodology. It should be emphasized that the analyses in this study are based on average efficiency scores and do not capture the full impact of remote teaching in all dimensions. In this regard, the critique by Saviani and Galvão (2020) on the challenges of digital inclusion in remote education—particularly in the Brazilian context—is relevant. They stress that maintaining efficiency in some programs does not negate the exclusionary effects of remote learning, which disproportionately affected students according to their socioeconomic conditions.

As a result, the assumption of independence between input and output variables may not hold in all complex educational contexts. Moreover, DEA does not directly incorporate external factors such as socioeconomic and cultural conditions that may influence institutional performance. The sensitivity of results to changes in variable weights also calls for caution in interpreting the conclusions. Future investigations may explore these qualitative dimensions more thoroughly by linking efficiency results to specific institutional practices. Further studies could combine efficiency analysis with qualitative approaches—such as case studies and interviews with administrators and faculty—to better understand the institutional strategies adopted and their relationship to academic performance during the pandemic period.

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