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CESAR AUGUSTO SAITO SHIMURA

PERFORMANCE GAP AMONG BRAZILIAN UNDERGRADUATE STUDENTS IN ONLINE AND FACE-TO-FACE COURSES

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Thesis presented to Escola de Administração de Empresas de São Paulo of Fundação Getulio Vargas, as a requirement to obtain the title of Master in International Management (MPGI).

Knowledge Field: International Economics and Finance

Adviser: Prof. Dr. Claudia Yoshinaga

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ABSTRACT

With SARS-CoV-2 pushing many higher education institutions to experiment different teaching formats, online education is becoming a relevant topic in the educational field. In the last twenty years, online education has been contributing for the expansion of higher education in Brazil, constantly increasing the number of enrollments and courses offered in this modality. In 2018, for example, the number of vacancies offered in the online modality exceed the number of vacancies offered in traditional face-to-face (F2F) format. Based on this context, this study investigates the existence of a performance gap among Brazilian undergraduate students in online and F2F courses. In other words, the purpose of the study is to analyze the impact of taking an online course, instead a F2F one, on students' performance. For the empirical analysis, the study considered 1,212,230 observations from the National Exam of Student Performance (ENADE), which is a Brazilian national exam that annually assess graduating students' performance. By using a linear regression with fixed effects model, the study verifies that there is the performance gap among students in online and F2F courses. Even by controlling with different explanatory variables, Brazilian graduating students in online courses tend to have a lower performance. Additionally, the study also analyzes which student's characteristics contributes for their performance. This research sheds light on how graduating students in online courses have been developing in the Brazilian post-secondary education, contributing for the debate of whether online education is equally effective for the development of undergraduate students.

Keywords: online education, higher education, performance, ENADE.

RESUMO

Considerando que a SARS-CoV-2 pode impulsionar muitas instituições do Ensino Superior a adotarem diferentes formatos de ensino, Ensino a Distância (EaD) ganha força no campo educacional. Nos últimos vinte anos, cursos de Ensino a Distância contribuíram para a expansão do Ensino Superior brasileiro, aumentando o número de matrículas e cursos oferecidos nesta modalidade. Em 2018, por exemplo, o número de vagas ofertadas na modalidade EaD superou o número de vagas ofertadas no ensino tradicional. Dado este contexto, o presente estudo investiga se existe uma diferença de desempenho entre alunos brasileiros de graduação em cursos EaD e presenciais. Em outras palavras, o objetivo deste estudo consiste em analisar o impacto que da modalidade EaD exerce no desempenho do aluno. Para a análise empírica, o estudo considerou 1.212.230 observações do ENADE, exame nacional que avalia anualmente o desempenho de alunos graduandos do Ensino Superior. Ao utilizar um modelo de regressão linear com efeitos fixos, o estudo verifica a existência da diferença de desempenho entre alunos de cursos EaD e presencial. Mesmo considerando diferentes variáveis independentes, alunos de graduação em cursos EaD tendem a ter um desempenho pior comparado com outros alunos em cursos presenciais. Adicionalmente, o estudo também analisou quais características do estudante contribuem para seu melhor ou pior desempenho. Esta pesquisa lança luz sobre como estudantes em cursos EaD estão se desenvolvendo no Ensino Superior brasileiro, contribuindo para o debate sobre a eficácia destes cursos para o desenvolvimento de alunos de graduação.

Palavras-chave: educação a distância, Ensino Superior, desempenho, ENADE.

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LIST OF ABBREVIATIONS

ENADE	Exame Nacional de Desempenho de Estudantes
F2F	Face-to-Face
HE	Higher Education
ICT	Information and Communications Technology
INEP	Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira

1. INTRODUCTION

Online education is a growing topic in Brazil. Considering the Brazilian higher education (HE) system, online education has been growing in the last twenty years, increasing the number of online courses offered and the quantity of student's enrollments in this modality. Among many reasons, this growth has been driven by Brazilian governmental initiatives that increased the flexibilization usage of online education courses, as well as, private investments that expanded the number of online courses available.

Online education generates many benefits to the educational field. According to Moore et al. (2007), online education enables a broader access for learning and training opportunities. Students are not limited by their physical space and they can learn from the same high-quality institutions that once were restricted in privileged areas. Online education also enables HE institutions to offer more courses in distant locations. For instance, in 2018, the number of vacancies offered in online education courses surpassed the number of vacancies offered in the traditional face-to-face (F2F) format. In addition, online education allows more convenience and flexibility to students (Maia & Meirelles, 2003), making them possible to adapt their studies with the rhythm of their life and work (Ferrugini et al., 2014).

However, theory might be different from reality and the way online education has been developing in Brazil incurs some drawbacks. Although online education relies on technologies as the main means for communication and interaction between professor and students (Moore et al., 2007), some regions in Brazil do not have the minimal infrastructure required for online courses, like electricity or internet (Martins & Mill, 2016). Furthermore, even though online courses require autonomous students to manage their learning process (Belloni, 2001), some students are more passive in their learning, not self-conducting their studies and absorbing much more information rather than properly developing new ones (Ferrugini et al., 2014).

Part of these issues is due to the lack of research about how online education has been developing in the Brazilian HE system. Some studies compare online and F2F courses in order to verify which modality is better, but they often focus on specific contexts, like a single course or a group of subjects, not necessarily contemplating a broad analysis. Furthermore, there is still a gap in academic studies that analyze online education using the ENADE. As further explained, the ENADE is a national exam that assesses graduating student's performance in Brazil. Based on the study of Lima et al. (2019), after conducting a systematic literature review

of more than a thousand research papers from 2005 to 2016, the authors found that only 40 studies were related to the ENADE and, considering only those related to student's academic performance, the number drops to 19. Given that not all of those 19 studies were related to online education, it is reasonable to argue that the number of studies related to online education and student's performance using the ENADE might be even lower.

Based on this panorama, the purpose of this study is to investigate the existence of a performance gap among Brazilian undergraduate students in online courses and F2F courses. By considering the academic performance of senior graduate students, as well as, their demographic, economic and other attributes assessed by the ENADE, this study analyzes the impacts of taking an online course, instead of a F2F one, on student's performance. In addition, this study also sheds light on which students' characteristics might affect their performance.

In order to consider a broader range of undergraduate students in online and F2F courses, this study uses data from the ENADE provided by INEP, which is the Brazilian autarchy responsible for providing evaluation and research for the Ministry of Education. INEP annually releases ENADE databases containing granular data of student's responses, like student's performance and other demographic, economic and academic attributes.

Based on that, after aggregating the last six ENADE databases available from 2013 to 2018 and applying additional filters, the final database used in this study consisted of 1,212,230 student observations. Additionally, the study conducted a multiple linear regression with fixed effects model in order to control many student's characteristics and investigate the impact that the variable course modality (1 = online and 0 = F2F) has on student's performance.

According to the study, students in Brazilian HE online courses have a different profile from to those enrolled in F2F courses. Among many characteristics considered in the study, students in online courses are majority women and, on average, they are older than students in F2F courses. In addition, more students in online courses work while studying and the minority of them reported to be single. These findings contribute to the understanding of Brazilian students who chose to take higher education through an online course.

Furthermore, based on the regression results, the study finds that there is a performance gap among students in online and F2F courses. By controlling different student's attributes, the beta for course modality in the regression model reports to be significantly negative, meaning that students in online courses perform worse than others in presential courses. Additionally,

the regression analysis also contributes to the debate of which student's characteristics impact their performance.

By considering more than a million observations, this study is one of a few researches in Brazil that analyzes online education using a large number of student observations. The holistic approach used in this study contributes for the understanding of online education in the Brazilian educational field, raising important issues regarding how this modality has been developing in the HE system. Members from HE institutions and the Government can use the findings in this study to better understand what is the average Brazilian online student's profile, what student's attributes might lead to a lower performance in academic courses and what causes might explain the performance gap among students in online and F2F courses. Given that SARS-CoV-2 might push many HE institutions to embrace online education, this study can help decision-makers to better understand the panorama of online education in the Brazilian HE system, promoting the debate of whether this modality is equally effective as the presential one for the development of undergraduate students.

The study is divided in the following chapters: first, it contextualizes the Brazilian higher education landscape and how online education has been developing in Brazil. After defying online education, the study explains what is the ENADE, how it works and what it evaluates. In addition, the study presents which demographic characteristics impacts student's performance, characterizing the Brazilian virtual student and analyzing different studies that compare the performance gap among online and F2F courses. After that, methodology for the empirical research is presented, describing the data collection and the model section used in the study. Finally, descriptive analysis and empirical results conclude the final part of the study, finishing with a discussion of the analysis found, limitations and possible future researches.

2. LITERATURE REVIEW

Higher Education in Brazil

Since the end of the 20th century, there has been a reconfiguration of the Brazilian educational field connected with the globalization process, especially in the post-secondary education (Andrade, 2012). The rapid transformations on scientific and technological developments have been demanding an attitude to constantly search for updates and a capacity to learn how to learn. Physical capital does not represent the main source of wealth; and knowledge, mainly technological, has been the main determinant for countries' economic and political power. Based on that, higher education (HE) became an important source producer of wealth by developing and distributing knowledge (Dias Sobrinho, 2009).

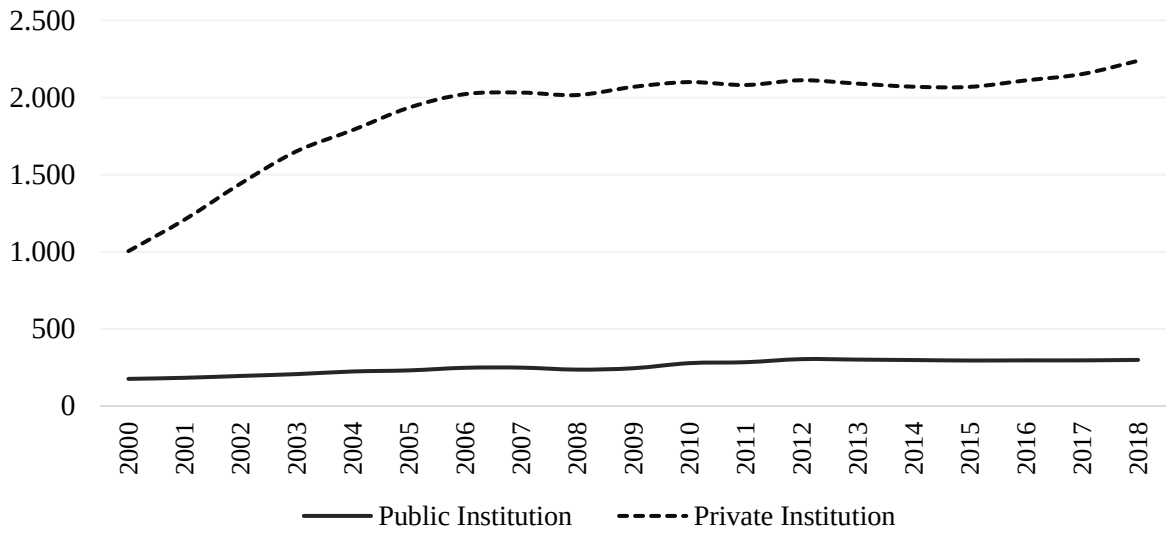
Additionally, the education required today calls for the formation of an efficient profile capable to comply with labor market's demands (Andrade, 2012). Given the need for professional qualification, the trend of HE systems is to be more aware of these demands, modifying course curriculum syllabus in order to guarantee an education that develops the "productive citizen" (Andrade, 2008). In this context, HE gains new dimensions either to foster social inclusion and human emancipation, as well as, to create level of competitiveness for the formation of students towards their success in the labor market (Andrade, 2012).

Nevertheless, even though HE is an efficient engine for the economy, HE faces the challenge of not losing its historical purpose to promote education as a public good. In general, governments are pressuring HE institutions to be more susceptible to external demands, guaranteeing an education that is relevant for the national economy. HE institutions have been incorporating a pragmatic and functional configuration while moving away from their important role in the process of society's democratization and emancipation (Andrade, 2012). According to Amaral (2009), education is considered to be more an indispensable ingredient for economic competition and less a social right.

One of the consequences of these transformations is the increasing concentration of private institutions in the Brazilian HE system. As shown on Figure 1, while the number of public institutions remained relatively stable between 2000 and 2018, the number of private institutions more than doubled. In 2018, for each public institution, there was at least seven private ones. This concentration can also be seen by ranking the top-30 institutions by number

of enrollments in 2009 and 2018 (Table 1). In 2009, from 25 HE institutions that concentrated 25% of all enrollments in Brazil, eight were public ones. In contrast, in 2018, from 13 HE institutions that concentrated 25% of all enrollments, only a single one was a public institution. This concentration of private institutions is higher if one considers that some them might belong to the same holding company.

Figure 1 – Total number of Brazilian HE institutions by administrative category.



Source: INEP – Sinopses Estatísticas da Educação Superior, created by the author.

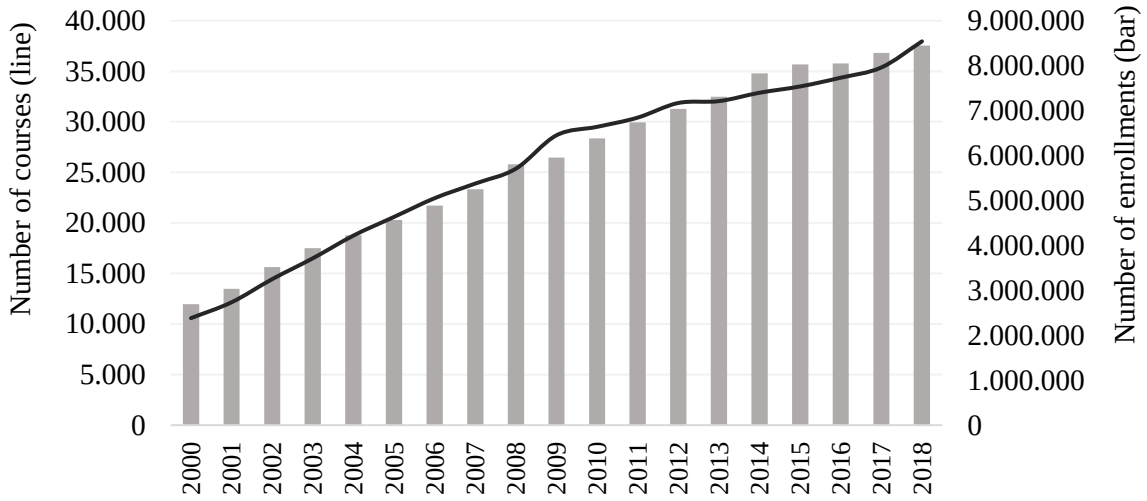
Table 1 – Ranking of HE institutions by number of enrollments (2009 and 2018).

	2009					2018				
nº	HE Institution	Administrative Category	Enrollments	% Enrollments	Accumulative %	HE Institution	Administrative Category	Enrollments	% Enrollments	Accumulative %
1	Universidade Paulista (UNIP)	Private	197.000	3,3%	3,3%	Universidade Paulista (UNIP)	Private	431.410	5,1%	5,1%
2	Universidade Luterana do Brasil (ULBRA)	Private	127.590	2,1%	5,5%	Universidade Pitágoras UNOPAR	Private	343.585	4,1%	9,2%
3	Universidade Pitágoras UNOPAR	Private	124.767	2,1%	7,5%	Universidade Estacio de Sá (UNESA)	Private	236.157	2,8%	12,0%
4	Universidade Estacio de Sá (UNESA)	Private	116.031	1,9%	9,5%	Centro Universitario Leonardo da Vinci (UNIASSELVI)	Private	205.020	2,4%	14,4%
5	Universidade Nove de Julho (UNINOVE)	Private	98.506	1,7%	11,2%	Centro Universitário Internacional (UNINTER)	Private	185.580	2,2%	16,6%
6	Universidade Estadual do Tocantins (UNITINS)	Public	67.075	1,1%	12,3%	Universidade Nove de Julho (UNINOVE)	Private	161.049	1,9%	18,5%
7	Centro Universitario Leonardo da Vinci (UNIASSELVI)	Private	59.465	1,0%	13,3%	Universidade Anhanguera (Uniderp)	Private	157.576	1,9%	20,4%
8	Faculdade de Tecnologia Internacional	Private	56.719	1,0%	14,2%	Centro Universitário de Maringá (UNICESUMAR)	Private	103.275	1,2%	21,6%
9	Universidade Anhanguera (Uniderp)	Private	56.626	1,0%	15,2%	Universidade Anhembi Morumbi	Private	68.079	0,8%	22,4%
10	Universidade Castelo Branco (UCB)	Private	55.916	0,9%	16,1%	Universidade Cruzeiro do Sul (UNICSUL)	Private	62.431	0,7%	23,1%
11	Pontifícia Universidade Catolica de MG (PUC-MG)	Private	51.466	0,9%	17,0%	Universidade de São Paulo (USP)	Public	62.241	0,7%	23,9%
12	Universidade de São Paulo (USP)	Public	51.328	0,9%	17,8%	Universidade Cidade de São Paulo (UNICID)	Private	61.381	0,7%	24,6%
13	Universidade Bandeirante de São Paulo	Private	49.734	0,8%	18,7%	Centro Univ. das Faculdades Metropolitanas Unidas (FMU)	Private	55.004	0,7%	25,2%
14	Universidade Presidente Antonio Carlos (UNIPAC)	Private	44.655	0,7%	19,4%	Universidade de Franca (UNIFRAN)	Private	50.743	0,6%	25,8%
15	Universidade Federal do Rio de Janeiro (UFRJ)	Public	37.854	0,6%	20,1%	Universidade Federal Fluminense (UFF)	Public	46.032	0,5%	26,4%
16	Universidade Salgado de Oliveira (UNIVERSO)	Private	36.370	0,6%	20,7%	Universidade Federal do Rio de Janeiro (UFRJ)	Public	45.729	0,5%	26,9%
17	Universidade Estadual Paulista J. de Mesquita F. (UNESP	Public	34.249	0,6%	21,3%	Centro Universitário Estácio de Ribeirão Preto	Private	45.177	0,5%	27,5%
18	Universidade Federal Fluminense (UFF)	Public	32.925	0,6%	21,8%	Pontificia Universidade Catolica de MG (PUC-MG)	Private	44.476	0,5%	28,0%
19	Universidade Presbiteriana Mackenzie	Private	32.274	0,5%	22,3%	Faculdade Educacional da Lapa (FAEL)	Private	40.890	0,5%	28,5%
20	Universidade de Caxias do Sul (UCS)	Private	32.165	0,5%	22,9%	Universidade Estadual Paulista J. de Mesquita F. (UNESP)	Public	39.989	0,5%	28,9%
21	Faculdade de Tecnologia e Ciências	Private	31.512	0,5%	23,4%	Universidade Federal do Maranhão (UFMA)	Public	39.211	0,5%	29,4%
22	Universidade Federal do Pará (UFPA)	Public	30.393	0,5%	23,9%	Universidade Federal da Bahia (UFBA)	Public	37.032	0,4%	29,8%
23	Universidade do Estado do Rio de Janeiro (UERJ)	Public	29.563	0,5%	24,4%	Universidade Federal do Pará (UFPA)	Public	36.959	0,4%	30,3%
24	Universidade do Sul de Santa Catarina (UNISUL)	Private	28.911	0,5%	24,9%	Universidade de Brasília (UNB)	Public	36.389	0,4%	30,7%
25	Universidade Federal do Rio Grande do Sul (UFRGS)	Public	27.491	0,5%	25,4%	Fundação Universidade Virtual do Estado de SP (UNIVESP)	Public	34.344	0,4%	31,1%
26	Universidade Federal de Minas Gerais (UFMG)	Public	27.193	0,5%	25,8%	Universidade Salgado de Oliveira (UNIVERSO)	Private	34.072	0,4%	31,5%
27	Universidade de Brasília (UNB)	Public	27.037	0,5%	26,3%	Universidade Luterana do Brasil (ULBRA)	Private	33.769	0,4%	31,9%
28	Universidade Tiradentes (UNIT)	Private	26.874	0,5%	26,7%	Universidade Federal do Piauí (UFPI)	Public	32.127	0,4%	32,3%
29	Universidade Federal do Piauí (UFPI)	Public	26.837	0,5%	27,2%	Universidade Federal de Pernambuco (UFPE)	Public	31.824	0,4%	32,7%
30	Universidade Potiguar (UNP)	Private	26.584	0,4%	27,6%	Universidade Presbiteriana Mackenzie	Private	31.647	0,4%	33,1%
	Subtotal	-	4.308.911	72,4%	72,4%	Subtotal	-	5.657.557	66,9%	66,9%
	Total	-	5.954.021	100,0%	100,0%	Total	-	8.450.755	100%	100%

Source: INEP – Sinopses Estatísticas da Educação Superior, created by the author.

Overall, Brazilian HE has been expanding in the last twenty years, continuously increasing the number of students accessing post-secondary education. From Figure 2, the number of students' enrollments increased from 2.7 million in 2000 to 8.4 million students in 2018, which represented a 213% growth. During the same period, the number of courses offered also had a significant expansion from 10.5 thousand in 2000 to almost 38 thousand courses in 2018.

Figure 2 – Total number of enrollments and courses in the Brazilian HE system.



Source: INEP – Sinopses Estatísticas da Educação Superior, created by the author.

Online Education in Brazil

Apart from the traditional face-to-face (F2F) modality, online education has an important role in the Brazilian HE expansion by considerably increasing the number of students enrolled in graduate courses (Gomes, 2013). Among many terminologies, this study uses the name online education as a direct translation for "Educação a Distância" which is the Brazilian terminology used for this modality in HE courses.

Online education is a relatively old concept in Brazil. Since the beginning of the 20th century, online education went through different phases in Brazil, from the post mail era to the radio, television and internet eras (Gomes, 2013). Based on the study of Viera, Cunha and Martinez (2017), the first generation of online education began with post mail courses in which there was an emphasis in printed materials and almost no interaction between tutors and students. In 1923, with the advent of radio broadcasting, online education began its second generation. Besides printed materials, radio has been a major vehicle for educational programs, focusing its educational contents to instruct professionals, especially those in lower classes of society.

In the 90's, in parallel with the emergence of new technologies, online education began its third generation by offering courses through audio and video formats transmitted by satellites, cables and computer networks. This phase enhanced synchrony communications, but there were still low interactions between tutor and student or one-to-many.

Furthermore, Viera, Cunha and Martinez (2017) continue by arguing that with the advent of the internet and the World Wide Web, online education entered its fourth generation. Different from the last generation in which interactions were characterized by one-to-many, the fourth generation favored a closer approach between tutor and student, enabling one-to-one interactions, using synchrony and asynchrony communications by chats and e-mails, respectively. Lastly, the fifth generation of online education began with the advent of the Web 2.0 that expanded interactions among users, enabling collaboration many-to-many. One of the main characteristics in this phase is the technology convergence in which many resources are accessed by a single device, like mobile phones, with the support of many media types. Information is exchanged faster, users produce and publish more contents and software communicate among themselves. These factors allowed the creation of "virtual learning communities" that enabled internet groups to share information, interact between each other and learn in a cooperative way.

Apart from technological and media transformations, the advancement of online education has been fostered by public policies in Brazil (Martins and Mill, 2016). In 1996, the Brazilian government approved the law "Lei de Diretrizes e Bases da Educação Nacional" nº 9.394 in which the name online education officially appeared in Brazil as "Educação a Distância" (Brasil, 1996). In addition, the Brazilian government has been increasing the flexibility of workload hours in which the online modality can be offered in HE courses. In 1996, the expansion of online education was limited by the law nº 2.253/01, because it stated that isolated disciplines using online education should not exceed 20% of the total workload of universities' courses (Gomes, 2013). However, this restriction changed in 2004 when a new government decree stated that, in semi-presential disciplines, HE institutions were allowed to offer online education courses over 20% of its total workload (Viera, Cunha and Martinez, 2017). More recently, in 2017, the Ministry of Education licensed HE institutions to offer exclusively undergraduate online courses without the need of another course in the presential modality (Brasil, 2017). This last change accelerated even more the expansion of online education in the Brazilian HE system.

Even though the term online education was mentioned by the Brazilian government in 1996, it was only in 2005 that this term was regulated and defined. According to the Brazilian decree nº 5.622, online education "is an educational modality in which the mediation didactic-pedagogy of teaching and learning process occur through the utilization of Information and Communication Technologies (ICT) with students and professors developing educational activities in distinct places or time" (Brasil, 2005, translated by the author).

Although some similarities with the Brazilian government's decree, Moore et al. (2007) define online education in a more comprehensive way. First, according to the authors, learning in online education is intentional and planned. A student deliberately proposes to learn and gets support by a professor that deliberately creates means to help the individual's learning. Second, different from F2F education in which the location of learning often occurs in the same place of teaching, in online education, the location of learning does not necessarily include the professor's presence. In this sense, learning normally occurs in a different place from teaching and it relies on technologies as the main means for communication and interaction with students. Another way to differentiate online education from the presential modality is by asking where major decisions are taken. Different from F2F courses, decisions in online education about what should be learnt and when learning has been completed are taken in a different place from the classrooms and communicated to students using different technologies (Moore et al., 2007).

Furthermore, online education changes some of the stakeholders' roles. According to Moore et al. (2007), course administrators have their roles changed, because instead of worrying about classrooms availability and hour schedules, in online education, administrators have to make sure that the resources for the preparation and offering of courses are accessible in distinct locations. Besides that, online education modifies the traditional classroom dynamic: the idea of professor's authority and dominance over the teaching process transforms into learning sharing (Maia and Meirelles, 2003). Instructors have to prepare materials without necessarily interacting with their students and, even if they do, they still have to learn how to teach using new information and communication technologies (Moore et al., 2007). Overall, professors are called to perform multiple functions that they have not been prepared for (Belloni, 2006). This is relevant if one considers that the instructor has an important role in the learning's process, influencing the student's satisfaction about the course (Redpath, 2012).

Moreover, in online education courses, educational institutions have more influence over the process of planning, systematizing and organizing contents (Keegan, 1996). According to Moore et al. (2007), online education requires special techniques for course creation and instruction, as well as, special organizational and administrative provisions. Some institutions might establish a special unit that has an administrative team, content producers and technical specialists responsible for online education courses. These units rarely have their own faculty, but rather uses the traditional faculty already established in the institution.

Finally, there is an important shift related to the student's role. Even though online education enables a broader knowledge access, students need to accept the consequence of assuming a greater responsibility for conducting their own leaning. They have to establish when they will study, how much they want to learn and how to find information individually (Moore et al, 2007). According to Maia and Meirelles (2003), online education's strategy has the assumption of a greater emphasis on self-learning and students' interest regarding their own learning.

One confusion pointed by Moore et al. (2007) is defying online education by the type of technology used. Recent expressions that define this modality include "e-learning" and even though "e" stands for electronic, it does not often consider all types of electronic communication, including radio or video recorders. It generally refers to online education using only the internet. Among other terminologies, Moore et al. (2007) argue that expressions that define online education are vaguely used and one must deduce what each author means. This is analyzed by Moore, Dickson-Deane and Galyen (2011). After running a survey to find the differences between "e-learning", "distance learning" and "online learning", the authors conclude that there is lack of consistency on those terminologies. "There is a myriad of instructional characteristics that can be found in any learning environment […] and it poses a problem when the specific context of the learning environment is not described in sufficient detail" (Moore, Dickson-Deane and Galyen, 2011).

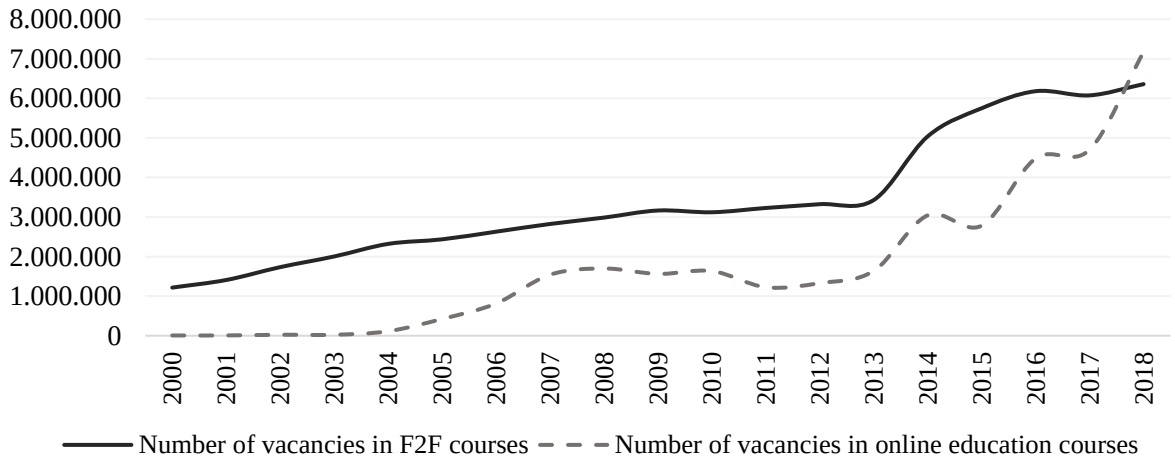
Related to the benefits of online education, this modality enables a greater access for learning and training opportunities (Moore et al., 2007). This means that more people are getting access to a greater and better learning resources compared to the past in which people were restricted to accept only what was locally offered. With online education, students from rural or countryside areas can participate in courses offered by the same institution and faculty that once were only available to students in privileged areas. The idea of a broader access is also beneficial for students with physical disabilities or for students who want to learn with

professors and colleagues from different nationalities. It eliminates the need to move, increasing convenience and flexibility (Maia and Meirelles, 2003).

In addition, online education enables opportunities for continuous development. Moore et al. (2007) argues that adults that need specialized training to improve their professional performance or to obtain basic capabilities can enroll in courses without moving away from their homes or jobs. This modality creates means for individuals to adapt their studies with the rhythm of their life and work (Ferrugini et al., 2014), reinforcing the idea that this modality can leverage learning opportunities for a greater number of people. According to Redpath (2012), online education also contributes to a wider range of sharing perspectives once students' contributions are not restricted to a specific physical space.

These benefits have been increasing online education popularity. According to Figure 3, the number of vacancies in online education courses has been expanding, surpassing the number of vacancies offered in F2F courses. In 2018, there were 7.2 million vacancies offered in online education courses which represented 13% more than the vacancies offered in F2F courses. Moreover, according to Table 2, the number of enrollments in online education have been increasing throughout the years. From 2015, while the number of enrollments in F2F courses began to stabilize, the quantity of enrollments in online education continued to increase. With the latest data available from 2018, the number of enrollments in online education courses represented almost one fourth of the total enrollments in Brazilian HE institutions.

Figure 3 – Total number of vacancies in F2F and online courses.



Source: INEP – Sinopses Estatísticas da Educação Superior, considering new vacancies, vacancies from special programs and remaining vacancies.

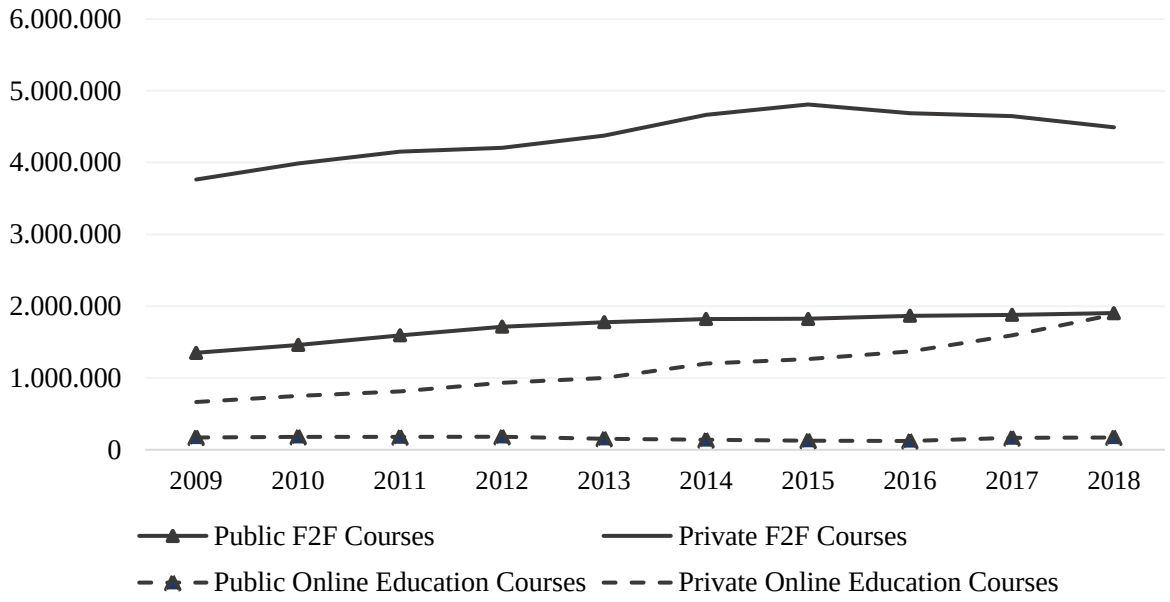
Table 2 – Number of enrollments in the Brazilian HE segmented by F2F and online courses.

Year	Total Enrollment	Enrollment in F2F Courses	% Relative to Total	Enrollment in Online Education Courses	% Relative to Total
2000	2.695.927	2.694.245	*99,9%*	1.682	*0,1%*
2001	3.036.113	3.030.754	*99,8%*	5.359	*0,2%*
2002	3.520.627	3.479.913	*98,8%*	40.714	*1,2%*
2003	3.936.933	3.887.022	*98,7%*	49.911	*1,3%*
2004	4.223.344	4.163.733	*98,6%*	59.611	*1,4%*
2005	4.567.798	4.453.156	*97,5%*	114.642	*2,5%*
2006	4.883.852	4.676.646	*95,8%*	207.206	*4,2%*
2007	5.250.147	4.880.381	*93,0%*	369.766	*7,0%*
2008	5.808.017	5.080.056	*87,5%*	727.961	*12,5%*
2009	5.954.021	5.115.896	*85,9%*	838.125	*14,1%*
2010	6.379.299	5.449.120	*85,4%*	930.179	*14,6%*
2011	6.739.689	5.746.762	*85,3%*	992.927	*14,7%*
2012	7.037.688	5.923.838	*84,2%*	1.113.850	*15,8%*
2013	7.305.977	6.152.405	*84,2%*	1.153.572	*15,8%*
2014	7.828.013	6.486.171	*82,9%*	1.341.842	*17,1%*
2015	8.027.297	6.633.545	*82,6%*	1.393.752	*17,4%*
2016	8.048.701	6.554.283	*81,4%*	1.494.418	*18,6%*
2017	8.286.663	6.529.681	*78,8%*	1.756.982	*21,2%*
2018	8.450.755	6.394.244	*75,7%*	2.056.511	*24,3%*

Source: adapted from Gomes (2013); INEP – Sinopses Estatísticas da Educação Superior

Private institutions are also responsible for the growth of online education (Gomes, 2013). From Figure 4, private institutions are predominant in the Brazilian HE landscape, concentrating 75% of total students' enrollments. From 2009 to 2015, the number of enrollments in private online courses has been increasing significantly, followed by the number of enrollments in private F2F courses. However, after 2015, while the number of enrollments in private F2F courses began to decrease, the quantity of enrollments in online courses continued to grow. During this 10-year period, the number of enrollments in F2F courses increased 41% in public institutions and 19% in private ones and the total number of enrollments in online courses increased 0.13% in public institutions and 183% in private ones.

Figure 4 – Total number of enrollments segmented by course modality and administrative category.



Source: INEP – Sinopses Estatísticas da Educação Superior

Although many benefits, online education also faces some negative aspects. First, Gatti and Barreto (2009) point out to the precarious quality in the online education formation, especially related to professors that will be teaching in this modality. There is lack of specialized faculty prepared to teach contents in the online format, lacking skills and knowledge (Ferrugini et al., 2014). In addition, there are obstacles and fragilities concerning the knowledge acquired by the students, preparing future professionals with limit capabilities for exercising their functions. Students in online education courses are more passive related to the creation and development of new knowledge and skills: they are absorbing much more information rather than properly developing contents and promoting new ones (Ferrugini et al., 2014).

Besides that, another negative aspect is related to some characteristics where online courses are offered. Some institutions do not have physical libraries located in presential centers where online courses are offered and student's learning is solely based on the materials offered by the professor's textbooks in the virtual platforms (Ferrugini et al., 2014). Furthermore, there are regions and areas that do not have the minimal infrastructure required for online courses, like electricity or broadband internet (Martins and Mill, 2016). Overall, there is a gap between teaching, formation and learning which is due to the failure of didactic-pedagogical process, lack of prepared and specialized faculty, absent of control and course assessment, inefficient teaching materials among other factors (Ferrugini et al., 2014).

Even with some negative aspects, the technology adopted in online education should be used as a catalyst to change the educational paradigm (Neitzel, 2001). A paradigm that promotes learning instead of teaching, places the learning process in the student's hand and assists professors to understand that education is not solely knowledge transferring, but a process of constructing knowledge built by the student as a result of her own intellectual engagement. This does not mean that online education is a substitute for F2F courses. According to Martins and Mill (2016), one modality does not exclude the other and the authors support the complementary idea between them. This is related to what Belloni (2002) refers to the "convergence of paradigms" in which presential and online education unify into new and diversify formats that will include the intense usage of ICT. According to Alves (2011), although relevant progress, there still a long path for online education to occupy a prominent space in the educational field. The lack of knowledge about the true functioning model of how online courses work causes student's evasion to be an aggravating factor for the growth and trust of this modality (Ferrugini et al. 2014).

The National Exam of Student Performance (ENADE)

In Brazil, both F2F and online courses are evaluated by an annual exam that assess student's performance. The exam is one of many instruments of a broader assessment system called the National System of Higher Education Assessment or SINAES (Sistema Nacional de Avaliação da Educação Superior) that the Brazilian government established in 2004. According to the Brazilian law nº 10.861, SINAES has the objective to ensure a national assessment process for HE institutions, bachelor courses and student's academic performance (Brasil, 2004). This last topic is accomplished by applying the The National Exam of Student Performance or ENADE (Exame Nacional de Desempenho de Estudante). The ENADE is controlled by The National Institute for Educational Studies and Research "Anísio Teixeira" or INEP (Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira) which is a federal autarchy from the Ministry of Education that provides educational research and evaluation.

According to the law nº 10.861 of 2004, the ENADE will "measure students' performance according to the predefined syllabus guidelines of the respective undergraduate course degree's curriculum, students' abilities to adjust them based on the arising demand of knowledge development and students' competencies to comprehend external topics outside the specific scope of their professional occupation related to other areas of knowledge" (Brasil, 2004). In

other words, the ENADE has the objective to assess basic skills, competences and knowledge regarding the student's undergraduate field, as well as, transdisciplinary issues involving a broader general knowledge (Brito and Limana, 2005).

There are many specificities regarding the ENADE assessment. First, this exam is a mandatory curricular component in Brazilian undergraduate courses, appearing in the student's bachelor transcript. Second, before 2011 the ENADE was applied annually to freshman and senior students, but now only graduating students take the exam. According to ENADE, senior or graduating students are those that already have completed more than 80% of the total course workload, but not yet graduated. Moreover, even though the ENADE is applied annually, the exam evaluates different subjects in each year, having a maximum periodicity of three years to evaluate the same undergraduate subject. This means that the ENADE is applied in every three years to the same set of subjects assessed. For instance, subjects assessed in 2013 will be revaluated in 2016 and 2019. Finally, besides the exam that evaluates student's performance, the ENADE is also composed by three other instruments: the student questionnaire that characterizes the students' profile and background, the student perception questionnaire about the exam and the coordinator questionnaire (Brasil, 2019).

Related to the structure of the exam, the ENADE has 40 questions segmented in two components: general education and subject area. The former is composed by questions that are common to all students and the latter is consisted of specific questions related to each subject assessed. The general education part has 10 questions: 8 multiple choice and 2 open-ended questions; and the subject area component has 30 questions: 27 multiple choice and 3 open-ended questions (Brasil, 2019). According to Brito and Limana (2005), the common component of the general education part is related to the tacit knowledge that individual needs to know in order to be successful, but it is not taught by HE institutions. Related to the subject area component, questions assess the domain of a certain area related to the knowledge of a specific field and abilities expected for the professional profile. Considering these both components, students have a total duration of 4 hours to answer all 40 questions.

Both the general education and subject area components constitute the ENADE overall score which is a grade between a continuous scale from 0 to 100 points. The student's final score is consisted of 25% of the general education part and 75% of the subject area component. On the one hand, the general education segment is graded by weighting 60% of the total number of correct answers from the eight multiple choice questions and 40% from the 2 open-ended

questions. On the other hand, the subject area component is weighted by considering 85% of the correct answers from the 27 multiple choice questions and 15% of the three open-ended questions. The calculation for the open-ended questions are done by a simple arithmetic mean (Brasil, 2019).

According to Brito and Limana (2005), the sample for the exam is composed of students selected by INEP from a list of senior students sent by HE institutions. It is worth noting that institutions only send the list of the students that meet the criteria for the exam and INEP applies the sample selection procedures. Hence, institutions do not have any interference to decide which students should take the exam.

Additionally, besides the forty questions, students who take the ENADE exam must also complete the student questionnaire. This form allows the comprehension of the students' background in order to better understand their results on the exam. The questionnaire is composed by questions like gender, age, family income, and other demographic, economic and academic topics. The complete filling of this form is configured to be one of the elements that characterizes the effective participation of the student in the exam. All answers are analyzed and aggreged by INEP, maintaining the confidentiality of the student's identity (Brasil, 2019).

Finally, according to Pedrosa, Amaral and Knobel (2013), using the ENADE for evaluating quality of a single course or a HE institution solely by a single final score implies some issues. Nevertheless, "for aggregates of institutions, grouped according various criteria, the system provides very useful information. […] It is possible to develop a detailed map of where the system is going, which areas have quality issues, which group of institutions are doing well and, if the system is expanding via better qualified programmes or not." (Pedrosa, Amaral & Knobel, 2013).

Face-to-Face Education and Student's Performance

Considering the work of Glewee et al. (2011) and Corbucci (2007), Miranda et al. (2015) organized the variables that may influence student's performance in F2F courses in three categories: faculty's characteristics, institution's characteristics and student's characteristics. The authors considered more than fifty academic articles to determine which variables were significant and if they had a positive or negative impact on student's performance. Based on their study, socioeconomic status, previous school performance, previous knowledge of the

content, area of expertise, study hours, motivation and type of learning had a positive relationship with student's performance.

First, according to Miranda et al (2015), previous school performance was the most relevant variable for predicting student's performance. Students with good performance in middle school and high school have a stronger probability to have a good performance in university and college education. Another interpretation is that students with a good performance in the beginning of the course will probably have a good performance in later disciplines. In addition, student's family has an important role on student's performance since it is fundamental that parents take care of their student's education and formation in early stages, even though the study found that parent's education does not necessarily have an impact on student's performance.

These findings are aligned with the study of Souza (2008) in which the author analyzed the variables that impact students' performance in Accounting courses assessed by the ENADE in 2006. First, the author found that previous student's grade that was used to enter the HE institution is an indicator for future academic performance success, meaning that previous knowledge influences student's performance throughout the course. However, Souza found that studying in public high school does not have a relationship with students' performance in HE. Secondly, both Souza (2008) and De Medeiros, Roseira and Pontes (2020) also found that family income has a positive impact on student's performance, but different from Miranda et al. (2015), the analysis of the ENADE found that parents' education had an impact on student's performance. As Souza (2008) argued, families with higher levels of education have more access to cultural resources which contribute to have children with better levels of schooling.

In addition, Miranda et al. (2015) also analyzed other demographic variables that were not determinant to predict student's performance. First, from 16 articles that analyzed the variable gender, six of them had no significance, while other six presented a positive impact and four a negative one. Based on Byrne and Flood's argument (2008), there is no more room in the educational field to sustain the idea that significant gender differences can be manifested on student's academic performance. Moreover, Miranda et al. (2015) found that other demographic variables, like age, marital status and ethnicity did not explain student's performance since those variables were reported in just a few studies.

In contrast, a study conducted by Ferreira (2015) which analyzed the factors that impacts student's performance in Accounting using the ENADE of 2012 found divergent results. While most of the academic literature referenced by Ferreira is in line with the study of Miranda et al. (2015), Ferreira's research found that female students tend to have a lower performance than men and While and Asian ethnicities tend to have better performance than other ethnicities. In addition, Ferreira found that socioeconomic status variables, like family income, had a positive impact on student's performance. Nevertheless, Ferreira found different results from Souza (2008): students that studied most of the time in public high school tend to have lower performance from those that studied in private schools. Besides that, aligned with Miranda et al.'s finding, parent's education did not impact student's performance. Not only the father's education did not present any significance in Ferreira's study, but the variable of mother's education presented negative relationship.

Related to work, even though Souza (2008) found that working during the HE period does not interfere on student's performance, the author argued that the work factor can have paradoxical behaviors. In Souza's study about students enrolled in Accounting courses, "on the one hand, students that work are in a disadvantage situation compared to those that do not work, because they will have less hours dedicated to study; on the other hand, it is possible that some of these students might work in accounting firms", having an advantaged compared to those that do not work (Souza, 2008). In contrast, Silva (2016) analyzed the effects of working on student's performance in the ENADE of 2013 and found that the academic performance was higher for students that did not work, but this impact also depended on the course enrolled. Overall, the literature is inconclusive regarding this variable.

Finally, according to Miranda et al. (2015), faculty's characteristics, teaching strategy or method and professional credentials had a positive relationship with student's performance. Related to institution's characteristics, none of the studied variables showed a robust conclusion, either because of inconclusive results or sample size issues. In addition, Ferreira (2015) found that student's characteristics and attitudes are responsible for explaining 90% of students' performance; only 10% is determined by faculty and institution's characteristics.

Online Education and Student's Performance

Besides analyzing variables that may affect student's performance in F2F courses, the following chapter analyzes if the same characteristics maintain for students in online education. The chapter first describes some aspects of virtual students and then analyze which characteristics impact online student's performance.

First, according to Moore et al. (2007), the majority of online education students in the US are composed by adults and some characteristics might differ this group from students in F2F courses. Some adults may enroll in online education courses to compensate neglected education or to develop and improve required knowledge for employment. Given that online education offers more flexibility regarding time and space, it enables online students to keep studying while having other responsibilities, like working and taking care of the family (Palloff and Pratt, 2004). A recent study by Ortagus (2017) found that "student's characteristics associated with the highest opportunity costs of engaging with residential education – such as being a full-time employee, parent or married – were often more likely than their peers to enroll in some online course and fully online programs" (Ortagus, 2017).

According to Las Casas, Almeida and Vianna (2012), in which the authors analyzed the Brazilian online education student's characteristics using the ENADE's results of 2009, students in online courses are on average 32 years old, being on average 7.43 years older than students taking F2F courses. In line with previous studies, the authors argued that older students in online courses may have different interests, since younger individuals tend to have less responsibilities. In accordance with Moore's (2007), Las Casas, Almeida and Vianna (2012) argued that online education students have more immediatism objectives, seeking to graduate in post-secondary education in order to progress in the job market.

Considering the Brazilian landscape, Las Casas, Almeida and Vianna (2012) found that women represented to be twice as men for the sample of students taking online education courses. The authors argued that this trend might be influenced by the fact that most of the courses offered in the online modality was related to Social and Human Sciences, which those courses had traditionally appeared to have more women than man enrolled. Regarding socioeconomic status, although not conclusive, the same authors found a higher percentage of students in online education courses with social support compared to other students in F2F courses. This

indicates that Brazilians students taking online education courses are economically disadvantaged.

Similar results were found by the "Associação Brasileira de Educação a Distância" (ABED) in 2017. This association collected information from more than 350 Brazilian HE institutions in order to understand the profile of the Brazilian online student. First, according to the study, the majority of online students was female (55%) and older: 48% of the students had between 26 and 30 years and 30% had between 31 and 40 years old. Second, almost two thirds (64%) of the sample belonged to the social class D and E. "Online education courses have a higher proportion of students who suffer financial limitations to study" (ABED, 2017). This is connected with another study conducted by the same association in 2018 (ABED, 2018), in which almost three fourth (74%) of the HE online courses charged monthly tuition between 100 and 500 reais. This implies that "online education courses are cheaper" than F2F ones in Brazil (ABED, 2018). Finally, according to ABED (2017), 51% of online students was While, followed by Brown (29%) and Black (15%) and the majority (63%) studied in public high schools.

Given that students in online courses have a different profile, a series of studies in the literature investigate which characteristics impact online learners' performance.

First, according to Rizvi, Rienties and Khoja (2019), gender does not impact the success in online education. Their finding is aligned with their previous literature research in which they found that gender effects remain inconsistent and inconclusive. The same result is found by Yukselturk and Bulut (2007). Moreover, even though Nistor (2013) found no gender differences in attitudes towards learning with technology, the author found that female students are more participative compared to male individuals. This is also observed by Diep et al. (2016) which the authors found that females reported to have more social interaction. Nevertheless, a studied conducted by De Oliveira Rodrigues et al. (2016) that analyzed student's performance using the ENADE of 2012 found that gender does impact student's performance in Accounting online courses. The authors found that male students tend to have a higher grade compared to female in the same modality.

Moreover, most of the research found in the literature argues that age does not impact online student's performance. Same as gender, Rizvi, Rienties and Khoja (2019) found that age remains inconclusive, even though their study found a small significant effect of age on overall

learning outcome. This result is different from other studies: Yukselturk and Bulut (2007) and De Oliveira Rodrigues et al. (2016) found that age does not impact student's success and performance, Ke and Kwak (2013) found that age does not predict quality of online discussion and Diep et al. (2016) argued that age does not predict different types of online participation.

Regarding socioeconomic status, Rizvi, Rienties and Khoja (2019) found that the geographical region in which the learner lived and the socioeconomic indicator measured by the Index of Multiple Deprivation Band, which measures the relative deprivation of an UK area, contributed to predict the learner's outcome. De Oliveira Rodrigues et al. (2016) also found the same conclusion by analyzing the ENADE's responses of 2012. The authors argue that income showed a significant relationship with student's academic performance. Students with a higher family income have more opportunities to study in more qualified schools and pay for courses outside the school environment (Ferreira, 2015). Based on the ENADE's questionnaires, De Oliveira Rodrigues et al. (2016) also found that the father's and mother's education did not impact students' performance in online education courses.

As Miranda et al. (2015) argued that previous knowledge influences student's performance, this variable is equally important in online education. According to Rizvi, Rienties and Khoja (2019), "prior education strongly influences the way leaners perform in further education". In parallel, Morris (2015) found that prior education is directly related to the level of completion of the course and De Oliveira Rodrigues et al. (2016) found that online Accounting students that did the majority of high school in public schools had a lower performance compared to those that attended private high schools.

Same as F2F courses, working variable is inconclusive to predict online student's performance. While Silva (2016) found that those who do not work in F2F courses had a higher performance in the ENADE of 2013, de Oliveira Rodrigues et al. (2016) found that work had no influence on the student's performance based on their study using the ENADE of 2012. Moreover, Morris (2015) found that online learners that do not work are more likely to complete their course and Diep et al. (2016) found that employment status was significant related to collaborative facilitation. The authors found that "adult learners who have either a full-time or a part-time job report more facilitating behaviors than those who are full-time learners".

Furthermore, related to ethnicity, De Oliveira Rodrigues et al. (2016) found the same results as Ferreira (2015) by analyzing the ENADE's results from students taking Accounting online

courses: those that self-declared to be White and Asian had a higher performance from those that self-declared Black, Brown and Indigenous. It is worth mentioning that the variable ethnicity might be related to other factors like student's socioeconomic. According to Ferreira (2015), there is the hypothesis that countries with homogeneous education opportunities might present a smaller performance gap between students from distinct ethnicities compared to those countries with significant opportunity differences.

Finally, given that the profile of online education students tends to be older, different studies based on the ENADE found that marital status impacts student's performance, but all those researches agree that there is lack in the literature about this variable. Based on De Oliveira Rodrigues et al. (2016) and Ferreira (2015), students that are single tend to have a lower performance compared to other students.

Performance Gap Between F2F and Online Education

One of the topics studied in the post-secondary educational field is the difference between online education and F2F education. More specifically, academics have been studying to what extend online education has the same effects on students compared to F2F education. This chapter introduces some findings regarding this comparison, considering the student's performance as the main metric to measure the performance gap between both modalities.

Overall, there is no convergence among studies. While some studies find that students taking F2F format performs better than those who take online education courses, others find no difference at all. One reason for this is the variability of contextual elements considered in each research. Some studies use available datasets, while others run their own experiments; some consider only a group of courses, while others adopt a broader range of it.

One study by Caetano et al. (2016) found that Brazilian graduating students enrolled in Accounting online courses had a lower performance compared to other students enrolled in the same course, but in a F2F modality. By analyzing more than 75,000 students' grades, the research found that universities, public institutions, male and senior students presented a higher performance in the total score of ENADE 2009. The authors argued that it is alarming the fact that the increase of online education courses happen at the expense of higher education's quality and they concluded the importance of a greater transparency in online education academic performance in order to track quantitative developments.

In a similar approach, Scudeler, Flores and Pires (2020) compared online education and F2F courses by using the ENADE course's score ("Conceito Enade"). This metric is assessed by INEP and it evaluates HE courses with a score ranging between a discrete scale of 1 to 5 (INEP, 2019), in which score 1 means a weak result and 5 an excellent one. The authors used the results of ENADE 2018, comparing Pedagogy online education and F2F courses of private institutions. Based on their findings, fewer Pedagogy courses offered in the F2F modality received a lower course's score between 1 and 2 (30.82%) compared to courses in the online education modality (40.63%), implying that online education courses for Pedagogy in private institutions are perceived as worse compared to the F2F ones.

When analyzing studies outside Brazil, Xu and Jaggars (2014) analyzed the performance gap between students taking an online course from those taking F2F one. By considering more than 40,000 observations from students enrolled in Washington State's 34 community or technical colleges, the authors found that students performed more poorly in online courses compared to those in F2F ones. Besides that, the authors also found that "males, young students, Black students, and students with lower prior GPAs had wider online performance gaps than their peers" (Xu and Jaggars, 2014).

Another research that contributes to the argument that students in online courses underperform is done by Bettinger, Fox, Loeb, and Taylor (2017). The authors used data from a large for-profit American university, considering over 230,000 students enrolled in more than 730 different courses. Based on their findings, students taking online courses earned on average a grade C (score 2.4) which is a lower performance compared to those in F2F modality which earned a grade B (score 2.8). Related to student's characteristics, students taking online courses were older (mean 32.9) and the majority was women (54%), supporting previous findings presented in the last chapter.

In a local study, Urtel (2008) analyzed the performance of students taking a F2F and online. By considering a sample of 116 students taking a F2F course and 269 students in online one, and taking into account the same course content, course instructor, performance evaluation and other constant variables, Urtel found that students who took a F2F course had a higher grade (3.16/4.00) compared to other students who took an online course (2.28/4.00). Moreover, while not under- or overrepresented, freshmen students underperformed in both F2F and online education formats. Regarding other demographics factors, while age is a predictor for taking

an online education format, it is not necessarily a predictor for academic performance. Related to gender, the study found no performance differences between men and women.

In contrast, other studies found that course modality does not impact student's performance. Looking at the Brazilian landscape, Nascimento and Junqueira (2012) compared two samples of students taking F2F and online education courses for an Accounting Introduction course from a federal university located in the Southeast region of Brazil. Both courses had many similarities, being taught by the same professor and having the same activities, materials and assessment methods. By analyzing both samples, the authors found no significant differences between students' score mean, which indicated that the online education course was efficient as the F2F course. Besides that, the authors also found that most of the online students was composed by women (61%), older than 25 years old (59%), majority worked (88.9%) and 21% already had a higher education diploma.

Another Brazilian study named "Classroom or Distance Learning: does the modality influence learning?", by Nascimento, Czykiel and Figueiró (2012), compared students taking F2F and online education courses for a Social-environmental subject. According to the study, both groups had similar results and, for most of the assessed items, student taking the online education modality had a better performance. The study concluded that depending on how the online course is delivered, as well as, its preparative conditions and dynamics used in the virtual classrooms, online education can motivate sceptics to believe that this modality can promote the same learning possibilities as traditional course modality.

Previous studies are related to Redpath's study (2012) which she talks about a bias towards online learning in Management Education. The assumption that presential interactions and physical instructor's presence are necessarily a superior method of educational delivery is a bias that needs to be overcome. Although the quality of the course and HE institution is a valid argument, "the method of delivery should not be confounded with the quality of an institution, its programs, or its teaching and learning effectiveness" (Redpath, 2012). Furthermore, Redpath suggests that administrators should learn more about the benefits of the online teaching and learning. The author recommends that institution's policy and incentives should be adapted in order to increase adoption of online delivery, like rewarding faculties members for dedicating extra time for developing online courses.

3. METHODOLOGY

3.1 Data Collection

Since 2004, INEP has been annually releasing databases containing granular data of students who took the ENADE exam. By assessing a range of variables, each ENADE database contains a variety of observations about student's performance on the exam, as well as, student's demographic, economic, academic and other attributes. Based on this, for the empirical analysis, the data used in the study comes from a set of ENADE databases.

As mentioned previously, the ENADE evaluates a different set of subjects every year and it takes three years to reassess them again. Given this, the study narrowed its data collection by using only the ENADE databases from the years 2013 to 2018. These six databases were selected, because not only the last available one is from 2018, but by selecting these years the study could consider at least two different datasets that evaluated the same set of subjects.

Before aggregating all six ENADE datasets into one, the study conducted an individual analysis in each one of them in order to modify responses that were differently classified among datasets. By doing that, the study certificated that all variables were compatible among the six datasets, measuring the same attribute. The consolidation of the six ENADE databases rendered an aggregated dataset of 2,528,339 observations.

Based on that, the study applied additional filters over the consolidated database. First, the study separated observations based on their course modality (F2F or online) and considered only those subjects that had at least 300 observations in both modalities. This first filter removed many observations from the dataset since many courses were not offered in both modalities, leaving the aggregated database with 1,474,949 observations.

In Brazil, students that finish high school can choose among three types of HE degree: Bachelor, Licentiate and Technologist. First, Bachelor is the generalist HE degree of scientific or humanistic formation that offers competences in a certain knowledge field for the exercise of professional, academic or cultural activities. Licentiate is the HE degree that offers competences for the graduate student to become a teacher in basic education. Finally, Technologist is the HE degree of a specialized formation in scientific and technological areas that offers competencies to work in a specific professional technical field (Brasil, 2007). Based

on that, the study did not consider Technologist courses degree, because they have a small representation in the Brazilian HE system, leaving the final dataset with 1,239,458 observations from Bachelor and Licentiate course degrees.

Moreover, other filters were applied in order to remove inconsistent data, like the year in which the student started HE being lower than the year that the individual finished high school, but higher than the year that the exam was taken. After all these filters, the final database used in the study consisted of 1,212,230 observations, analyzing 2,023 HE institutions and 28 subjects (Table 3).

Table 3 – Subjects and number of observations considered in the study.

Subjects	**F2F**	**online**
Accounting	96,723	29,815
Administration	210,375	58,548
Biological Sciences (Licentiate degree)	29,673	6,763
Chemistry (Licentiate degree)	10,776	1,486
Civil Engineering	51781	439
Computer Science (Licentiate degree)	2,187	1,339
Environmental Engineering	8,456	320
Geography (Licentiate degree)	17,956	5,621
History (Licentiate degree)	27,682	12,071
Information System	29,282	1,577
International Relations	5,406	334
Mathematics (Licentiate degree)	21,297	8,375
Modern Languages - English	2,425	674
Modern Languages - Portuguese & English (Licentiate degree)	15,989	3,82
Modern Languages - Portuguese & Spanish (Licentiate degree)	4,506	2,211
Modern Languages - Portuguese (Licentiate degree)	23,153	9,298
Music (Licentiate degree)	5,261	1,51
Pedagogy (Licentiate degree)	129,863	125,476
Philosophy (Licentiate degree)	6,472	3,516
Physical Education	17,587	1,486
Physical Education (Licentiate degree)	56,428	7,042
Physics (Licentiate degree)	5,981	1,079
Production Engineering	40,95	1,548
Public Administration	2,546	5,673
Social Sciences (Licentiate degree)	6,381	1,301
Social Service	32,398	40,518
Theology	5,37	2,774
Visual Arts (Licentiate degree)	5,185	5,527
Total	**872,089**	**340,141**

Source: INEP – Sinopses Estatísticas da Educação Superior, created by the author.

Finally, the study adapted some of the ENADE's responses of the final database in order to better fit the study's interests. The main variables considered in this study are presented on Table 4 and the full questionnaire of the ENADE database is in the Appendix.

Table 4 – Main variables considered in the study.

Variable	Description	Measurement
HE_Institution	*Brazilian HE institution's code ID*	HE Institution ID
Year_ENADE	*Year of the database*	Year from 2013 to 2018
Subject	*Subject studied by the student*	Subject ID
Online	*Course modality*	1 = online; 0 = F2F
TimeSpent	*Time spent by the student to complete the exam.*	A = Less than an hour B = Between one and two hours C = Between two and three hours D = Between three and four hours E = Four hours and the student did not finish
Age	*Student's age*	Discrete variable
Gender	*Student's gender*	1 = Male; 0 = Female
Single	*Student's marital status*	1 = Single; 0 = Other marital status
White	*Student's ethnicity*	1 = White; 0 = Other ethnicities
AffirmativeAction	*Whether the student entered HE through affirmative action policy.*	1 = Entered HE through affirmative action 0 = Did not enter HE through affirmative action
FamilyIncome	*Student's total family income*	A = Up to 1.5 minimum wage B = Between 1.5 to 3 minimum wages C = Between 3 and 4.5 minimum wages D = Between 4.5 to 6 minimum wages E = Between 6 and 10 minimum wages F = Between 10 and 30 minimum wages G = Above 30 minimum wages
Work	*Student's working situation.*	1 = Student works 0 = Student does not work or works eventually
SchoolLoan	*Whether the student received scholarship to support monthly expenses.*	1 = Student received school loan 0 = Student did not receive school loan or did not have to pay for it
FinancialAid	*Whether the student received financial aid.*	1 = Student received financial aid 0 = Student did not receive financial aid
Scholarship	*Whether the student received academic scholarship.*	1 = Student received scholarship 0 = Student did not receive scholarship
ExchangeProgram	*Whether the student participated in curricular programs and/or activities abroad.*	1 = Student did an exchange program 0 = Student did not an exchange program
HighSchool	*Type of high school in which the student studied.*	A = All in public school B = All in private school C = All abroad D = Majority in public school E = Majority in private school F = Part abroad and part in Brazil
Score_General	*Score of the ENADE general education component*	Continuous variable from 0 to 100
Score_SubjectArea	*Score of the ENADE subject area component*	Continuous variable from 0 to 100
Year_ENADE - YearFinishHS	*Proxy for student's maturity (year of the exam subtracted by the year that the student finished high school.)*	Discrete variable

Source: INEP – Sinopses Estatísticas da Educação Superior, created by the author.

3.2 Model Selection

In order to investigate the existence of a performance gap among Brazilian undergraduate students in online and F2F courses, a multiple linear regression with fixed effects model was chosen for the empirical analysis (equation 1).

$$Score\_SubjectArea_{itsh} = \beta_1 Online_{it} + \beta_2 Score\_General_{it} + \beta_3 TimeSpent_{it} + \gamma X_i + \delta_t + \delta_s + \delta_h + \varepsilon_{itsh} \quad (1)$$

The main objective for selecting this model is to investigate the impact that the key variable *Online* has on students' performance and this variable is 0 if the course was taught F2F or 1 if the course was taught online. The idea behind this variable is to measure whether studying through an online course contributes or not for the graduating student's performance. Hence, this variable measure whether the course modality supports students to achieve the predefined course's curricular objectives established by the Ministry of Education.

Choosing the subject area component grade (*Score_SubjectArea*) as a dependent variable for performance is appropriate given that it measures the direct impact that the course had on student's learning. This dependent variable was standardized based on the subject studied by the student and the year of the ENADE exam. The study did not adopt the ENADE overall score as a dependent variable given that this score also considers the general education grade which is common among all courses and not necessarily assess taught knowledge from the course.

Related to other independent variables, a proxy for the student's intelligence was considered by using the grade from the ENADE general education component (*Score_General*). This variable was also standardized based on the year of the ENADE. In addition, time spent on the exam (*TimeSpent*) was also considered given the hypothesis that students who spend more time on the exam can answer more questions and, hence, increase their score. Moreover, the model also considered student's demographic, economic and academic variables (X_i). First, the demographic variables used in the model were: *Gender, Age*, *Single*, *White, AffirmativeAction* and *Year_ENADE-YearFinishHS*. Additionally, student's economic variables considered in the study were: *FamilyIncome*, *Work, SchoolLoan* and *FinancialAid*. Finally, regarding student's academic variables, the model considered: *Scholarship, ExchangeProgram* and *HighSchool*.

Additionally, the model also adopted three fixed effects: the year in which the ENADE was taken (δ_t), the student's subject (δ_s) and the HE institution (δ_h); as well as, a double clustered-robust standard error at the individual (i) and year (t) levels.

Based on equation 1, the study analyzed six different regression models by adding distinct combinations of explanatory variables in each case (Table 5).

Table 5 – Variables considered in each regression model of the study.

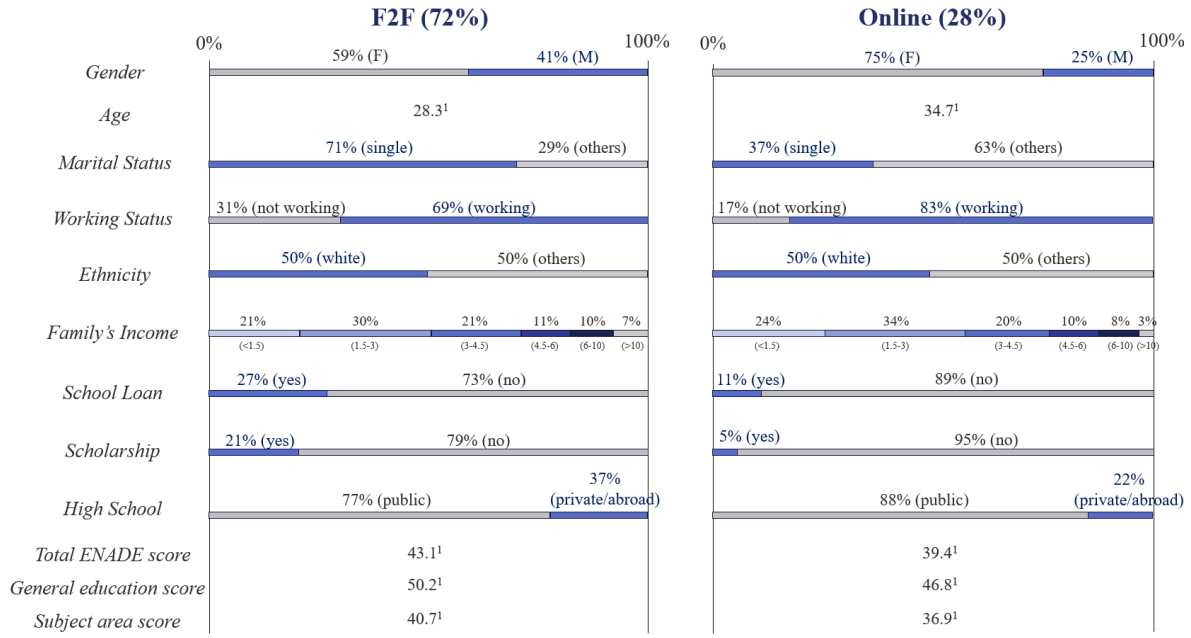
	Models					
Variables	Online and Score (1)	Adding Subject FE (2)	Adding Time to Complete Exam (3)	Adding student's demographic attributes (4)	Adding student's economic attributes (5)	Adding student's academic attributes (6)
Online	Yes	Yes	Yes	Yes	Yes	Yes
Score_General	Yes	Yes	Yes	Yes	Yes	Yes
TimeSpent			Yes	Yes	Yes	Yes
Age				Yes	Yes	Yes
Gender				Yes	Yes	Yes
Single				Yes	Yes	Yes
White				Yes	Yes	Yes
AffirmativeAction				Yes	Yes	Yes
Year_ENADE - YearFinishHS				Yes	Yes	Yes
FamilyIncome					Yes	Yes
Work					Yes	Yes
SchoolLoan					Yes	Yes
FinancialAid					Yes	Yes
Scholarship						Yes
ExchangeProgram						Yes
HighSchool						Yes
HE_Institution FE	Yes	Yes	Yes	Yes	Yes	Yes
Year_ENADE FE	Yes	Yes	Yes	Yes	Yes	Yes
Subject FE		Yes	Yes	Yes	Yes	Yes

4. RESULTS

4.1 Descriptive Analysis

The descriptive analysis of the final database found many similarities with the literature review. Main findings are shown on Figure 5 and the full descriptive analysis table is in the Appendix.

Figure 5 – Summary of the main descriptive analysis found in the study

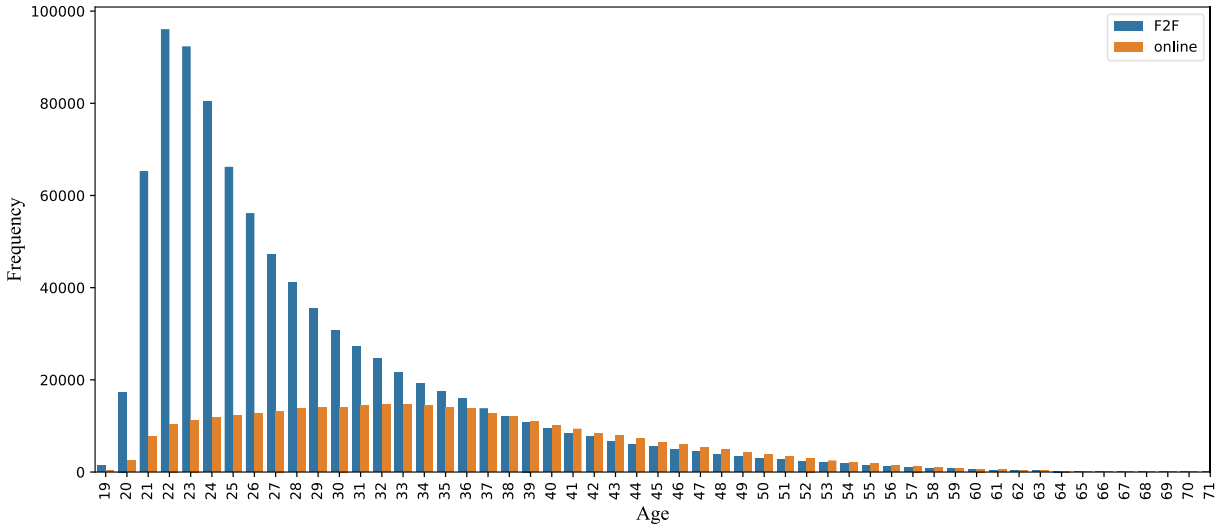


[1] Mean. Created by the author.

First, as presented on Figure 5, a little more than one fourth (28%) of the students considered in the database chose to take an online course. This result reinforces the increasingly popularity that this modality has been gaining over the last twenty years. Second, three fourth of the students in online education courses were female. While this result is in accordance with other studies (Nacimento & Junqueira, 2012; Bettinger, Fox, Loeb, & Taylor, 2017; Las Casas, de Almeida & Viana, 2012; ABED, 2017), it is worth noting that most of the subjects selected in the study was related to either Pedagogy or other Licentiate course degrees. This finding may be related to the argument of Las Casas, de Almeida and Viana (2012): most of the Brazilian courses offered in the online modality is related to Social and Human Sciences, which traditionally appeared to have more women than men enrolled.

Additionally, students in online education courses had on average 34.7 years, while those who took F2F courses had on average 28.3 years. This finding reinforces previous studies in which students taking online courses are older, presenting a higher frequency of age over 40 years old (Las Casas, de Almeida & Viana, 2012). From Figure 6, while the majority of the online students had between 25 to 40 years, students in F2F courses had between 21 to 25 years old, which indicates that students in this range still prefers F2F courses for their first graduation (ABED, 2017).

Figure 6 – Distribution of observations based on student's age**.**



Source: INEP – Sinopses Estatísticas da Educação Superior

Related to marital status, while 71% of students in F2F courses reported to be single, the percentage decreases to 37% for students in online education. This finding reinforces the idea that since online education promotes flexibility, online students can study while having other responsibilities, like working or giving attention to their family (Palloff and Pratt, 2004).

In addition, the majority (72%) of Brazilian graduating students worked while studying. This percentage increased if the students were enrolled in an online course (83%) and decreased if students were enrolled in a F2F one (69%). As previous studies found, since working might be a high opportunity cost for engaging in presential courses, individuals who work are more likely to enroll in an online course (Ortagus, 2017). Besides that, online education courses might also attract adults to improve required knowledge for employment (Moore et al., 2007).

Moreover, half of the students in both groups self-declared to be White, followed by Brown (38% in online and 35% in F2F) and Black (9% in online and 11% in F2F); Asian and

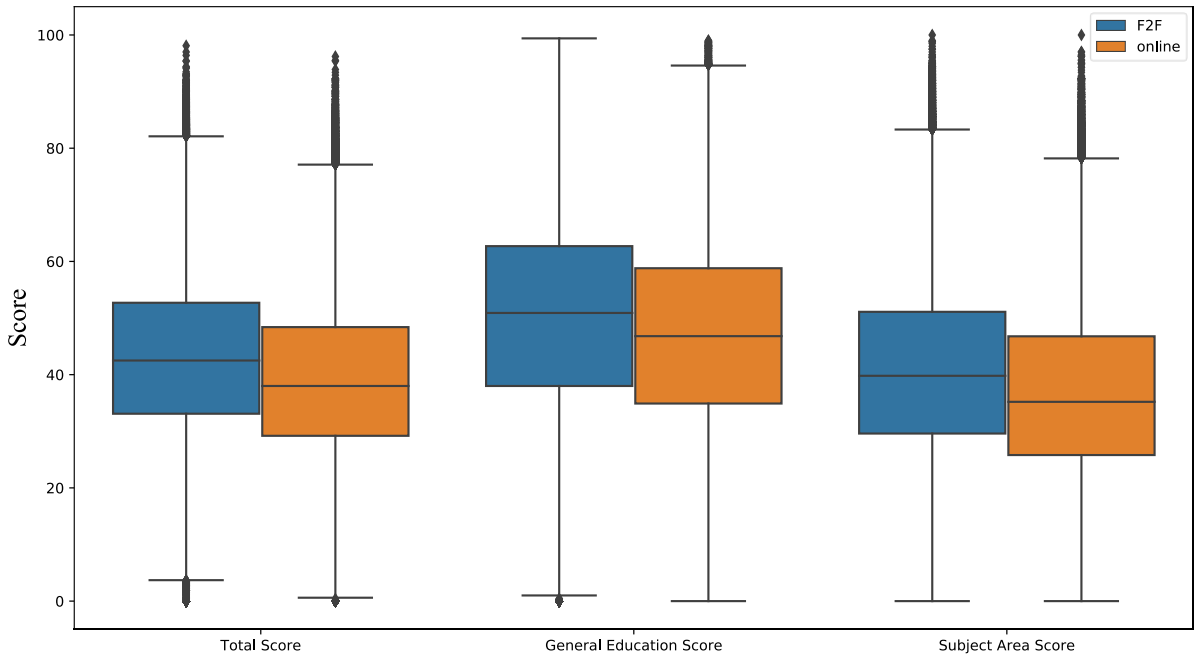
Indigenous are the minority in the dataset. This result is similar with ABED's finding about the profile of online students in 2017.

Whenever comparing socioeconomic attributes, more than 50% of the students who took the ENADE had a family income of less than three minimum wages. Even though the distribution of family income remained almost the same in both modalities, students in online courses had a slightly lower income on average. This is coherent with ABED's study in 2018 which showed that online courses offered by HE institutions are cheaper than other F2F courses.

Regarding if the student received school loan or scholarship, less students enrolled in online courses received these economic and academic support compared to those enrolled in F2F courses. Related to the type of high school, while 75% of the respondents did high school in a public institution, this percentage increased to 82% for those who took online courses.

Finally, concerning student's overall performance in the ENADE, the average score of students in online education courses was lower compared to other students in F2F courses, scoring on average 39.4 and 43.1, respectively. From Figure 7, students in F2F courses also had a higher score both in the general education and subject area components.

Figure 7 – Student's performance in the ENADE (2013-2018) by course modality.



Source: INEP – Sinopses Estatísticas da Educação Superior.

4.2 Empirical Results

The statistical model proposed in this study investigates the existence of a performance gap among Brazilian undergraduate students taking online and F2F courses. The purpose is to analyze the coefficient of the key variable course modality (*Online*) and it is 1 if the student did an online course or 0 if it was a F2F one. Overall, all models considered in this study were statistically significant (p-value < 0.01). By analyzing the last regression (model 6) in which all independent variables were taken into account, the model resulted a R^2 of 0.31. Regression outcomes are presented on Table 6.

The model proposed by this study verifies that there is a performance gap among Brazilian students in online and F2F courses. By running all different regressions, the beta for course modality presented to be significantly negative in all of the six models considered in the study. This means that even controlling with more explanatory variables students in the online courses tend to have a lower performance compared to those in F2F courses. This finding is in accordance with previous studies by Caetano et al. (2016) and Scudeler, Flores and Pires (2020) in which they found that students in Accounting and Pedagogy online courses had a worse performance in the ENADE. This result is also in accordance with Xu and Jaggars (2014) and Bettinger et al. (2017) which the authors found the same finding by studying American undergraduate students.

Regarding demographic attributes, men tend to have a higher performance than women. Even though the literature review found that gender is an unconclusive variable to determinate student's performance, the model's result is aligned with other Brazilian studies that used the ENADE as a database (Ferreira, 2015; De Oliveira Rodrigues et al., 2016; Caetano et a., 2016). Moreover, the model found a small negative coefficient for age, meaning that the older the student the worse the student's performance. This finding is different from the literature review, reinforcing the inconclusiveness of this variable to predict student's performance.

In addition, single students tend to have a lower performance, reinforcing the lack of research related to the marital status variable (De Oliveira Rodrigues et al., 2016 and Ferreira, 2015). Regarding ethnicity, the model finds that students that are White had a positive coefficient in the model, meaning that White people have a better performance than other ethnicities. While this result is in accordance with Ferreira (2015) and Caetano et al. (2016), this result might be related to other factors. According to Ferreira (2015), historically Black and Indigenous people

did not have the same opportunities for education access, income distribution and education in Brazil and these other elements might explain the differences between students' performance, not just ethnicity in isolation.

By analyzing student's economics attributes, family income has a positive effect on student's performance, meaning that students with higher family income tends to perform better. This finding is accordance with many studies (Miranda et al., 2015; Souza, 2008; De Oliveira Rodrigues et al., 2016; Ferreira, 2015). Students with a higher family income are those that have the opportunity to study in better qualified schools and invest in courses outside the school environment (Ferreira, 2015). They have easy access to sources of cultural assets, like books, magazines, trips and cinema that can positively influence their school performance (Souza, 2008).

Regarding working conditions, the model's results showed a small significant negative coefficient, meaning that students who work tend to have a worse performance. This finding reinforces the argument that students who do not work have more time to dedicate for their studies (Souza, 2008). Related to whether the student received school loan, the model resulted a positive coefficient (De Oliveira Rodrigues et al., 2016 and Ferreira, 2015). Students with school loan must meet certain conditions to keep the loan and a good performance might be one of them (Ferreira, 2015). Finally, concerning whether the student received any financial aid, like housing or food support, the model presented a negative coefficient. This variable might be related to student's income, implying that students with less income and the need for financial aid have a worse performance.

Related to student's academic attributes, students who studied most of their high school in public institutions had lower performance compared to those who studied in a private one. If one considers that Brazilian public high schools have a lower quality compared to the private ones, this finding is in accordance with Miranda et al. (2015) and Rizvi, Rienties and Khoja (2019) in which they found that previous knowledge influences student's performance. This may also explain why the variable *ExchangeProgram* had a positive coefficient, meaning that students that did an exchange program abroad tend to have a better performance, even though only 3% of all students managed to study abroad. Finally, students that received a scholarship tend to perform better and this might be associated with Ferreira's (2015) argument in which students must maintain a certain score in order to keep the scholarship.

According to the regression, student's performance on the general education component of the ENADE was the most important variable to predict student's grade on the subject area component. Although still lack of research, one can argue that the comprehension of knowledge related to general formation of the student, which is not related to the student's specialization, positively contributes for the student's learning in the course. In addition, the time spent by the students to complete the exam is directly related to their performance. Students who finish the exam in less than two hours tend to have a lower performance compared to those who spent more time to complete it. Related to this last dummy variable, the omitted category in the regression result was the empty answers which some students decided not to respond this question in the questionnaire.

Table 6 – Regression model's results.

	Models					
	Online and Score (1)	Adding Subject FE (2)	Adding Time to Complete Exam (3)	Adding student's demographic attributes (4)	Adding student's economic attributes (5)	Adding student's academic attributes (6)
Online	-0.196*** (0.037)	-0.262*** (0.031)	-0.258*** (0.035)	-0.237*** (0.035)	-0.208*** (0.034)	-0.179*** (0.029)
Score_General	0.415*** (0.012)	0.430*** (0.013)	0.409*** (0.014)	0.398*** (0.014)	0.385*** (0.013)	0.381*** (0.013)
TimeSpent (*A = < 1 hour*)			-0.301*** (0.046)	-0.349*** (0.048)	-0.368*** (0.045)	-0.380*** (0.045)
TimeSpent (*B = 1-2 hours*)			-0.036 (0.038)	-0.072 (0.040)	-0.083* (0.039)	-0.087* (0.040)
TimeSpent (*C = 2-3 hours*)			0.110** (0.031)	0.087** (0.034)	0.085* (0.033)	0.085* (0.034)
TimeSpent (*D = 3-4 hours*)			0.251*** (0.022)	0.239*** (0.023)	0.243*** (0.023)	0.244*** (0.024)
TimeSpent (*E = 4h not finished*)			0.223*** (0.014)	0.220*** (0.015)	0.224*** (0.015)	0.223*** (0.016)
Age				-0.013*** (0.001)	-0.013*** (0.001)	-0.012*** (0.001)
Gender (M)				0.105** (0.029)	0.089** (0.028)	0.091** (0.028)
Single				-0.040*** (0.006)	-0.031*** (0.005)	-0.035*** (0.005)
White				0.078*** (0.003)	0.059*** (0.003)	0.056*** (0.004)
AffirmativeAction				0.024** (0.009)	0.028** (0.007)	0.032** (0.009)
Year_ENADE – YearFinishHS				0.011*** (0.001)	0.010*** (0.001)	0.010*** (0.001)
FamilyIncome (*B = 1.5 to 3 minimum wages*)					0.101*** (0.008)	0.096*** (0.008)
FamilyIncome (*C = 3 to 4.5 minimum wages*)					0.178*** (0.015)	0.170*** (0.014)
FamilyIncome (*D = 4.5 to 6 minimum wages*)					0.227*** (0.017)	0.215*** (0.015)
FamilyIncome (*E = 6 to10 minimum wages*)					0.292*** (0.022)	0.275*** (0.018)
FamilyIncome (*F = 10 to 30 minimum wages*)					0.376*** (0.027)	0.345*** (0.023)
FamilyIncome (*G = above 30 minimum wages*)					0.372*** (0.048)	0.327*** (0.041)
Work					-0.028*** (0.005)	-0.017** (0.005)
SchoolLoan					0.113*** (0.015)	0.123*** (0.013)
FinancialAid					0.008 (0.012)	-0.039*** (0.008)
Scholarship						0.146*** (0.021)
ExchangeProgram						0.055** (0.015)
HighSchool (*B = all private*)						0.077*** (0.017)
HighSchool (*C = all abroad*)						0.141*** (0.034)
HighSchool (*D = majority public*)						-0.033** (0.008)
HighSchool (*E = majority private*)						0.005 (0.014)
HighSchool (F = *abroad/Brazil*)						0.126** (0.043)
Observations	1,003,523	1,003,523	1,003,523	991,111	990,751	975,143
R2	0.266	0.282	0.295	0.301	0.309	0.312
Adjusted R2	0.264	0.281	0.293	0.299	0.308	0.311

Note: *p<0.1; **p<0.05; ***p<0.01. Values in parenthesis correspond to the standard error of the estimate.

5. DISCUSSION

The purpose of this study consisted of investigating the existence of a performance gap among Brazilian undergraduate students in online and F2F courses. More specifically, this research proposed to analyze if taking an online education course, instead of a F2F one, has an impact on the performance of graduating Brazilian students. Based on that, the study used six databases from the ENADE which is the Brazilian national exam that annually assess graduating students' performance from all HE institutions. With these datasets, a linear regression with fixed effects model was used for the empirical analysis. The key explanatory variable analyzed by the study was the modality of the course (*Online*) and this variable was 0 if the student did a F2F course or 1 if the student did an online one.

The study concludes that there is a performance gap among Brazilian graduating students in online courses compared to those in F2F courses. In all the six models considered in the study, the key variable that measures the course modality (*Online*) presented to be significantly negative. This means that even by considering student's demographic, economic and academic attributes, students who take online education courses perform worse than those in F2F courses. Interpretating this result from the perspective of the ENADE, graduating students taking online courses are less subjected to achieve the predefined course's curricular objectives established by the Ministry of Education. Based on this result, it is reasonable to assume that online courses in Brazilian HE system negatively contributes for student's learning, implying a performance gap compared to the F2F modality.

One reason for this performance gap can be related to the way in which online education has been expanding in Brazil. According to Ferrugini et al. (2014), students join this modality by assuming it is an easier way to learn, it requires fewer studying hours and it is an easier way to obtain a graduate diploma without too much effort. Nevertheless, online education courses require dedication, discipline and formation of the student's own knowledge. As mentioned before, online education's strategy has the assumption of a greater emphasis on self-learning and students' interest regarding their own learning (Maia and Meirelles, 2003). Students have to establish when they will study, how much they want to learn and how to find information individually (Moore et al., 2007). This becomes a bigger challenge if one considers that students might decrease their efforts since they are less oversighted by professors, following

the principal-agent problem (Bettinger et al., 2017) and most of students work while studying, having less time to dedicate for their studies (Souza, 2008).

Additionally, private institutions and government's actions should not expand the number of online courses without considering what is required for online education to succeed. As Rizvi, Rientes and Khoja (2019) found, student's region of origin and socio-economic indicators can predict learning outcomes. In Brazil, there are still some regions in Brazil that lack the minimum infrastructure required, like electricity, internet and other required supports for online education (Martins and Mills, 2016). In a recent study by De Oliveira Rodrigues et al. (2016), conditions of the presential hubs in which online education courses are offered by HE institutions in Brazil had a negative coefficient to predict student's performance, creating the hypothesis that these hubs lack in infrastructure quality. Finally, the lack of specialized faculty prepared to teach contents in the online format (Ferrugini et al., 2014) tends to continue if one considers that some HE institutions do not incentive or support faculty members to develop and deliver online courses (Redpath, 2012).

Online education should not be marginally treated by institutions nor be simply offered as a modality, business unit or a flexible way to offer HE courses (Gomes, 2013). This modality is not a palliative solution to reach students that are geographically distant from institutions nor to simply transpose presential contents and methods into digital formats (Martins & Mill, 2016). It is alarming that the increase of online education courses occurs to the detriment of higher education's quality (Caetano et al., 2016). This expansion of online education could intensify, rather than decrease, educational inequality (Xu & Jaggars, 2014).

It is likely that online education will continue to grow in the educational field, especially with SARS-CoV-2 pushing many HE institutions to try new formats to deliver education. If this is true, HE institutions might rethink of how to embrace more online courses and academic researches like the one presented in this study can support them with that. By analyzing 28 different subjects and considering 1,212,230 respondents from the ENADE, this study contributes for the debate of how online education has been developing in Brazil. The holistic approach considered in this study also sheds light on how students' characteristics influences their performance in online and F2F courses from the Brazilian post-secondary education.

That being said, the research presents some limitations. First, the number of subjects considered in the study does not include all assessed by ENADE given the lack of observations in some

online courses. In addition, the study was subjected to the variables and observations provided by the ENADE databases, not being able to modify questionnaires applied in the exam nor INEP's method of collecting and processing student's responses. According to Ferreira (2015), the awareness promotions fostered by HE institutions close to the exam date imply another limitation for the study, since some HE institutions train and bonus their students before the exam which may result in responses not consistent with reality. Finally, the research does not consider an analysis of investment and return. Given that the investment to study in private online education courses is lower compared to F2F courses due to the cheaper price of online courses (ABED, 2018), it is expected a lower return from the students; however this element was not considered in the study.

For future researches, more subjects that offer online education courses could be evaluated using the model presented in this study. With more ENADE databases, future studies could encompass more subjects to see if the performance gap between online and F2F courses decreases over time. In addition, future studies could use instrumental variables to measure students' choice for enrolling in online education which are not related to their performance. Adding instrumental variables in the model could generate different results and enrich the debate about the online education in Brazil.

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APPENDIX

Appendix 1 – Available variables assessed by the ENADE used in the study.

nº	ENADE Variable	Description	Measurement
1	NU_ANO	Year of the database	Year from 2004 to 2018
2	CO_IES	Institution's code ID	HE Institution ID based on e-Mec
3	CO_CATEGAD	Institution's administrative category	1 = Federal (Public); 2 = State (Public); 3 = Municipal (Public); 4 = For-profit Private; 5 = Non-profit Private; 7 = Special
4	CO_ORGACAD	Institution's type	10019 = Federal Center of Technology Education; 10020 = University Center; 10022 = College; 10026 = Federal Institution of Education, Science and Technology; 10028 = University
5	CO_GRUPO	Course's group ID	90 different groups of courses ID assessed according to the year.
6	CO_CURSO	Course's code ID	Course ID based on e-Mec
7	CO_MODALIDADE	Course modality	0 = F2F; 1 = online
8	CO_MUNIC_CURSO	Location of the course (city)	City ID based on IBGE
9	CO_UF_CURSO	Location of the course (state)	State ID from 27 Brazilian states
10	CO_REGIAO_CURSO	Location of the course (region)	1 = North; 2 = Northeast; 3 = Southeast; 4 = South; 5 = Midwest
11	NU_IDADE	Student's age	Discrete variable
12	TP_SEXO	Student's gender	M = Male; F = Female
13	ANO_FIM_2G	Year that concluded high school	Year
14	ANO_IN_GRAD	Year that entered higher education	Year
15	IN_MATUT	Course is taught in the morning	0 = No; 1 = Yes
16	IN_VESPER	Course is taught in the evening	0 = No; 1 = Yes
17	IN_NOTURNO	Course is taught at night	0 = No; 1 = Yes
18	QE_I01	Marital Status	A = Single; B = Married; C = Divorced; D = Widow; E = Other
19	QE_I02	How do you consider yourself?	A = White; B = Black; C = Brown; D = Asian; E = Indigenous or other
20	QE_I03	What is your nationality?	A = Brazilian; B = Naturalized Brazilian; C = Foreign
21	QE_I04	What stage of schooling did you father conclude?	A = None; B = Elementary School; C = Middle School; D = High School; E = Higher Education; F = Graduate Studies
22	QE_I05	What stage of schooling did you mother conclude?	A = None; B = Elementary School; C = Middle School; D = High School; E = Higher Education; F = Graduate Studies
23	QE_I06	Where and with whom do you currently live?	A = House/Apartment, alone; B = House/Apartment with parents/partners; C = House/Apartment with spouse/children; House/Apartment with other people; School accommodation; Other type of accommodation
24	QE_I08	What is your total family income?	A = Up to 1.5 minimum wage; B = Between 1.5 to 3 minimum wages; C = Between 3 and 4.5 minimum wages; D = Between 4.5 to 6 minimum wages; E = Between 6 and 10 minimum wages; F = Between 10 and 30 minimum wages; G = Above 30 minimum wages.
25	QE_I09	Which of the following alternatives best describe your financial situation?	A = I do not have income and my expenses are financed by governmental programs; B = I do not have income and my expenses are financed by my family or other person; C = I do have income, but I receive financial support; D = I do have income and I do not need financial support; E = I do have income and I contribute to support my family; F = I am the main responsible for financially support my family.
26	QE_I10	Which of the following alternatives best describe your working situation?	A = I do not work; B = I eventually work; C = I work up 20h weekly; D = I work between 21 and 39h weekly; E = I work more than 40h weekly.
27	QE_I11	What type of scholarship you received to support your monthly expenses?	A = None, because my course is free; B = None, but my course is not free; C = ProUni (full); D = ProUni (partial); E = FIES (only); F = ProUni (partial) and FIES; G = Governmental scholarship; H = Scholarship offered by HE; I = Scholarship offered by other institution; J = Financial support offered by HE; K = Banking financial support.
28	QE_I12	Throughout your studies, did you receive any residence aid?	A = None; B = Habitation assistance; C = Food assistance; D = Food and Habitation assistance; E = Permanence aid Scholarship; F = Others

29	QE_I13	Throughout your studies, did you receive any academic scholarship?	A = None; B = Scientific scholarship; C = Extension scholarship; D = Assistance scholarship; E = PET scholarship; F = Others
30	QE_I14	Have you participated in curricular programs and / or activities abroad?	A = No; B = Yes, Science without Boarders; C = Yes, exchange program fund by the federal Government; D = Yes, exchange program fund by the state Government; E = Yes, exchange program from my HE; F = Yes, exchange program not from HE
31	QE_I15	Did you enter HE institution by any affirmative policy?	A = No; B = Yes, ethnicity-race criteria; C = Yes, income criteria; D = Yes, because I studied in public school; E = Yes, by 2 or more criteria mentioned before; F = Yes, by other system.
32	QE_I16	Which state did you conclude high school?	27 Brazilian states
33	QE_I17	What type of school did you attend high school?	A = All in public school; B = All in private school; C = All abroad; D = Majority in public school; E = Majority in private school; F = Part abroad and part in Brazil
34	QE_I18	Which modality of high school did you conclude?	A = Traditional; B = Technical; C = Professional teaching; D = EJA; E = Others
35	QE_I19	Who gave you the incentives to attend HE?	A = Nobody; B = Parents; C = Other family members; E = Professors; F = Religious leader; G = Friends; H = Others
36	QE_I20	Any of the following groups was determinant for you to face HE difficulties and conclude the course?	A = I did not have any difficulty; B = I did not receive any support; C = Parents; D = Grandparents; E = Brothers, cousins and uncle/aunt; F = Religious leader; G = Friends; H = Course professors; I = Supporting student service; J = Work colleagues; K = Other
37	QE_I21	Somebody from your family concluded HE?	A = Yes; B = No
38	QE_I22	Apart from the books indicated in the course, how many books did you read this year?	A = None; B = One or two; C = Three to five; D = Six to eight; E = More than eight
39	QE_I23	Apart from the classrooms, how many hours did you dedicated in your studies?	A = None, I just attend classes; B = One to three hours; C = Four to seven hours; D = Eight to twelve hours; E = More than twelve hours.
40	QE_I24	Did you have any opportunity to learn a foreign language?	A = Yes, only in F2F; B - Yes, only in hybrid modality; C = Yes, F2F and hybrid; D = Yes, online learning; E = No.
41	QE_I25	What is the main reason you chose your course?	A = Labor market; B = Family influence; C = Professional appreciation; D = Social status; E = Vocation; F = Other
42	QE_I26	What is the main reason you chose your HE?	A = Free course; B = Price; C = Close to my residence; D = Quality/reputation; E = The only I got approval; F = Scholarship opportunities; G = Other
43	TP_PRES	Type of Presence at ENADE	Absent, Present with valid result, Present with invalid result
44	TP_PR_GER	Type of Presence at the exam	Absent, Present with valid result, Present with invalid result, Present with empty answer, Inappropriate participation
45	TP_PR_OB_FG	Type of Presence at the general education component (multiple questions)	Absent, Present with valid result, Present with invalid result, Present with empty answer, Inappropriate participation
46	TP_PR_DI_FG	Type of Presence at the general education component (open-ended questions)	Absent, Present with valid result, Present with invalid result, Present with empty answer, Inappropriate participation
47	TP_PR_OB_CE	Type of Presence at the subject area component part (multiple questions)	Absent, Present with valid result, Present with invalid result, Present with empty answer, Inappropriate participation
48	TP_PR_DI_CE	Type of Presence at the subject area component (open-ended questions)	Absent, Present with valid result, Present with invalid result, Present with empty answer, Inappropriate participation
49	TP_SFG_D1	Situation of the Question 1 in the general education component	Not applied (absent student), not answered, not valid, valid and answer disregarded
50	TP_SFG_D2	Situation of the Question 2 in the general education component	Not applied (absent student), not answered, not valid, valid and answer disregarded
51	TP_SCE_D1	Situation of the Question 1 in the subject area component	Not applied (absent student), not answered, not valid, valid and answer disregarded
52	TP_SCE_D2	Situation of the Question 2 in the subject area component	Not applied (absent student), not answered, not valid, valid and answer disregarded
53	TP_SCE_D3	Situation of the Question 3 in the subject area component	Not applied (absent student), not answered, not valid, valid and answer disregarded
54	NT_GER	Student's final score	Continuous variable from 0 to 100
55	NT_FG	General education score	Continuous variable from 0 to 100

56	NT_OBJ_FG	General education - multiple questions score	Continuous variable from 0 to 100
57	NT_DIS_FG	General education - open-ended score	Continuous variable from 0 to 100
58	NT_FG_D1	General education - open-ended score – Q. 1	Continuous variable from 0 to 100
59	NT_FG_D1_PT	General education - open-ended score – Q. 1.1	Continuous variable from 0 to 100
60	NT_FG_D1_CT	General education - open-ended score – Q. 1.2	Continuous variable from 0 to 100
61	NT_FG_D2	General education - open-ended score – Q. 2	Continuous variable from 0 to 100
62	NT_FG_D2_PT	General education - open-ended score – Q. 2.1	Continuous variable from 0 to 100
63	NT_FG_D2_CT	General education - open-ended score – Q. 2.2	Continuous variable from 0 to 100
64	NT_CE	Subject area score	Continuous variable from 0 to 100
65	NT_OBJ_CE	Subject area - multiple questions score	Continuous variable from 0 to 100
66	NT_DIS_CE	Subject area - open-ended score	Continuous variable from 0 to 100
67	NT_CE_D1	Subject area - open-ended score – Q. 1	Continuous variable from 0 to 100
68	NT_CE_D2	Subject area - open-ended score – Q. 2	Continuous variable from 0 to 100
69	NT_CE_D3	Subject area - open-ended score – Q. 3	Continuous variable from 0 to 100
70	CO_RS_I1	How difficult was the general education component?	A = Very Easy; B = Easy; C = Medium; D = Hard; E = Very Hard
71	CO_RS_I2	How difficult was the Subject area component?	A = Very Easy; B = Easy; C = Medium; D = Hard; E = Very Hard
72	CO_RS_I3	Given the time for completing the exam, do you think the exam was:	A = Very Long; B = Long; C = Appropriate; D = Short; E = Very Short
73	CO_RS_I4	Were the questions of the general education component clear and objective?	A = Yes, all of them; B = Yes, the majority; C = Half of them; D = A few; E = No, none.
74	CO_RS_I5	Were the questions of the Subject area component clear and objective?	A = Yes, all of them; B = Yes, the majority; C = Half of them; D = A few; E = No, none.
75	CO_RS_I6	Were the information provided to solve the questions sufficient?	A = Yes, too much; B = Yes, all of them; C = Yes, the majority; D = Yes, just a few; E = No, none of them.
76	CO_RS_I7	What was the biggest difficulty in the exam?	A = Did not know the content; B = Content was approach differently; C = Lack of space to answer; D = Lack of motivation; E = Did not have any difficulty.
77	CO_RS_I8	Considering only multiple questions, do you think you:	A = Did not study the majority of the contents; B = Studied a few contents, but did not learn; C = Studied the majority of the contents, but did not learn; D = Studied and learned most of the contents; E = Studied and learned all the contents.
78	CO_RS_I9	How much time did you spend to complete the exam?	A = Less than a hour; B = Between one and two hours; C = Between two and three hours; D = Between three and four hours; E = Four hours and I did not finish
79	QE_I27	The subjects taken contributed to your formation as a citizen and professional.	1 = Strongly Disagree; 6 = Strongly Agree
80	QE_I28	The contents offered by the course subjects favored you in internships or in professional activities.	1 = Strongly Disagree; 6 = Strongly Agree
81	QE_I29	The methodologies used in the course challenged you to deepen your knowledge and develop reflective and critical skills.	1 = Strongly Disagree; 6 = Strongly Agree
82	QE_I30	The course offered innovative learning experiences.	1 = Strongly Disagree; 6 = Strongly Agree
83	QE_I31	The course contributed to your personal development about ethical sense for professional exercises.	1 = Strongly Disagree; 6 = Strongly Agree
84	QE_I32	In the course, you had opportunities to learn and work in teams.	1 = Strongly Disagree; 6 = Strongly Agree
85	QE_I33	The course enabled you to strength your reflective and argumentation ability.	1 = Strongly Disagree; 6 = Strongly Agree
86	QE_I34	The course developed your capacity to critical thinking, to analyze and to reflect about solutions to society's issues.	1 = Strongly Disagree; 6 = Strongly Agree
87	QE_I35	The course contributed to broaden your communication (written and oral) capacities.	1 = Strongly Disagree; 6 = Strongly Agree
88	QE_I36	The course contributed to develop your capacity to learn continuously.	1 = Strongly Disagree; 6 = Strongly Agree
89	QE_I37	The relationship professor-student motivated you to study and learn.	1 = Strongly Disagree; 6 = Strongly Agree
90	QE_I38	The study plan presented by the professors helped your studies.	1 = Strongly Disagree; 6 = Strongly Agree

91	QE_I39	The bibliographic references indicated by the professors helped your studies and learning.	1 = Strongly Disagree; 6 = Strongly Agree
92	QE_I40	The course offered opportunities for the students to overcome issues and challenges related to the formation process.	1 = Strongly Disagree; 6 = Strongly Agree
93	QE_I41	The course coordination offered mediation actions related to possible conflicts between professor and student.	1 = Strongly Disagree; 6 = Strongly Agree
94	QE_I42	The course required you regularly organization and dedication to your studies.	1 = Strongly Disagree; 6 = Strongly Agree
95	QE_I43	The course offered opportunities for students to participate in programs, projects or activities extra academic.	1 = Strongly Disagree; 6 = Strongly Agree
96	QE_I44	The course offered opportunities for students to participate in scientific projects and activities that stimulated academic investigation.	1 = Strongly Disagree; 6 = Strongly Agree
97	QE_I45	The course offered conditions for students to participate to internal and external events from the HE.	1 = Strongly Disagree; 6 = Strongly Agree
98	QE_I46	The HE offered opportunities for students to participate with collegiate bodies.	1 = Strongly Disagree; 6 = Strongly Agree
99	QE_I47	The course articulated theory knowledge with practical activities.	1 = Strongly Disagree; 6 = Strongly Agree
100	QE_I48	The practical activities were sufficient for your professional formation.	1 = Strongly Disagree; 6 = Strongly Agree
101	QE_I49	The course offered updated knowledge for your field.	1 = Strongly Disagree; 6 = Strongly Agree
102	QE_I50	The internship offered diverse experience for your formation.	1 = Strongly Disagree; 6 = Strongly Agree
103	QE_I51	The activities regard your thesis conclusion help you to qualify professionally.	1 = Strongly Disagree; 6 = Strongly Agree
104	QE_I52	The course offered opportunities for students to study or work in Brazil.	1 = Strongly Disagree; 6 = Strongly Agree
105	QE_I53	The course offered opportunities for students to study or work abroad.	1 = Strongly Disagree; 6 = Strongly Agree
106	QE_I54	The course conducted periodic assessments about the subject and professors.	1 = Strongly Disagree; 6 = Strongly Agree
107	QE_I55	The learning assessment conducted by the professors was coherent with the teach content.	1 = Strongly Disagree; 6 = Strongly Agree
108	QE_I56	The professors were available to support the students.	1 = Strongly Disagree; 6 = Strongly Agree
109	QE_I57	The professors presented content domain in the disciplines that they teach.	1 = Strongly Disagree; 6 = Strongly Agree
110	QE_I58	The professors used ICT in the learning process.	1 = Strongly Disagree; 6 = Strongly Agree
111	QE_I59	The HE offered sufficient employees for supportive academic administration.	1 = Strongly Disagree; 6 = Strongly Agree
112	QE_I60	The course offered assistant professors to support students.	1 = Strongly Disagree; 6 = Strongly Agree
113	QE_I61	The infrastructure classroom conditions were adequate.	1 = Strongly Disagree; 6 = Strongly Agree
114	QE_I62	The offered equipments and materials in the classrooms were adequate for the quantity of students.	1 = Strongly Disagree; 6 = Strongly Agree
115	QE_I63	The infrastructure in practical sessions suitable for the course.	1 = Strongly Disagree; 6 = Strongly Agree
116	QE_I64	The library offered bibliographic references for the students' need.	1 = Strongly Disagree; 6 = Strongly Agree
117	QE_I65	The HE had a virtual library or offered the access for virtual libraries.	1 = Strongly Disagree; 6 = Strongly Agree
118	QE_I66	The academic environment favored the social interaction in order to promote diversity respect.	1 = Strongly Disagree; 6 = Strongly Agree
119	QE_I67	The HE had cultural, leisure, social and interaction spaces.	1 = Strongly Disagree; 6 = Strongly Agree
120	QE_I68	The HE offered dining hall and bathrooms in adequate conditions.	1 = Strongly Disagree; 6 = Strongly Agree

Appendix 2 – Summary of the descriptive analysis of the study.

	Total Database	*F2F*	*Online*
Online (n = 1,212,230)	*100%*	*72%*	*28%*
Time Spend on the ENADE exam (n = 944,971)			
Less than an hour	*1%*	*1%*	*1%*
Between one and two hours	*16%*	*15%*	*17%*
Between two and three hours	*31%*	*30%*	*35%*
Between three and four hours	*43%*	*43%*	*40%*
Four hours and did not finish	*9%*	*10%*	*7%*
Age (n = 1,212,230)	*30.1*[1]	*28.3*[1]	*34.7*[1]
Gender (n = 1,212,230)			
Female	*63%*	*59%*	*75%*
Male	*37%*	*41%*	*25%*
Marital Status (n = 1,046,220)			
Single	*62%*	*71%*	*37%*
Married	*29%*	*22%*	*49%*
Separated	*4%*	*3%*	*6%*
Widowed	*0.4%*	*0.3%*	*1%*
Other Marital Status	*4%*	*3%*	*6%*
Ethnicity (n = 1,046,196)			
White	*50%*	*50%*	*50%*
African American	*10%*	*11%*	*9%*
Brown	*36%*	*35%*	*38%*
Asian	*2%*	*2%*	*2%*
Indigenous	*1%*	*1%*	*1%*
Not Answered	*1%*	*1%*	*1%*
Affirmative Action (AA) (n = 1,045,973)			
Student entered HE through AA	*21%*	*24%*	*15%*
Student did not enter HE through AA	*79%*	*76%*	*85%*
Family Income (n = 1,046,168)			
< 1.5 minimum wage	*22%*	*21%*	*24%*
1.5 - 3 minimum wages	*31%*	*30%*	*34%*
3 - 4.5 minimum wages	*21%*	*21%*	*20%*
4.5 - 6 minimum wages	*11%*	*11%*	*10%*
6 - 10 minimum wages	*10%*	*10%*	*8%*
10 - 30 minimum wages	*5%*	*6%*	*3%*
> 30 minimum wages	*1%*	*1%*	*0.3%*
Working Status (n = 1,046,122)			
Not Working	*28%*	*31%*	*17%*
Working Eventually	*7%*	*7%*	*6%*
Working < 20h weekly	*9%*	*9%*	*9%*
Working 21-39h weekly	*13%*	*12%*	*15%*
Working > 40h weekly	*44%*	*41%*	*52%*
School Loan (n = 1,046,017)			
Student received school loan	*23%*	*27%*	*11%*
Student did not receive school loan	*77%*	*73%*	*89%*
Financial Aid (n = 1,046,164)			
Student received financial aid	*7%*	*9%*	*2%*
Student did not receive financial aid	*93%*	*91%*	*98%*
Scholarship (n = 1,046,035)			
Student received scholarship	*17%*	*21%*	*5%*
Student did not receive scholarship	*83%*	*79%*	*95%*
Exchange Program (n = 1,046,040)			
Student did an exchange program	*3%*	*3%*	*1%*
Student did not an exchange program	*97%*	*97%*	*99%*
High School (n = 1,035,035)			
All in public school	*75%*	*72%*	*82%*
All in private school	*17%*	*20%*	*9%*
All abroad	*0.1%*	*0.1%*	*0.1%*
Majority in public school	*5%*	*5%*	*6%*
Majority in private school	*3%*	*3%*	*3%*
Part abroad and part in Brazil	*0.2%*	*0.2%*	*0.1%*
Total ENADE score (n = 1,003,543)	*42.1*[1] *(14.2)*[2]	*43.1*[1] *(14.1)*[2]	*39.4*[1] *(14.0)*[2]
General education score (n = 1,003,543)	*49.3*[1] *(17.5)*[2]	*50.2*[1] *(17.5)*[2]	*46.8*[1] *(17.1)*[2]
Subject area score (n = 1,003,543)	*39.7*[1] *(15.6)*[2]	*40.7*[1] *(15.5)*[2]	*36.9*[1] *(15.4)*[2]

[1]Mean. [2]Standard deviation. Source: INEP – Sinopses Estatísticas da Educação Superior, created by the author.