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Result of Comparative Investigation betweenFace-to-Face Teaching Method and Simultaneous Online and Live Teaching Method

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Abstract

This is a concise summary of this investigation, which is a comparative research and analysis in a bivariate model of approval rates between in-person and remote (distance) students, with simultaneous live online transmission. The reference database is the management system and student registry in the graduate program at Federal University of Paraná (UFPR), aiming to compare the performance rates between in-person students and a synchronous remote class (live and online). The investigatedmodel is an innovative pedagogical approach, featuring an interface with a television-like format that is broadcasted live. This approach differs from pedagogical models such as distance learning, hybrid, or synchronous. Thus, a direct comparison with the results of distance learningmodels can provide evidence to measure student performance data. In this model, remote students attend live courses without temporal flexibility, only spatial flexibility. This work presents the results of a comparative study based on a bivariate model, considering approval rates between students attending remote (live online) and in-person classes. The aim of this research is, considering the comparative approval rates of students and possible statistical correlations, to propose adjustments and contributions for better guidance of the hybrid and synchronous online class system. Additionally, it examines the impact of technology onteaching and learning outcomes.

Keywords: assessment, distance learning, information and communication technologies, information science, live streaming

1. Introduction

The present investigation performs a comparative study using a bivariate model of study of variables, to analyze the pass rates of students in face-to-face and remote classes with live synchronous transmission. The data comes from the UFPR's academic management system. The main objective is to comprehensively compare student performance in traditional face-to-face teaching and synchronous online classes.

The pedagogical model addressed in this research stands out due to its innovation, presenting an interface akin to the live transmission of television programs. It is noteworthy that such an approach distinguishes itself from conventional distance learning paradigms, as well as hybrid or traditional synchronous instructional models. Given this context, a direct comparison with outcomes garnered from distance learning models assumes significance, as it furnishes empirical evidence for gauging student performance indicators.

A distinctive feature of this model resides in the fact that participants in remote classes engage in on-site courses, albeit without the temporal flexibility characteristic of distance education. Hence, spatial flexibility alone is maintained as a distinguishing element of this approach. The current work presents results obtained through a comparative study grounded in a bivariate analysis model. In this context, approval rates of students attending remote classes with live online transmission are juxtaposed against rates observed among those in traditional in-person classes.

In the second half of the 20th century, live video transmissions, via satellite, via broadcast telecommunications networks, became viable, present, and disseminated, consolidating Marshall McLuhan's concept of global village formation (McLuhan, 1972). According to this concept, information and communication reach the technological capacity to break national borders to form global networks.

Academically, the study by Umberto Eco (1979) on the consequences of implementation in thework "Apocalyptic and integrated" addresses the loss of the "artistic aura" due to mass production and consumption, while others consider technological advances as an opportunity for democratization cultural. Pierre Lévy (1999) reinforces the concept of the global village, inwhich information circulates beyond national borders, compressing time. The use of digital strategies represents a profound change in habits and information manipulation, according to Gouveia (2019) with practical impacts in time and space.

1.1 Society 5.0 and education

There is a need for an urgent response from the higher education system, as the power of 4IR technologies for positive social impacts or devastating environmental damage is imminent. The educational plans must be reformulated and consider the new technological advances of the third industrial revolution, as the fourth revolution is already present. Educational plans must consider the Third Industrial Revolution to contemplate hybrid online and presential efficient instruction with continuous and effective global videoconference, within a wide spectrum of asynchronous educational resources (Penprase, 2018).

The Organization for Economic Co-operation and Development (OECD), in its latest Education and Innovation Survey (OECD, 2020), part of the triennial series Trends Shaping Education, seeks to provide future scenarios to support strategic education plans. One of the scenarios points to the possibility of experimentation in new forms of education, with a combination of remote teaching (online), tutoring and even community learning, in which specialized learning platforms and digital and face-to-face services (public and private) play

a role. important. In fact, the 2014 Future of Education Report, produced by MIT, already recommended strengthening remote learning for undergraduate students. It highlights that higher education is at a turning point, where costs and access for students of all socioeconomic levels are at stake. There is a worldwide need for online learning.

1.2 Education

The impacts of technologies were almost not felt in schools and universities over the centuries. The use of blackboards and classes with textbooks seemed unlikely to change, despite pedagogical reforms (Jülicher, 2018). However, the repercussion of information and communication technologies from the 21st century (e.g., tablets, cell phones, and online material) are already within reach and are part of the routine of many preschools. It is expected that significant changes will occur in the entire learning process, with emerging new technologies that are likely to considerably transform the education sector, i.e., from pre-schools to universities (Jülicher, 2018).

The wave of digital transformation came along with the third industrial revolution and pushed educational institutions toward the online world. It was expected, that "massive open online courses would completely replace traditional face-to-face higher education and expand access to university education for millions of previously unmet all over the world" (Penprase, 2018). Despite the driving force, the use of new technologies also directly impacting education still have significant failure rates when compared to students attending presential classes. This natural adaptation and migration from a well-established culture of face-to-face teaching to a new approach involving remote teaching may take time. However, this advance is evident and defines new forms of planning and teaching practices.

It has been reinforced that a possible interaction between face-to-face and remote teaching, delivered synchronously, is plausible and viable. It is believed that the higher education revolution will likely result in integrating high-quality, face-to-face learning environments withonline technologies to enable students to develop skills and knowledge quickly and in a timely manner (Penprase, 2018). It is analogous to what is proposed by the transversal disciplines offered by the University Federal of Paraná (UFPR).

2. The experience of the University Federal of Paraná (UFPR)

Brazil, a country of continental dimension with large social inequality, saving resources to promote social inclusion is crucial. In higher education, 69 Federal Institutions of Higher Education (FIHE) linked to the Ministry of Education are spread across all 26 states of the federation. University Federal of Paraná (UFPR) implemented a project, from 2017 to 2019 (in the pre-pandemic period of Covid-19), which consisted of four courses offered to all graduate students. The proposal aimed to optimizeteaching resources, reduce redundancies and better explore the expertise of teachers. This approach also allowed for the standardization of teaching on different campuses of the university, which is present in several regions of the state of Paraná, in Brazil. The selected disciplines were Writing for academic texts in English, Research methods, Philosophy of science and Statistics, with the aim of expanding access and testing a new pedagogical approach(UFPR, 2017-2019).

The model used by UFPR was configured as an unprecedented pedagogical approach, as it hasan interface that contains a television model language that is broadcast live. This approach differs from pedagogical models such as distance, hybrid or synchronous teaching. Thus, a direct comparison with the results of distance learning models may indicate evidence to measure student performance data.

In this model, remote students attend live courses, with no time flexibility. There is only spatial flexibility, as they must dedicate themselves to synchronous classes with face-to-face students at defined times. This innovative approach brings the student into the classroom, regardless of location, rather than the classroom to the student as with traditional models. This model can also be a facilitator for inclusion, saving resources and even reducing traffic in large cities.

The Foundation for the Coordination of Improvement of Higher Education Personnel (CAPES) – an agency of the Ministry of Education of the Brazilian Government – regulates master's and doctoral graduate programs and recognizes that the sparse offer of distance courses does not, per se, characterize, distance courses. Since each institution can introduce the offer of disciplines that, in whole or in part, use distance methods, in their pedagogical and curricular organization of their recognized face-to-face programs (CAPES, 2018, Normative Instruction 275).

In this scenario, it is possible to think of a different format from the traditional face-to-face teaching in graduate courses. This innovative pedagogical model proved to be efficient throughout a pilot experiment carried out from 2017 to 2019. These were pre-pandemic years when online classes were still a discussion far from reality in traditional Brazilian universities. The financial constraints experienced by the Brazilian Universities also required an alternative solution to preserve quality while optimizing resources.

3. Methodology

This work presents the results of a study that compares the bivariate model, considering the approval rates between students attending remote and face-to-face classes. The grades were obtained from the academic registration system of the University. A qualitative assessment involving the teachers responsible for delivering the courses was also performed. The study's results may help to understand the outcomes from different methodological approaches to improve future course offers. Therefore, the data from 1204 students enrolled to participate in 2019 were assessed and are described in Table 1.

Table 1: Variables assessed

Variable	**Definition**
Status (Outcome)	Final status “Pass” or “Fail”
Course	The course the student is enrolled
Year	The year the course was offered
Mode	Presential (face-to-face) or Remote (*live stream*)
Age	Age of the students
Level	MSc or PhD level
Scholarship	The students receiving financial support
Grade	Final grade 0 to100
Field	Field of student
Socio-economic status	Student’s monthly income when formally employed

Source: From the author

Initially, a standard descriptive statistical approach was performed. Then, variables were tested for normality. Comparisons were conducted using the Chi-square test. The degree of association between variables was performed using Pearson’s correlation coefficient. The analysis of multiple correspondences was applied.

3.1 Analysis protocol

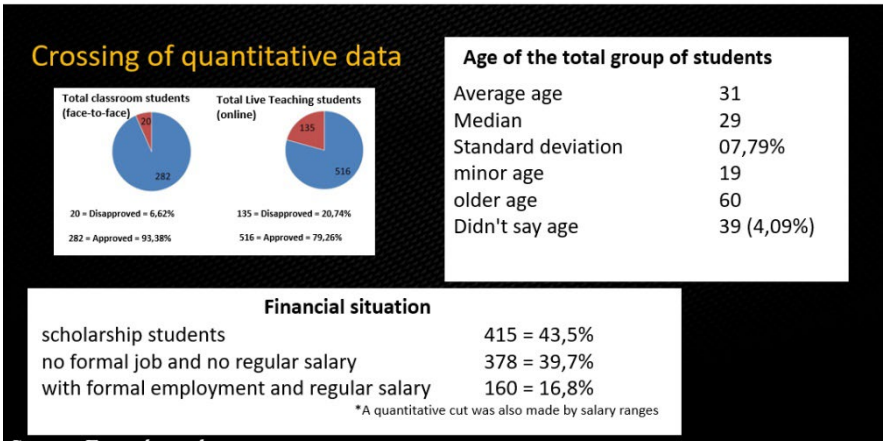
Table 2: Methodological Procedure

Step	Procedure	Variables	Objective
1	Descriptive statistics:	Age	Describe the data set and profile the classes.
		Model (face-to-face X On-line)	
		Student level (Grad. Espec. MBA. Mest. Dout.)	
		Student type (teacher or student)	
		Scholarship (Yes ou Not)	
		Type scholarship (CNPq, CAPES etc.)	
		Regular Salary (scholarship, salaried or without formal employment)	
		Salary range	
		Academic sector of origin	
		Situation (Approved or Disapproved)	
		Truancy	
		Final grade	
		Profile of the 4 face-to-face disciplines	
		Profile of the 4 on-line disciplines	
2	Chi-Square Test X Situation (Approved or Disapproved)	Model X Situation	Identify differences in frequencies between categorical groups (nominal variables). Crossing the variables with the Status (Approved or Disapproved)
		Level X Situation	
		Type X Situation	
		with scholarship X Situation	
		Type scholarship X Situation	
		Salary range X Situation	
		Regular Salary X Situation	
3	Normality test (Shapiro-Wilk)	Age X Situation (Approved or Disapproved)	Check the normality of the data set.
4	Test U-Mann-Whitney	Age X Situation (Approved or Disapproved)	Identify differences between numerical x nominal variable groups
5	Multiple Correspondence Analysis	Situation (Approved or Disapproved)	Visualize the measures of association for each variable, expressing them in a perceptual map. This procedure uses the chi-square test to standardize the frequency values of the paired categories of each variable, adjusting the chi-square test to obtain metric distance measurements (inertia).
		Model (face-to-face or on-line)	
		Level (Grad, Espec, Mest ou Dout)	
		Type (teacher or student)	
		with scholarship (Yes or Not)	
		Salary range	
		Regular Salary (student who receives scholarship, Salaried or Unpaid).	

Source: From the author

First step: The first stage of analysis of the variables makes a general descriptive quantitative balance involving the complete data of the students in the 4 disciplines, including dropout. Then, still in this 1st stage, the profile of each of the disciplines was prepared without taking into account the dropout values, as this is the subject of future study.

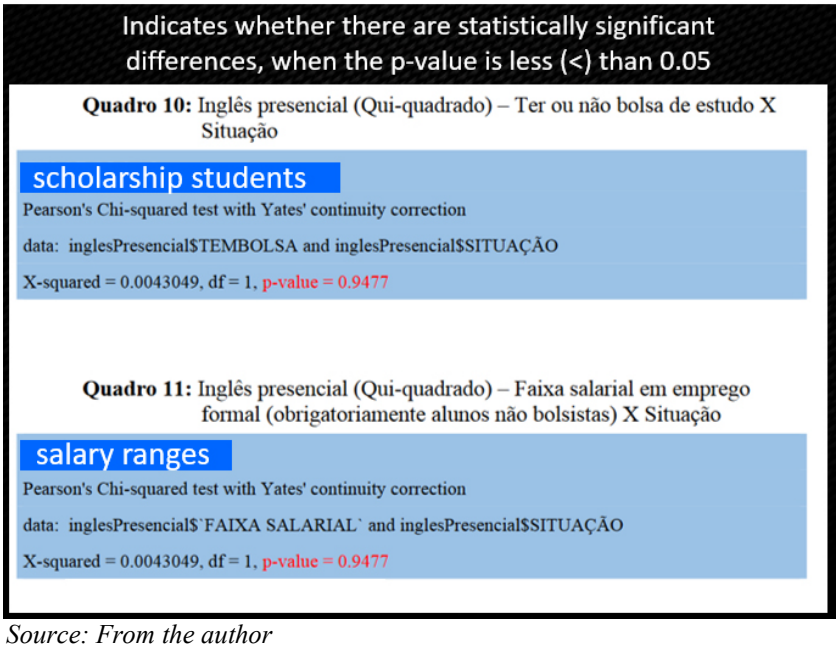
Figure 1: Crossing of quantitative data



Source: From the author

Second step: At this stage, we sought to identify the differences in frequencies between the categorical groups of nominal variables using the Chi-Square test, to verify the existence of an association between these variables and approval rates with the crossing of the other variables with the Situation: Approved or Failed (two samples). Because according to Chahine (2013), Chi-Square is a hypothesis test, evaluating the existing association between them. Null results demonstrate non-dependence, that is, they are variables that do not interfere with the investigated result.

Figure 02: Chi-square Test versus Situation



Source: From the author

At this point, we will filter the variables, choosing only those that meet a minimum significance value with the target variable by the Chi-Square test. This way, we will have two bases for modeling: One with all the original variables; and this one where we will eliminate those that do not reach a minimum Chi-Square value with the target variable. (CHAHINE, 2013, P20).

Figure 3: Formula for calculating X^2

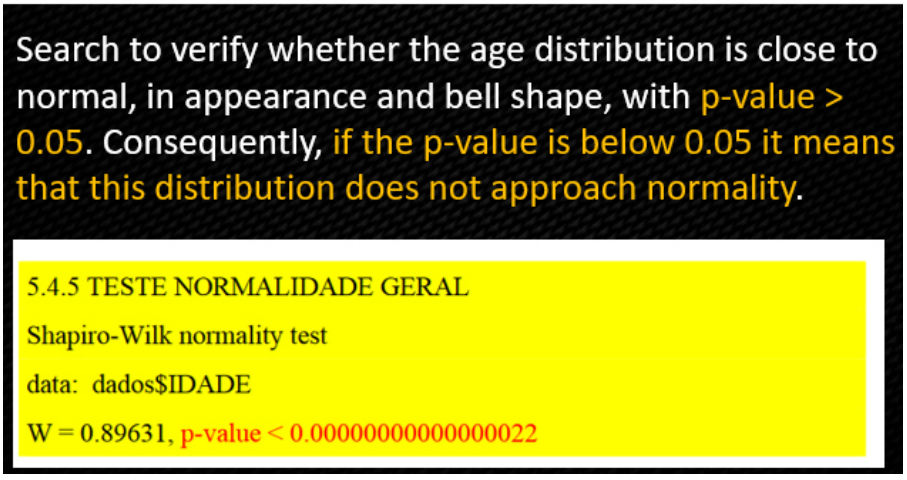
$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

O*i* = Observed Frequency
E*i* = Theoretical expected frequency, by the null hypothesis
n = Number of observations in the database

Source: CHAHINE, 2013, P41

Third step: After the second stage, the Normality Test (Shapiro-Wilk) was applied to verify the normality in the data set of the 953 students (on-site and remote), from the disciplines under investigation, already discounting the dropout numbers (object of future analysis). Because according to Miot (2017), there are many types available for statistical tests to verify the fit of data and the respective normality of the distribution based on algorithms, but the tests may be influenced by the sample size.

Figure 4: Normality test - Shapiro-Wilk



Source: From the author

Normality tests are influenced by the sample size regarding their efficiency. In small samples (between 4 and 30 units), there is inflation of the type I error, with preference given to the Shapiro-Wilk and Shapiro-Francia tests (greater specificity). As samples increase, especially above 500 units, all tests perform better; however, it is prudent to adopt a significance level of $p < 0.01$, due to the inflation of the type II error caused by the sample increase (loss of sensitivity). (MIOT, 2017, P02).

According to ANJOS (2005), the objective of using Shapiro-Wilk for Normality is to assess whether a sample has a normal distribution and the defined formula is:

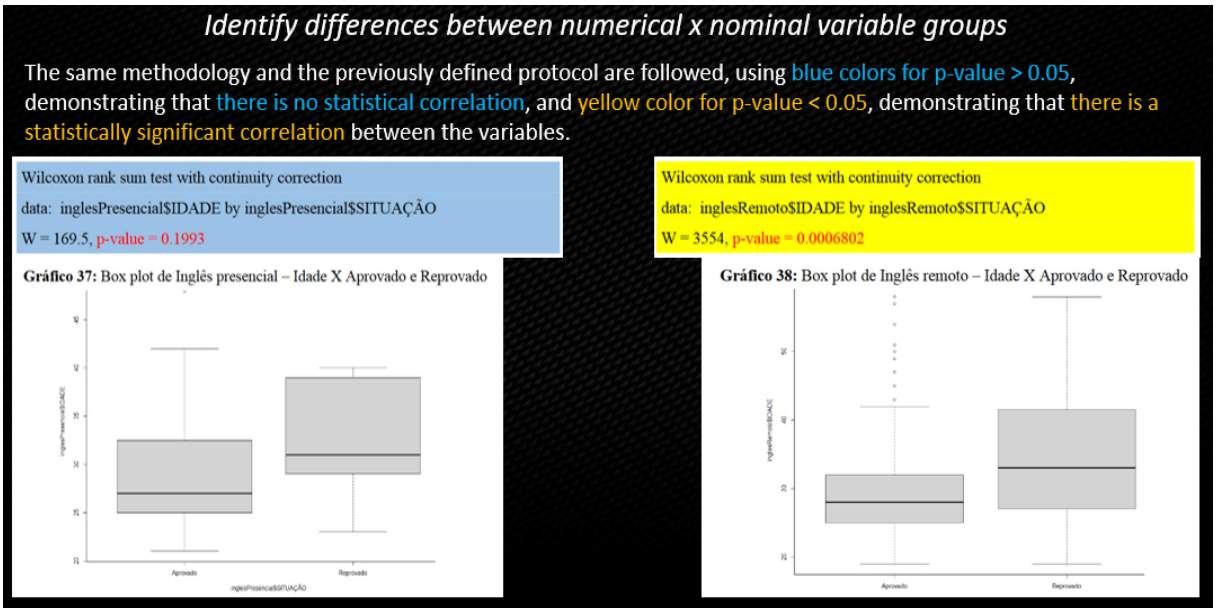
Figure 5: Shapiro-Wilk Formula for Normality

$$W = \frac{b^2}{s^2} = (\sum_{i=1}^{n} a_i y_i)^2 / \sum_{i=1}^{n} (y_i - \bar{y}_i)^2)$$

Source: ANJOS (2005)

Fourth step: After the result of the third stage, which indicates that there is no normal variation for the Age variable, the U-Mann-Whitney test was chosen, always working with 2 samples. In this fourth step, we must seek to identify differences between groups of numeric variables (age) x nominal (Pass or Fail).

Figure 6: U-Mann-Whitney TEST



Source: From the author

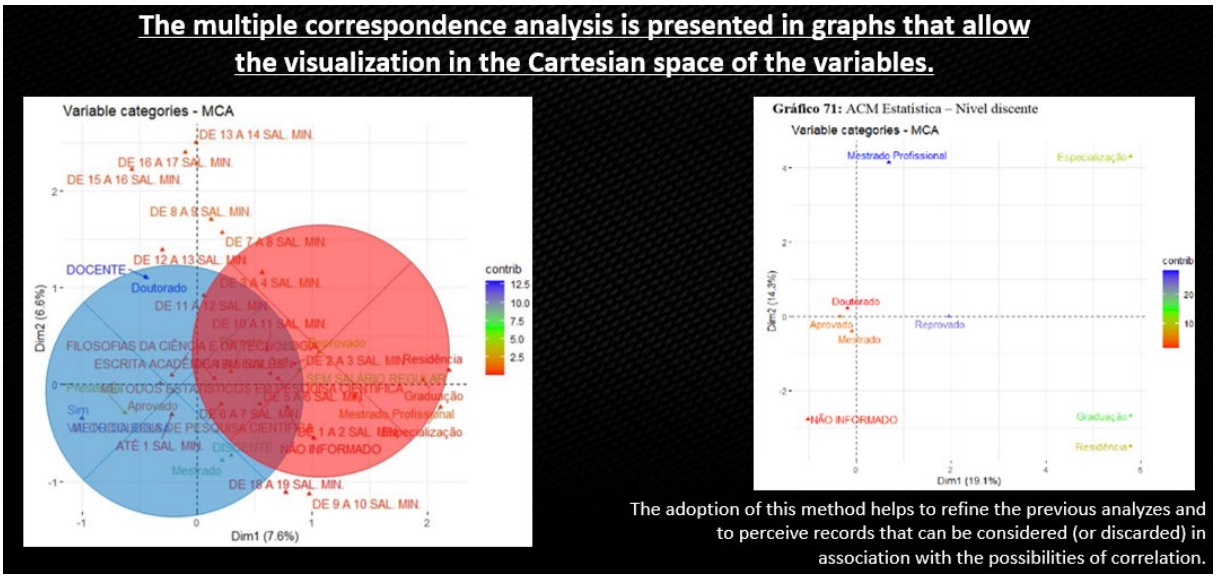
There is evidence to validate hypotheses that a certain age or age group is more susceptible to approval than another. This was elaborated in a general group (of the 4 disciplines) and then in 2 more separate groups (Onsite and Remote), always with validation in Approval x Fail. According to Silva, P. G. and Bogoni, J. A. (2015), the U-Mann-Whitney test can be considered the non-parametric version of the Student T test, for independent samples.

In this specific investigation, not only a "sample" is analyzed, but the entire population of classes that include a group of on-site students and another group of remote students (8 classes in all, thus 2 for each subject offered), but that have different population sizes.

The fourth step then seeks to identify differences for the average values in numerical variables (age) versus another nominal variable (pass), having 1 General group (general performance of students in relation to passing in each subject) and 2 different groups of analyzes (Onsite Classes and Remote Classes).

Fifth step: Multiple Correspondence Analysis seeks to visualize the association measures of each variable, expressing them in a perceptual map. This procedure uses the chi-square test to standardize the frequency values of the paired categories of each variable, adjusting the chi-square test to obtain metric distance measurements (inertia).

Figure 7: Multiple Correspondence Analysis



Source: From the author

Error margin: In the stages of crossing data with numerical results (p-value), a margin of error of 5% (0.05) was chosen, for an acceptable level of statistical significance. Thus, the analyzes in steps 2 (Chi-Square), 3 (Shapiro) and 4 (Mann-Whitney), indicate whether there are statistically significant differences, when the p-value is less (<) than 0.05.

4. Discussion and conclusion

In some cases, the positive performance was higher than in presential and remote courses.

The knowledge of the students' characteristics may help the university to propose a better understanding of the internal and external community willing to enroll and participate in the courses. It also impacts the planning of the courses while selecting strategies, contents, and assessments that may contribute to better teaching quality. It is also related to the assessment of general rankings, as it is one of the elements present in such methodologies.

In addition, the offer of such a model can also generate financial benefits. While universities are benefited as they expend fewer human and physical resources, students may benefit from having fewer costs involved in transport and time. The project was designed to involve tutors to help assist and support a large number of students, which was proven effective in providing a smooth running of the courses, especially in establishing a fluent and continuous dialog with those attending the course remotely.

According to Jülicher (2018), the use of data for educational purposes is similar to the use of data for commercial purposes. The analysis of educational data is not yet a reality in its entire possible use. In commercial systems, the strategic management model based on data, information and knowledge has already been shown to function ubiquitously in the functioning of activities, that is, data are collected in real time, which generate information, which in a queue of actions and understandings, in turn, generate quicker and more accurate decision-making. The analysis of educational raw data can generate interpretation and assess knowledge, which can be auxiliary or even decisive for strategic management. Still, based on the academic notes of Jülicher (2018), it appears that this process is called predictive analysis.

4.1 Results and contributions

The approval rates detected in this investigation, of students completing the disciplines, also showed that statistically it is possible that we have correlations with the other variables collected, treated and analyzed.

Based on the results of the Chi-square test, we established the variables that may have a statistical correlation with passing and failing:

Table 3: Chi-square general analysis.

General Analysis	**is related**	**has no relation**
General analysis - Level 2	Student level Origin sector Have access to the bag Salary range Teaching modality	*Student type*

Source: From the author

As a result, the data were polished and treated in depth in multiple correspondence analyses (MCA), in order to seek to show in as much detail as possible the characteristics of the detectedvariables. In order to obtain a viable suggestion of improvement for strategic management in the academic management system, which allows guidance in the future on actual enrollment decisions? This deeper level of analysis was even more necessary, which we sought to work onby investigating each of the disciplines separately, either in person or remotely, and establishingthe respective correlation indices. In the following table we have all the disciplines and the variables listed. We used the text formatting caption to show that the variables recorded in blackproved to be statistically positively relevant to the approval rate; and the variables in italics andunderlined which, on the contrary, proved to be negative, more linked to failure rates:

Table 4: Specific analyzes - Multiple correlations

Discipline	**In person**	**Remote/distant**
English	Master Level Doctoral Level scholarship *No source of regular income*	Master Level Doctoral Level scholarship Age under 30 *No regular source of incomeno scholarship* *Age over 30* *Area of origin: Teachers; Applied SocialSciences and Humanities Sector.*
Philosophy	*MBA level* Master Level Doctoral Level Scholarship *Area of origin: Earth Sciences and Exact Sciences*	*MBA level* Master Level Doctoral Level Scholarship *no scholarship*
Methodology	Age under 30 *No regular source of income* *Age over 40* *Area of origin: Exact Sciences; Applied Social; Humanities and the Interdisciplinary (from the UFPR coastal campus)*	*No regular source of income* *no scholarship* *Area of origin: Exact Sciences; Applied Social; Humanities and the Interdisciplinary (from the UFPR coastal campus)*

Discipline	In person	Remote/distant
Statistic	*Nível MBA* Master Level Doctoral Level Teacher Type Scholarship *no scholarship* Area of origin: Technology, Humanities, Applied Social, Biological, Earth, Health, Education and also UFPR's Teachers and Technicians	*Nível MBA* Master Level Doctoral Level Teacher Type Scholarship *no scholarship*

Source: From the author

Based on the research involving the offer of transversal disciplines in UFPR's postgraduate courses, it can be concluded that face-to-face teaching simultaneously with face-to-face students online is a viable possibility.

Teachers were able to go through the contents with minimal interference in the intermediation of Information and Communication Technologies instruments and the technical team for synchronous transmission. The need for tutors in hybrid and synchronous disciplines is strong evidence of this thesis, which was corroborated by the analyses.

This work has also mainly demonstrated that the pass rates achieved in face-to-face online teaching are superior to the indices of traditional distance education. The researched online class methodology achieved better pass rates than those recorded in other similar studies.

Table 5: UFPR Approval rates in the investigation objec

	Approval	
Course name	Dist. Learn.	Face-to-face
Academic Writing in English	71.48%	95.35%
Research Methods	86.21%	93.10%
Philosophy of Science	87.80%	93.18%
Statistics	80.33%	91.30%

Source: From the author

Table 6: Mean grades and approval rates

	Dist. Learn.		Face-to-face	
	Math. average	Approval	Math. average	Approval
UTA 1 - Engineering Fundamentals				
Introduction to Computer Engineering	6,7	42,70%	7,3	93,80%
Pre-calculus	6,6	53,30%	5,1	60,00%
Technical Drawing	6,7	50,70%	7,7	93,80%
Analytical Geometry	6,9	52,10%	5,1	50,00%
UTA 2 - Engineering Principles Physics				
Mechanics General	7,6	66,30%	5	42,10%
Chemistry	7,1	60,50%	6,3	75,90%
Differential and Integral Calculus of One Variable	6,7	51%	4,7	55,20%
Applied Mathematical Tools	6,1	30,30%	8,3	95,20%
UTA 3 - Engineering Principles				
Programming Logic and Algorithms	6,4	31,30%	3,8	31,60%
Mechanics and Materials Strength Principles	4,9	21,70%	7,5	90,50%
Physics - Electricity	4,7	11,90%	4,2	32,10%
Environmental Science and Sustainability	5,8	8,10%	6	71,40%

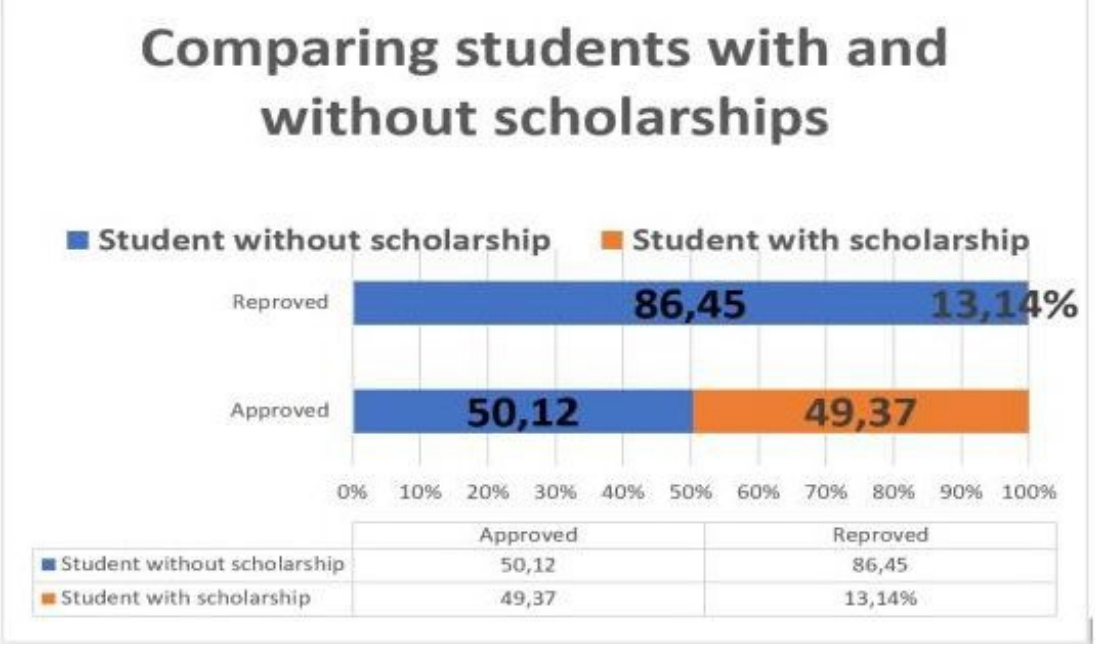
Source: Ferlin, and others. (2017)

Penprase (2018) reinforces that the interaction between face-to-face and remote synchronous teaching is plausible and viable. Analogous to what is experienced with the transversal disciplines offered by UFPR.

The statistical correlations of the students' data, in this investigation at UFPR, allow studying and verifying how this helps and reduces the failure rate in both classes of students, face-to-face and distance learning, in the transversal, hybrid and synchronous disciplines offered at UFPR.

One more consistent fact that is evident in this investigation is the low failure rate of scholarshipstudents in the distance model.

Figure 8: Comparing students with and without scholarships



Source: From the author

Thus, it allows us to consider that, in order to seek to improve the approval rates of the transversal disciplines, whenever possible, priority should be given to the offer of scholarships.It is also noticed that following in detail the academic life of students generates a huge databasethat can be used in a relevant way by higher education institutions, with the aim of seeking to improve approval rates.

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