Determinants of Students' Satisfaction in an Online Environment in Portuguese Higher Education Institutions

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***Abstract*—Online education assumed an increasing relevance in the last two years in face of the successive pandemic-motivated lockdowns by SARS-Cov-2. Considering the potential strengthening of this type of education in Portugal, particularly in the context of higher education, this study aims to analyze the perspective of students on three vectors of the online education quality, namely the overall quality of classes, the assessment process, and the online teaching tools available. Students' perceptions regarding these vectors will be assessed from the demographic variables, and factors that underlie online education according to the literature. The research is based on a quantitative methodology. Data was carried out through a structured questionnaire applied online, which had the answers of 2,107 students from different courses and higher education institutions in Portugal in July 2020. Factor analysis and logistic regression were used. The findings identified a significant association between the three vectors of the quality of online education proposed, and the factors usually proposed in the literature that are part of the student, instructor, and technology dimensions. It is expected that this research provides the inputs to the different players involved either in the implementation or development of courses offered through online learning in Portugal.**

***Index Terms*—Dimensions, Higher education institutions, online education, quality vectors, students.**

I. Introduction

The basic law of the educational system in Portugal [1] already included, since 1986, distance learning, using "multimedia and new information technologies, not only as a complementary form of regular education but also as an alternative type of education." Despite this, distance learning was regulated only in 2014 [2], and just for primary and secondary school. In the context of higher education, only five years later it was approved the legal regime in Portugal [3].

Despite that the distance learning courses must be expressly accredited by the national agency, the Universidade Aberta was practically the only higher education institution (HEI) that offered distance courses in Portugal until 2019. The lack of regulation also prevented the courses that could be taught in this way from being evaluated by the national accreditation agency.

Distance learning is defined as teaching "predominantly taught with physical separation between participants in the educational process, namely teachers and students" [3]. Additionally, it must comply with the following characteristics [3]: 1). interaction and participation are technologically mediated and supported by online teams of academic and technological support; 2). the course design is oriented to allow access without time limits and place to the contents, processes, and contexts of teaching and learning; 3). the pedagogical model is specially designed for teaching and learning in virtual environments.

Despite the delay in regulating this matter, Portugal seeks now to keep up with the global trend of distance educational supply, particularly through synchronous online classes. The need imposed by the successive periods of lockdown resulting from the SARS-Cov-2 pandemic will inevitably have contributed to the expansion of efforts in this direction.

Among the relevant parameters for assessing the quality of courses in this type of education, it is worthwhile to stress the following: i). the adequacy of the course to this modality; ii). the skills of the teaching staff; iii). the adequacy of the infrastructure and technological systems; iv). the fairness, reliability, and accessibility of the methodologies and assessment processes; v. and, finally, the existence of mechanisms for monitoring the academic success of students. Thus, these elements seek to assess the aspects that also make part of the quality measurement of the teaching in general, even if adapted to this modality.

Then, and given that the overall quality of the classes, the assessment process, and the online teaching tools available comprise the main elements to be considered within the accreditation process, these vectors of the online education quality will be the object of analysis in this research.

As a result of the lockdown imposed by the national authorities, higher education students had contact with online education, thus joining other students who had previously experienced this type of education. The opportunity to conduct a questionnaire to a broader universe of students from different courses and profiles, raised by the pandemic, motivated the development of this research.

The study has the following research question: "what are, from the students' perspective, the factors and demographic variables that contribute to the overall quality of online learning, based on the different aspects (vectors) that can explain it in more detail?".

For this purpose, the demographic characteristics, as well as the elements (factors) that will result from a factor analysis performed, will be obtained through a questionnaire. The set of these elements will constitute the independent variables of this study, which will be included in logistic regression models. Those models will use, as dependent variables, three vectors that can explain the online education quality in a more detail, namely: i) the overall quality of classes; ii) the quality of the assessment process; iii) the quality of the online teaching tools available.

The joint analysis of those three vectors (classes,

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assessment, and tools) for the assessment of the overall quality of online education is an element usually not explored in studies in this field, which often assesses the quality of this type of education in a general sense only, thus neglecting the different components that integrate it. Further, it is relatively rare to provide an in-depth analysis of findings by demographic variables since it is difficult to collect a representative sample.

Therefore, the combination of those elements can contribute to the literature on this topic, not only in Portugal but also in a broader context. Finally, it is expected that the conclusion of this study will provide the necessary elements to the different players involved in implementing or developing courses offered through online learning.

Due to the rapid spread of online education throughout the world, recently motivated by the SARS-Cov-2 pandemic, it is of relevance to identify the factors that can improve the students' satisfaction, which will aid in improving pedagogical techniques and resources available to promote global satisfaction and, consequently, improve student success rates.

This paper is structured in three other sections, in addition to this introduction. The next section (literature review) identifies the items and factors or dimensions that impact student satisfaction regarding the overall quality of online education. The third section (empirical study) presents the methodology and results obtained. Finally, the fourth section intends to present the discussion, conclusions, limitations, and proposals for the development of future studies in this field.

II. Literature Review

The literature on e-learning education presents as a recurring theme the evaluation of critical success factors in the implementation of this type of education, from either the perspective of institutions, teachers, and technical staff that implement distance learning [4]-[6] or the perspective of students (majority) of HEIs [7]-[17]. It is also possible to identify studies that analyze these elements from different perspectives simultaneously, as the research by [18], that involved students, instructors, and staff members of HEIs in Saudi Arabia, as well as the study by [4], which included both experts in information and communication technologies and instructors.

The research covers several countries, such as South Korea [7], England [9], India [10], Saudi Arabia [5], [6], [18], Vietnam [11], Taiwan [12], Pakistan [13], United Arab Emirates [14], [15], Malaysia [16] and The Caribbean [17], also including multi-country studies, where the analysis of cultural differences is highlighted. For instance, the study by [8], which included a total of 1,884 students from HEIs in Spain, the United States, China, and Mexico, as well as the study by [4], which analyzed the answers from respondents of different developed countries.

The qualitative and specific element of analysis that defines ‘success’ is not always clear, since a significant part of the studies seeks to identify and, in some cases, hierarchize, the elements (factors or dimensions) considered as relevant by the respondents [4]-[6], [16], [17].

However, in some cases, it is also possible to identify, exclusively or together with other elements, the analysis of barriers to implementation [18], the overall level of student satisfaction [8]-[12], [14], [15], the assessment of the quality of education [7], [13], the acquisition of knowledge or the ability to transfer the content of the courses [8], the perception of utility [15], the net benefits of the course [10] or even the loyalty of students [11], [15]. Furthermore, it can also be identified research on the critical success factors already developed in the context of the Covid-19 pandemic [5], [19]-[25].

Studies identifying the critical success factors represent the main theoretical-conceptual basis of these investigations [4]-[6], [12], [14], [16], [17]. However, it is also possible to verify an association of this topic with other lines of investigation, models, or theories, namely:

1) the analysis proposed by [8], which seeks explanations around the model of cultural dimensions by [26];
2) the assessment of the quality of services in the context of online education or in general terms [7], through the use of the model proposed by [27];
3) the influence of the quality of e-learning services on the satisfaction and loyalty of students [11], from the model of evaluation of the quality of services (SERVQUAL) proposed by [28]; or, furthermore, an extension of this model adapted for e-learning education, from the inclusion of the content and website dimensions [13];
4) the perspective of the e-learning system as a social entity [9];
5) research based on two strands proposed by [10], namely that of the a) e-learning system, subdivided into system quality, information, and service; and b) the e-learning effectiveness, subdivided into net benefits and users’ satisfaction;
6) investigations on the barriers to the successful implementation of e-learning education [18];
7) the input-process-output analysis [8] proposed by [29];
8) the acceptance of technologies [12] in its original [30] or adapted [17] model;
9) from the perspective of a successful implementation of an information system-based model [15], originally proposed by [31] or through its subsequent developments [32], [33].

Despite some more consensual elements, the critical factors or dimensions (groups of factors) identified in such studies often face significant divergences, due to their diverse objectives and methodologies, or due to the items and designations assigned to the factors or dimensions.

In more specific terms, such divergences can be explained by the following reasons: i). the questionnaires proposed; ii). constructs or latent variables that group different items of diverse nature, with distinct proposals of inclusions and designations for the factors of dimensions; iii). theories and objectives of analyses proposed that are frequently divergent; iv). several methodologies.

Among the most common dimensions, it can be identified those related to students [4], [12], [14], [18], [21]-[24], [34]-[37], instructors [4], [12], [14], [18], [23],[38], services [4], and technological component [4], [12], [14], [18], [23], [39]-[45], although they can be presented with different designations: for instance, the service component can be identified as "Institution and quality of services" or "quality of e-learning service", while the technological component

includes "system infrastructure and quality" or "technology and infrastructure".

The dimension related to students, includes factors as diverse as English language knowledge, anxiety, students' expectations, attitude, motivation, students' characteristics, knowledge or self-efficacy regarding technologies, and e-learning methodology.

The dimension related to instructors encompasses the attitude towards students, characteristics, competence and quality of instructors, knowledge in information technologies and e-learning teaching, quality of teaching, response time, and availability for the development of courses.

Other factors included in the dimensions related to both students and instructors have different designations, although associated with the concepts described before, such as positive attitude, collaborative attitude, level of collaboration, attitude and mastery of technologies, online self-efficacy, Internet self-efficacy, attitude in the use of technologies, and attitude in the use of e-learning.

The dimension related to services includes factors such as reliability, the tangibility of services, empathy, response times, the course website or e-learning environment, and the interactivity of the system. It also includes different parameters relating to quality in general or in more specific terms, such as the quality of instructors, content, support, and administrative services. The inclusion of those factors depends on the different theories underlying the assessment of the quality and satisfaction of services provided.

The dimension related to the technological component includes, in turn, the quality of the system, technology, the Internet, as well as issues relating to the reliability, accessibility or ease of use and availability of the system, in addition to the response time of systems and infrastructure, and information technologies. It also includes issues relating to training in the area and technical support (to students or the technology team).

Among the factors included in the less recurrent dimensions, can be identified the questions of the diversity of evaluation mechanisms, and the perception of interaction (in the dimension related to the analysis of the environment), clear direction, and perception of the usefulness (in the dimension related to information), and, finally, the factors related to the quality and flexibility of the course, as well as the perception of the usefulness and ease of use of e-learning systems or platforms (in the dimensions related to the course or design of the course, and course and quality of information). Other dimensions include the analysis of the environment, motivations, information, course or course design, and, finally, as an aggregation of the two dimensions previously mentioned, the course and the quality of the information [12], [20], [24].

Models based on the input-process-output classification are also identifiable, namely in the study proposed by [8], which includes, in addition to the previous ones, factors such as the previous knowledge of students and their expectations regarding the course, student support, interaction, and instructional issues.

The number of factors is still identifiable in more than one dimension, according to the classification criteria adopted in each study. Additionally, as already mentioned, a set of studies do not promote the aggregation of factors into dimensions.

Finally, among the factors not identified in dimensions are subjects as diverse as the accessibility of students to computers [17], the support of management [6] and the participation and involvement of the promoter of the courses [16], knowledge management [5], the credibility of the institution, information, and advertising of the course [7], social norms [17], as well as sufficiently supportive workforce and the regularity of e-learning initiatives [6].

The literature review presented in this chapter led to the development of an instrument (a survey) that will be used to evaluate the quality of online learning using factors that are commonly found in previous studies. Nonetheless, three factors were used as paths to explain the quality of online learning based on in-depth analysis from the students' perspective, namely classes, assessments, and technological tools.

Even though the research in this field is substantially developed, the elements that influence online learning quality were assessed simply as possible inputs to explain either its overall quality or using just one of those, depending on the research aims. Using a different approach, this research put those three vectors (outputs) of analysis together in single research. By conducting this analysis, it might be possible to determine which elements are particularly relevant, considering each context individually, based on the aspect that contributes to the overall quality of online learning that needs to be improved. In addition, the inclusion of demographic variables to explain those various aspects (vectors) increases the relevance of the analysis.

The next chapter is dedicated to the presentation of the empirical study, which includes the definition of the methodological lines and the results obtained.

III. Empirical Analysis

A. Methodology

This study aims to identify the factors that influence the satisfaction of higher education students in Portugal with online learning. To this end, the analysis is based on the perspective of students on three vectors of the online education quality, namely the overall quality of classes, the assessment process, and the online teaching tools available. To this end, a structured questionnaire, of online application through Google Forms, was distributed in July 2020 among students of different courses and HEIs that took synchronous online classes and online assessments, whose participation was entirely voluntary and free. In the light of the literature review, the questionnaires constitute the main source of data collection for studies in this line of research [4], [7], [8], [10], [11], [13]-[15], [17], [18].

Factor analysis by principal component analysis (PCA) with varimax rotation, and binary logistic regression are used, through the IBM Statistical Package for the Social Sciences Statistics for Windows, version 27.0. Factor analysis is used to identify factors (independent variables) that are potentially related to overall student satisfaction. Logistic regression will include, in addition to the demographic variables proposed, the factors then identified in factor analysis as potential explanatory factors of satisfaction according to three strands

(dependent variables), namely the overall quality of classes (X_1), the quality of the assessment process (X_2), and the quality of the online teaching tools available (X_3). The proposed techniques follow the approach of different studies in this area, which uses, more often, factor analysis techniques, accompanied or not, by other techniques, such as regression models and structural equations [7], [9]-[15], [17], [18].

The analysis is based on a sample of 2107 students, of which 68.6% are female, 58.2% are under 22 years old, 62.9% are attending the bachelor's degree and 65.9% are students taking the course during the day, which are mostly students-only (not workers). From the considerations by [46], the sample error of the study is less than 5% with a confidence level of 95%, considering the reference population.

The first part of the questionnaire includes demographic variables relating to gender (V_1), age (V_2), the cycle of studies (bachelor's or postgraduate) (V_3), period (day or night classes scheme) (V_4), worker versus non-worker (if students are also workers or not) (V_5), HEIs (V_6), and course (V_7).

The second part identifies the different items proposed for factor analysis, based on the items most frequently observed in the different studies that can be included in the classically observable dimensions, namely those related to students, instructors, and technology. This methodology is justified, on the one hand, by the diversity of the literature on the subject and, on the other hand, for the wide and rapid dissemination of online education in Portugal due to the pandemic of SARS-Cov-2. Such factors motivate an analysis of the theme that was conceived, at this stage, in a more generalist and cross-sectional way, regardless of other theories that are associated with it.

Thus, the items frequently associated with the analyses that focus on the assessment of the services provided, as well as specifically on the quality of institutions and courses, were not included when not directly linked to the perception of students about the quality of synchronous online classes in general. Likewise, the proposed regression models do not include, as demographic variables, the analysis by HEIs (V_6) and by courses (V_7).

Therefore, items that are part of the factors associated with the following dimensions were included: i) quality of the classes and the resources made available to students [4]-[18], [20], [23], as a cross-sectional dimension (students, instructors, and technology); ii) performance, autonomy, participation, self-confidence, and socialization [4], [5], [7]-[10], [12], [14], [15], [17], [18], [21], [22], [24], [35]-[37] in the dimension related to students; and, finally, (iii) conditions of access to the Internet [4], [12], [14], [18], [23]-[25], [39]-[45] in the dimension related to technological issues.

The items proposed for analysis are listed in Table I, which were answered by the students from a Likert agreement scale of five points, being 1 'not important' and 5 'very important'.

TABLE I: SURVEY ITEMS

I_1 - Overall quality of synchronous online classes (real-time)
I_2 - Overall quality of the available contents
I_3 - Overall quality of teachers (pedagogical capacity)
I_4 - Overall quality of the pedagogical tools proposed
I_5 - Self-confidence attending online classes while I see my colleagues' image
I_6 - Self-confidence attending online classes while I see the teachers' image
I_7 - Self-confidence attending online classes with my image and sound
I_8 - Improving performance as a student
I_9 - Improving student autonomy
I_{10} - Improving time management
I_{11} - Ease of Internet connection
I_{12} - Quality of Internet connection
I_{13} - Quality of technological means used by teachers
I_{14} - Lack of opportunity to interact with other colleagues
I_{15} - Lack of self-confidence in the process of self-learning
I_{16} - Difficulty in applying the contents taught
I_{17} - Absence of opportunities for interaction with teachers

The next section is dedicated to presenting the results considering the methodology proposed in this study.

B. Results

Exploratory data analysis was initiated by performing a factor analysis by the method of principal component analysis (PCA) with the twofold objective of reducing the items under study by aggregating them into factors.

To validate the use of PCA, Bartlett and Kaiser Meyer Olkin's (KMO) tests were used, and it can be affirmed that the correlation between the items under study is sufficiently good, with $\chi^2_{Bartlet}$ = 14,577.386 (p-value=0. 000<0.05) [47] and KMO=0.829 (>0.5) [48]. Thus, the overall adequacy of factor extraction via PCA is verified. Items with a factor loading lower than 0.5 were disregarded. After verifying the communalities of the items and estimates of the PCA model, the results of the values and the percentages of the variance explained were obtained, which led to the identification of five factors that explain approximately 67.9% of the total data variability.

Table II presents the different items included in the identified factors, communality ranges, as well as Cronbach's Alpha (α) values used to ascertain the internal consistency of these items. It is verified that both indicators (communalities and α) present very satisfactory values, above 0.5 and 0.7, respectively.

TABLE II: CHARACTERISTICS OF THE FACTORS IDENTIFIED IN THE PRINCIPAL COMPONENT ANALYSIS

Factor	Items	Communalities	α
F_1	I_1, I_2, I_3, I_4, I_{13}	0.507 to 0.870	0.836
F_2	I_8, I_9, I_{10}	0.773 to 0.861	0.850
F_3	I_{14}, I_{15}, I_{16}, I_{17}	0.674 to 0.719	0.715
F_4	I_5, I_6, I_7	0.735 to 0.881	0.776
F_5	I_{11}, I_{12}	0.903 to 0.910	0.853

By simplification, each of the factors was renamed, according to the items that were included, as follows: F1=Quality of classes (cross-sectional dimension: students, instructors, and technology); F2=Performance and autonomy (dimension related to students); F3=Self-confidence and socialization (dimension related to students); F4=Forms of participation in synchronous class (dimension related to students); and F5=Internet access conditions (dimension related to technological issues).

The students' perception on the overall quality of classes

(X1), the quality of the assessment process (X2), and the quality of the online teaching tools available (X3), proposed as dependent variables of this research, were transformed into dummies, attributing the code '1' to the evaluations at levels 4 and 5 of the 5-point Likert scale, and '0' in the remaining cases. This procedure was similarly used in studies in different fields to combine, more accurately, higher or lower levels of perception or agreement, respectively, with a certain topic [49], [50].

As the dependent variables were transformed into a nominal binary variable, logistic regression seemed to be the most suitable technique to be used.

Binary logistic regression has as the main objective to assess the probability of occurrence of an event (the dependent variable X_j) defined by Y that is presented in a qualitative dichotomous form (Y = 1 to describe the occurrence of the event of interest and Y = 0 to describe the occurrence of the non-event), based on the behavior of explanatory variables.

Then, logistic regression allows to model the probability of occurrence of an event, as presented in equation 1). Three different models were created from each of the three dependent variables, based on the general equation 2), which includes the five factors identified and the five demographic variables proposed as independent variables:

$$P(Y=1)=\frac{1}{1+e^{-X_{j,i,t}}} \quad (1)$$

$$X_{\mathrm{j,i,t}}=\beta_0+\beta_1F_{1,\mathrm{i,t}}+\beta_2F_{2,\mathrm{i,t}}+\beta_3F_{3,\mathrm{i,t}}+\beta_4F_{4,\mathrm{i,t}}+\beta_5F_{5,\mathrm{i,t}}+\beta_6V_{1,\mathrm{i,t}}+\beta_7V_{2,\mathrm{i,t}}+\beta_8V_{3,\mathrm{i,t}}+\beta_9V_{4,\mathrm{i,t}}+\beta_{10}V_{5,\mathrm{i,t}} \quad (2)$$

Logistic regression is used to handle the classification problems. For example, linear regression provides a continuous output whilst logistic regression provides discreet output. The method for calculating loss function in linear regression is the mean squared error whereas for logistic regression it is maximum likelihood estimation. This is the adjustment method used, which estimates the coefficients of the regression that maximize the probability of occurrence of the event.

The Enter method was used to include predictors to allow the analysis of the statistical significance of their coefficients in the model.

The assumption of multicollinearity was analyzed by performing the tolerance and Variance Inflation Factor (VIF) tests for each of the three proposed models, as suggested by [51]. These values were adequate, as they were higher than 0.1 and less than 10, respectively, in each of the estimated models.

The Omnibus test, in turn, allows assessing the significance and quality of each of the proposed models and their coefficients. It can be seen a significance level lower than 1% for the $\chi^2_{Omnibus}$ test statistics for the models proposed, confirming the existence of independent variables with explanatory power.

Table III shows the statistics of -2LogLikellhood (-2LL) used to assess the quality of the adjustment, together with the values of Cox & Snell (R2CS), R2 de Nagelkerke (R2N), and Hosmer and Lemeshow test [52]. The results indicate the existence of a good adjustment of the proposed models (p-value>0.05).

TABLE III: SUMMARY OF THE MODELS AND HOSMER AND LEMESHOW TEST

Model	-2*LL*	R^2_{CS}	R^2_N	χ^2	Df	*P-value*
X_1	1765,299[a]	0.391	0.531	6,759	8	0.563
X_2	1891.376[a]	0.305	0.425	9,152	8	0.330
X_3	2197.668[a]	0.288	0.385	5,592	8	0.693

[a.] Estimation ended at iteration number 5 because parameter estimates changed to less than 0,001

The overall percentage of correctly classified cases for each of the estimated models is 80.4%, 78.5%, and 73.1%, respectively. Thus, and in addition to the initial cases, there was an increase of 19.1, 11, and 20.2 percentage points in each of the models proposed, respectively. Therefore, the independent variables included in the models improve the overall level of success, especially models 1 and 3.

Table IV shows the beta coefficients (B), standard error (SE), Wald's statistics, and the significance levels for the three models.

TABLE IV: VARIABLES IN THE EQUATIONS

Model	1				2				3			
	B	S.E.	Wald	Exp(B)	B	S.E.	Wald	Exp(B)	B	S.E.	Wald	Exp(B)
Constant	-1.193*	0.117	103.91	0.303	-1.431*	0.114	158.651	0.239	-0.23*	0.101	5.141	0.795
F1	1.168*	0.079	217.208	3.217	0.939*	0.074	161.696	2.556	0.997*	0.064	239.511	2.71
F2	1.185*	0.067	308.497	3.272	0.947*	0.062	235.132	2.578	0.769*	0.055	195.47	2.157
F3	-1.037*	0.071	215.244	0.354	-0.764*	0.063	148.344	0.466	-0.679*	0.059	134.468	0.507
F4	0.525*	0.064	67.536	1.69	0.434*	0.06	51.382	1.543	0.282*	0.055	26.629	1.325
F5	0.375*	0.064	34.738	1.454	0.363*	0.063	33.577	1.438	0.482*	0.056	74.945	1.619
V1	-0.003	0.133	0	0.997	0.272*	0.127	4.565	1.313	0.311*	0.117	7.13	1.365
V2	0.195*	0.061	10.264	1.215	0.094	0.057	2.681	1.098	-0.025	0.055	0.21	0.975
V3	0.154	0.324	0.225	1.166	0.54	0.305	3.133	1.716	-0.015	0.3	0.003	0.985
V4	-0.316	0.335	0.886	0.729	-0.692*	0.316	4.796	0.5	0.062	0.309	0.04	1.064
V5	0.283	0.176	2.598	1.327	0.355*	0.167	4.529	1.426	-0.061	0.158	0.15	0.941

* p-value < 0.05

Finally, using Wald's statistics and the significance levels of the variables included in models, equations (3), (4), and (5) synthesize the estimated models for each dependent variable:

$$X_{1,i,t}=-1.193+1.168F_{1,\mathrm{i,t}}+1.185F_{2,\mathrm{i,t}}-1.037F_{3,\mathrm{i,t}}+0.525F_{4,\mathrm{i,t}}+0.375F_{5,\mathrm{i,t}}+0.195\,V_{2,\mathrm{i,t}} \quad (3)$$

$$X_{2,i,t}=-1.431+0.939F_{1,\mathrm{i,t}}+0.947F_{2,\mathrm{i,t}}-0.764F_{3,\mathrm{i,t}}+0.434F_{4,\mathrm{i,t}}+0.363F_{5,\mathrm{i,t}}+0.272\,V_{1,\mathrm{i,t}}-0.692\,V_{4,\mathrm{i,t}}+0.355\,V_{5,\mathrm{i,t}} \quad (4)$$

$$X_{3,i,t}=-0.23+0.997F_{1,\mathrm{i,t}}+0.769F_{2,\mathrm{i,t}}-0.679F_{3,\mathrm{i,t}}+0.282F_{4,\mathrm{i,t}}+0.482F_{5,\mathrm{i,t}}+0.311\,V_{1,\mathrm{i,t}}-0.015\,V_{3,\mathrm{i,t}} \quad (5)$$

Globally, all factors appear as significantly and positively related to the students' perception of the quality of online classes, considering all the three strands (dependent variables) proposed, namely the overall quality of classes (X_1), the quality of the assessment process (X_2) and the quality of the online teaching tools available (X_3). The exception for the F3 may be explained by the fact that items included in this factor were proposed in a negative perspective (the lack or absence of the elements under assessment). On the other hand, the demographic variables showed divergent results, as some of the five independent variables proposed in this group were not significantly related to those dependent variables.

Following the results identified, the next chapter is

dedicated to presenting the conclusions obtained from this study.

IV. Discussion and Conclusions

This study identified five factors that significantly explain students' perception on three different vectors of online education quality: the overall quality of classes, the quality of the assessment process, and the quality of the online teaching tools available.

The factors can be summed up around the following elements, ranked from the highest to the lowest significant coefficient as follows: quality of the classes (as cross-sectional dimension related to students, instructors, and technology), performance and autonomy (dimension related to students), self-confidence and socialization (dimension related to students), ways of participation in synchronous class (dimension related to students) and, finally, the access to the Internet (dimension related to technological issues).

These findings follow the literature as the quality of the classes and the resources made available to students [4]-[18], [20], [23], the performance, autonomy, participation, self-confidence, and socialization [4], [5], [7]-[10], [12], [14], [15], [17], [18], [21], [22], [24], [35]-[37], as well as the conditions of access to the Internet [4], [12], 14, [18], [23], [24], [25], [39]-[45], are seen as explanatory of the students' perceptions regarding online classes.

If the first topic is commonly mentioned by literature as regards face-to-face, online, and hybrid learning, the second and third remaining aspects are stressed by research that specifically assesses distance learning, through either synchronous or asynchronous classes. The importance of the second may be explained either by the lack of confidence when interacting online or the missing of face-to-face interaction, with teachers and colleagues, that can be felt by students. In this sense, the literature has been highlighting the need of mitigating these matters when developing distance learning as a path to improve the students' satisfaction. The third topic, in turn, is particularly emphasized by the literature developed within the pandemic, which pointed out that technical matters are most relevant in influencing the students' perception of online learning.

Following this, it is important to emphasize the novelty of this study by combining those vectors with different demographic variables measured by the questionnaire.

However, less robust and inconsistent results were found for those variables. More specifically, age seemed to be the only relevant demographic variable as regards the overall quality of classes. Then, the variables gender, period, and if students are also workers or not appeared as relevant regarding the assessment process. Finally, gender exclusively arose as a significant variable in terms of the quality of the online teaching tools available.

Understanding the factors that help explain student satisfaction is an element of relevance, given the rapid dissemination of online education around the world. In some countries, such as Portugal, this learning method increased its relevance by the recent lockdown to which students and teachers have been forced due to the SARS-Cov-2 pandemic. The knowledge of these factors will allow the improvement of pedagogical techniques and resources made available to promote global satisfaction and, consequently, increase the students' success rates.

The study presents as main limitations the subjectivity associated with the collection of information through a questionnaire, as well as the specific period in which it was performed. Finally, it is suggested new research in times of ordinary use of synchronous online classes in Portugal. In this context, it is important to assess the inclusion of other variables considering the existing theories used in this field. Furthermore, it can be performed more specific analyses that allow understanding, inter alia, the effects of different types of educational institutions (e.g., public versus private HEIs) and courses.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Albuquerque, Martinho e Gomes dos Santos conducted the research, analyzed the data, and wrote the paper together. All the authors approved the final version.

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