STATISTICAL ANALYSIS AND USE OF QUESTIONNAIRES FOR EVALUATION OF THE KNOWLEDGE AT UNIVERSITY. A PRACTICAL CASE.

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ABSTRACT:

The accomplished experience, using the data processing platform Moodle, in the execution of multiple-option questionnaires with automatic evaluation; is presented. The obtained results have been utilized subsequently for their statistical analysis by means of centered measures and basic dispersion.

The documented experience was implemented in the subject: Construction of Traditional Structures and Equipments (CETE), in the Technical Architecture (AT) career of the Technical University of Catalonia (UPC) The summary of the information includes the results obtained for a total sampling of 437 students distributed in four different groups. In those groups, three different professors taught the classes for the two available schedules.

The obtained results facilitate to discern among the different professors, student typologies, student gender, different levels of acquired knowledge, relation to other evaluation techniques applied, and relation to the documented prior knowledge.

It is proposed and analyzed, basing on the obtained results, educational adaptations that will allow future improvements in subjects with similar requests or needs on the part of the students. Similarly, possible poor preceding formation in students or in the teaching by professors can be determined; both shall be corrected after the analysis.

This work is part of the effort achieved in the educational improvement field, that is being executed inside the Upper-Technical Building College of Barcelona (EPSEB) and framed in the European Space of Higher Education [1, 2, 3, 4, 5, 6]. The objective is to show the current descriptive focal point on the learning and continuous evaluation field, applied in this subject.

Keywords: Statistical analysis in teaching, Questionnaires for evaluation, Higher Education, Student Evaluation.

I THEORETICAL – CONCEPTUAL FRAMEWORK.

There are numerous published investigations describing the convenience to introduce teaching evaluation questionnaires by means of data processing systems. Likewise, there have been observed some advantages that those systems contribute with, such as results management, savings in the evaluation time, the not need to supply the questionnaire in paper, etc. On the other hand, the existence of some objections has been shown, such as: students ID confidentiality, the subsequent use of the information, the possible repercussion of its use in the educational process, etc. [7, 8, 9, 10, 11]

The statistical analysis in the evaluation (its reliability and the surveys authority for the educational quality evaluation) has given credibility to these processes. In some occasions, and currently in a more official form; these processes have not served just as developers of educational changes, but also as promotion tools in the teaching, as criterion of academic compliance, and as an evaluator parameter for economic incentives concession for the teaching staff or for the educational institution [12, 13, 14, 15, 16]

It is important to emphasize that there are nowadays tools and calculation processes which permit: multiple processes analysis, creation of simulations or hypothesis validation in the prediction of guidelines inside the teaching field [17]. It is not common to analyze the results data in students evaluations for their comprehension and subsequent analysis by professors [18]; there are just few documented cases about the use of these analysis in programs and educational systems in the national situation [19, 20, 21]

As possible causes of this lack of empathy by part of the educational community, we could enumerate the following conjectures observed in daily practice of educational labor:

1. The traditional position by conventional faculty towards these new tools; since it is commonly considered that there has been already a considerable time invested in the students evaluation, and it is not necessary "to be more overwhelmed" in this "ineffective" process.
2. Since, with the evaluation of students, the course finishes, the faculty will not have again contact with the same students and, therefore, "it is not necessary to explore situations that will not be repeated again".

3. The analysis and derivations that this type of information can generate "does not contribute anything or very little to the educational process" or to the educational improvement.
4. The information generated with this type of analysis would be able to generate guidelines for the intervention and specific supports to students or groups that need it; nevertheless, "the university teaching shall not promote this type of specialization".
5. The specific actions produced by these analyses would be able "to generate needs of additional resources that the university teaching cannot assume".

But the reality is that, according to the adaptation process to the European Space of Higher Education (ESHE); conceptual and deep structuring changes related to the teaching staff work, to the form in which the knowledge should be transmitted, to the way in which is easier to learn by students, and to the correct social satisfaction in a competent education required by society and by the educational institution; are being prompted [**¡Error! Marcador no definido.**, 22]

In line with these ideas, it has been begun to question and to analyze all the professors and university educators acting: incorporating the analysis and the deduction of learning results in students as a new educational tool that provides answer to the current need of analysis and deduction of possible tendencies. Similarly, as second derivation of this information, it will be able to predict and to validate the correct educational performing or the process and system to evaluate the students. In a nearby future, all this system will permit, besides, to include instruments such as [18]:

1. Specific software tools for educational institutions that permit the analysis of existing or future data.
2. Standardized methods or practices that permit to identify cases or critical situations.
3. Development of professors in specific positions with particular thematic contents.

II EVALUATIVE HISTORIC PROFILE OF THE SUBJECT

The study and analysis of data presented is with reference to the subject "Construction of Traditional Structures and Equipments (CETE or Construction III): this subject is part of the Technical Architecture syllabus (AT) in the Upper-Technical Building College of Barcelona (EPSEB) of the Technical University of Catalonia (Spain) (UPC) It is a four-month term subject in the second year of the career (Obligatory in Curriculum Block BC3) and it is taught in the four-month term 2A, its worth is 4.5 credits (one credit equals to 10 class hours) subdivided in: 3.0 theoretical credits and 1.5 credits of practices.

The subject is taught simultaneously in four groups in all the four-month terms (1Q: Autumn and 2Q: Spring): two groups for students that attend class in the mornings (Groups 1M and 2M), and two groups more for students that attend class in the afternoon (3T and 4T) A global view, for the four groups, of the statistical facts for the subject is summarized in Table 1 [23]:

Table 1. Academic results

Course	Semester	Total Student	Notes					
			Distinction	Excellent	Notable	Approved	Suspended	Not submitted
2002/2003	1Q	363	0	0	10	234	105	14
	2Q	343	0	0	12	233	80	18
2003/2004	1Q	315	0	0	7	174	116	18
	2Q	271	0	0	10	199	64	12
2004/2005	1Q	290	0	0	7	142	132	9
	2Q	285	0	0	24	180	64	3
2005/2006	1Q	302	0	0	8	170	105	19
	2Q	257	0	0	11	137	95	14
2006/2007	1Q	299	0	0	11	182	89	17
	2Q	205	0	0	4	149	46	6
2007/2008	1Q	273	0	0	19	172	70	12
	2Q	236	0	0	13	160	61	2
TOTALS		**3439**	**0**	**0**	**136**	**2132**	**1027**	**144**
% ON THE TOTAL			**0,0%**	**0,0%**	**4,0%**	**62,0%**	**29,9%**	**4,2%**

As shown in Table 1, the historic percentage of approved students in the subject is about 66% (Notable more Approved) Also, a simple significant correlation can be appreciated (of the direct type) as that for the four-month term 2Q there are better results than for the 1Q (with the exception of 2005/2006 school year, just for a 3%) The previous aspect is of greater importance if it is linked with the number of students registered by term: while the average of all the courses is about 72 students by class, in the 2Q the number of students is always slightly lower. As conclusion of this, generally, courses with smaller number of registered students report greater number of approved students; being the four-month term 2Q the one with, historically, lesser number of students and, consequently, more amounts of approved students.

In accordance with the authors criteria and by their own experiences; it seems that, although the contributed data do not correlate in a direct form these variables (because they are not filtered), great part of the first-time registered students manage to accredit the subject; leaving as unsuccessful the students who repeat the term. It is also evident that the larger number of students in a class causes a detriment in the quality and personalized dedication that a professor can give to his or her class.

On the other hand, an investigation to relate the number of students that manage to approve the subject with the ones who have prior basic knowledge acquired in approved related subjects (Construction I and Construction II) or with supposed accreditations of their knowledge (not always in a sufficiently truthful form), has been done; as it will see further on in this work.

It can be observed in Table 1 that the majority of the grades to accredit the subject are concentrated in the approved item, and the second important statistical figure is for those who have suspended the subject.

A conclusion of the previous paragraphs, in general conditions, is that having the subject as a one concept, it exists a high number of students that suspend it; in the cases of classes with smaller number of students, the approved figures improve sensitively by the

order of the 10%; and, on the other hand, the obtained grades to accredit it have been historically near to the low limit.

III METHODOLOGY

III. 1 Procedure for the analysis to apply.

For the design of the evaluation analysis system to utilize in this work, some general criteria and practical recommendations have followed [16, 20], in order to guarantee a correct application of the work and to avoid bias by its incorrect use.

In this way, from the generic fields used for the processing of this type of information, there exist the **levels of analysis and of application**. For these levels, in a summarized form, there are three sections for each one of them. For analysis levels: individual, institutional and systematic. For application levels: faculty or students, educational institutions or programs, and the entirely educational system.

In order to have affinity with the reality evaluated, and because the degree of takes of decisions or the conclusions and hypothesis analyzed explanation; for this work, it has prescribed some application and analysis levels in an organize form: most of the variables to be analyzed will be of individual level (variable linked to the students and to their evaluation process), which will be utilized to decide and to propose actions tending to the teaching improvement and to the cognitive development of the students. In smaller range, variables will evaluate to analyze, in an institutional level, a program of possible interventions in the educational field, an adaptive improvement of the program to obtain the degree, and a general development of the institution. In a summarized form, for both cases, the complete work is eminently of formative nature.

For the **report typology and content structure**, it has been opted to elect, similarly to the previous case, a mixed report, this is: more scientific than evaluative, since the technical soundness sought has dominate on the need of efficient communication. Also because the information here presented is more, in a deliberate way, aimed at specialists than to not specialize audiences.

The information utilized in this work also responds to the **statistical answers for specific items**, that is, it is utilized and analyzed, giving the items multiple option percentages or grades percentages of the students.

Finally, referring to the **report characteristics**, it has been opted to include all the necessary information for the potential or real beneficiaries (faculty and educational institution), applying the necessary criteria of: maximum relevance, importance, conciseness, etc.

III. 2 Design of the research.

The analysis here presented obtains the information to process by means of the results extracted in the valuation of the studied subject. That evaluation process was defined in the school term 2008/09-2Q, it consisted of a continuous evaluation in which each two modules from the thematic content, a to-grade directed activity was developed. Also, two countable exams were complete, with the following considerations (Table 2):

Table 1 Evaluation procedure of the subject.

Academic Content (Modules)	Contents (%)	Technical Evaluation	Final Grade (%)
1 y 2	25	Activity nº 1	5
3 y 4	25	Activity nº 2	5
1, 2 , 3 y 4	50	1st Mid-term Exam	40
5 y 6	25	Activity nº 3	5
7 y 8	25	Activity nº 4	5
5, 6 ,7 y 8*	50*	2nd Mid-term Exam*	40*

* Recovery 1st Midterm Exam (optional)

The activities developed by students consisted in solving problems or real cases associated to applications from the thematic contents given in classes. These activities were developed individually by students and graded according to some previously established rules (class agreements)

The evaluations with grade were based on the resolution of two clearly differentiated sections, in the case of the 1st. mid-term exam they consisted in the resolution of a graphic–conceptual problem, with a specific 50% value of this exam grade, and a multiple answers test with a the other 50% value for the grade.

The multiple answer test utilized was formed by a 20-question format with three possible answers to select in each one, and implemented in the subject Virtual Campus by means of the Moodle data processing platform [24]; this test was proposed to evaluate the different knowledge levels acquired by students according to the called Taxonomy of Bloom [25] In a summarized form, the subdivision of the evaluated knowledge levels is presented in Table 3, including the number of questions for each one of them.

Table 2 Bloom's Taxonomy of evaluative test.

Levels	Type	Number of questions
Level 1	Knowledge	4
Level 2	Comprehension	2
Level 3	Application	7
Level 4	Analysis	4
Level 5	Synthesis	2
Level 6	Evaluation	1
	TOTALS	**20**

For the case of the 2nd mid-term exam, the graphic-conceptual problems resolution, incorporated in this part of the thematic content, was utilized as evaluation method; permitting in this occasion (as a request from the students) to recover the grade of the first mid-term exam, resolving the proposed test in the that 1st exam.

Therefore, for the analysis of this first part of the statistical study, twelve different variables were taking into account, assigning them codes and meanings that are presented in Table 4.

Table 3 Nomenclature of the study variables.

Nomenclature	Meaning associated with the variable	Range of possible values
VAR01	Student Gender	1 = male, 2 = female
VAR02	Groups they belong to the students	1 = 1M, 2 = 2M, 3 = 3T, 4 = 4T
VAR03	Hours in which class is offered	1 = Morning, 2 = Afternoons
VAR04	Activity Note nº 1	Del 0 al 10 *
VAR05	Activity Note nº 2	Del 0 al 10 *
VAR06	Note the 1st midterm exam (part-conceptual graph)	Del 0 al 10 *
VAR07	Note the 1st midterm exam (hand test)	Del 0 al 10 *
VAR08	Activity Note No 3 and No 4	Del 0 al 10 *
VAR09	Note the 2nd term exam (part-conceptual graph)	Del 0 al 10 *
VAR10	Note recovery of the 1st midterm exam (test)	Del 0 al 10 *
VAR11	Note end of the course	Del 0 al 10 *
VAR12	Number of times you have registered for the course	Del 1 al 5

* With accuracy of two decimal places of significance.

With these criteria and variables to analyze, the data processing program of statistical analysis SPSS V17 for Windows, was utilized in order to obtain the following parameters: general statistical descriptive for each one of the variables in a isolated form, with the purpose of knowing and distinguishing the samples in an isolated form also; next an analysis of bi-varied correlation was performed to seek affinity among the values of pairs of samples and to compare among them with the aim of verifying the relation among the different variables.

III. 3 Examination of external variables of the subject.

With the intention of investigating the relation among the achievement of this subject knowledge (and thus to obtain the approved status) and the previously acquired knowledge (the access to the university for students and their origin), a second statistical analysis has been accomplished.

For this, the grades obtained previously, corresponding to the two prior subjects with related knowledge to Construction III: Construction and materials knowledge (Construction I) and Construction of elements (Construction II); and finally, the origin of the student has been considered.

In this case, the variables to enclose to the data analysis before mentioned are presented in Table 5, (adopted nomenclature, description and possible ranks that each variable can adopt)

Table 4 Nomenclature of variables external analysis.

Nomenclature	Meaning associated with the variable	Range of possible values
VAR13	Note accreditation Construction I	Del 0 al 10 *
VAR14	Note accreditation Construction II	Del 0 al 10 *
VAR15	Access to college	1 = Test Access to University (PAU), 2 = Foreign selectivity, 3 = Diploma, 4 = Training (FP), 5 = Studies initiated via University Course (COU), 6 = Studies initiated via FP, 7 = Over 25

* With accuracy of two decimal places of significance.

III. 4 Data analyzes.

From the data universe analyzed (437 students), fourteen samples or students were separated because they did not present evaluative activity in any of the variables to analyze; understanding that these students, for a specific motive (their own decision), do not belong to the developed sampling. So, the analysis is done with a total number of 423 students.

As first step, to know better the proposed variables, the process to obtain a series of parameters was developed; among them: Centering measures (Mean, Median, Mode and Sum), *Disp*ersion measures (standard deviation, Variance, Amplitude, Minimum, Maximum and Media typical error), Samples distribution (Asymmetry and Kurtosis), and finally the Percentiles Values.

In Table 6, the general results obtained for all the samples and analyzed variables, referring to its general description, are presented. The values reported for the variables: VAR01, VAR02, VAR03 and VAR15, have to be analyzed taking into account that they suffered a change from alphabetical variable to numerical, in agreement to the indications shown in Table 4 and Table 5; to permit the analytic process of them; therefore, they do not exactly determinate the habitual statistical meaning (especially the parameters of centering measures) Nevertheless, the analysis parameters of the samples can contribute with general information about to dispersion measures such as: the standard deviation and the variance, as well as their own distribution.

Table 5 Descriptive statistics for study variables.

		VAR01	VAR02	VAR03	VAR04	VAR05	VAR06	VAR07	VAR08	VAR09	VAR10	VAR11	VAR12	VAR13	VAR14	VAR15
N	Valid	422	423	423	423	423	423	422	423	423	422	423	423	322	138	423
	Lost	1	0	0	0	0	0	1	0	0	1	0	0	101	285	0
Mean		1.37	2.53	1.51	6.349	6.34	4.719	5.87	6.415	4.371	8.29	6.122	1.1	5.597	5.48	2.64
Standard error of the mean		0.024	0.059	0.024	0.078	0.102	0.108	0.095	0.113	0.096	0.087	0.064	0.021	0.039	0.058	0.095
Median		1	3	2	6.5	7	5	6.25	7	4.5	8.88	6.3	1	5.4	5.2	1
Mode		1	4	2	6	7	5	6.3	7.3	5	10	5	1	5	5	1
Standard deviation		0.484	1.219	0.501	1.618	2.091	2.2205	1.955	2.325	1.979	1.779	1.321	0.434	0.695	0.677	1.962
Variance		0.234	1.487	0.251	2.62	4.37	4.931	3.82	5.406	3.915	3.165	1.744	0.188	0.484	0.458	3.848
Asymmetry		0.531	-0.033	-0.033	-2.099	-1.465	-0.017	-0.772	-1.658	-0.2	-2.573	-2.055	5.27	1.308	1.607	0.62
Standard error of asymmetry		0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.136	0.206	0.119
Kurtosis		-1.726	-1.574	-2.008	7.268	2.658	-0.359	0.968	2.43	-0.158	8.8	7.772	32.236	1.436	1.905	-1.108
Standard error of Kurtosis		0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.237	0.271	0.41	0.237
Amplitude		1	3	1	9.5	10	10	10	10	10	10	9	4	3.5	3	6
Minimum		1	1	1	0	0	0	0	0	0	0	0	1	5	5	1
Maximum		2	4	2	9.5	10	10	10	10	10	10	9	5	8.5	8	7
Sum		579	1070	638	2685.5	2682	1996.3	2477.3	2713.8	1848.8	3498	2589.6	467	1802.1	757	1116
Percentiles	10	1.0	1.0	1.0	5.5	4.5	2.5	3.5	4.3	1.5	6.6	5.0	1.0	5.0	5.0	1.0
	20	1.0	1.0	1.0	5.5	5.0	2.5	4.3	5.3	2.8	7.5	5.3	1.0	5.0	5.0	1.0
	25	1.0	1.0	1.0	6.0	5.5	3.8	4.8	5.8	3.0	7.5	5.5	1.0	5.0	5.0	1.0
	30	1.0	2.0	1.0	6.0	6.0	3.8	5.0	6.3	3.5	8.0	5.7	1.0	5.0	5.0	1.0
	40	1.0	2.0	1.0	6.0	6.5	3.8	5.6	6.8	4.0	8.5	6.0	1.0	5.2	5.0	1.0
	50	1.0	3.0	2.0	6.5	7.0	5.0	6.3	7.0	4.5	8.9	6.3	1.0	5.4	5.2	1.0
	60	1.0	3.0	2.0	6.5	7.0	5.0	6.5	7.3	5.0	9.0	6.5	1.0	5.6	5.3	4.0
	70	2.0	4.0	2.0	7.0	7.5	6.3	7.0	7.5	5.5	9.5	6.8	1.0	5.8	5.5	4.0
	75	2.0	4.0	2.0	7.0	7.5	6.3	7.1	7.8	5.8	9.5	7.0	1.0	6.0	5.7	4.0

		VAR01	VAR02	VAR03	VAR04	VAR05	VAR06	VAR07	VAR08	VAR09	VAR10	VAR11	VAR12	VAR13	VAR14	VAR15
	80	2.0	4.0	2.0	7.1	8.0	6.3	7.5	8.0	6.0	9.5	7.1	1.0	6.2	6.0	5.0
	90	2.0	4.0	2.0	8.0	8.5	7.5	8.3	8.5	7.0	10.0	7.5	1.0	6.6	6.6	5.0
	100	2.0	4.0	2.0	9.5	9.5	10.0	10.0	10.0	10.0	10.0	9.0	5.0	8.5	7.9	7.0

Now, based on Table 6, Figure 1, Figure 2 and Figure 3; some reflections that concern to the determined statistical parameters for the studied variables are mentioned.

For the centering measures, the general behavior of the samples (from VAR04 to VAR09 and VAR11) can be summarized saying that the evaluated parameters are centered slightly above the center of the distributions; the same with the symmetry of its distribution.

For VAR10, it is evident that the recovery process of the first mid-term exam moves away from the habitual behavior of the subject; because of different factors such as: prior knowledge of the content by students (it is easier), excessive time in test application (calibration), levels of low control (guarantee of application), etc. Being therefore necessary that these factors be calibrated in future put in practice.

For VAR12, the values of the reported parameters indicate that the initially proposed hypothesis, in which the students who repeat the course were considered as the origin of the subject fails, does not have a numerical support; therefore, it is verified that the rejuvenation of students in the courses is produced in a natural and constant form.

Finally, for VAR13 and VAR14, the values reported for their central parameters indicate to be much related among them; being on the other hand, of greater demand in the referring to their evaluation in comparison with the subject Construction III. This is due to factors such as: affinity in the thematic contents of the subjects Construction I and Construction II, or, by contrary, opposition of both with those of Construction III.

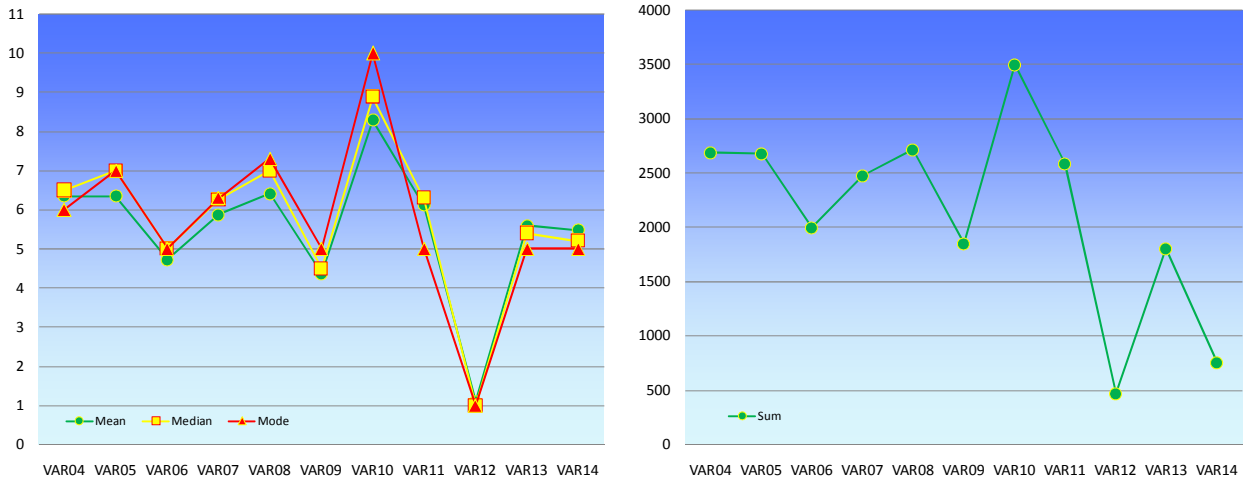

Figure 1 Graphic representation of the behavior of the measures centering of the variables.

For the dispersion parameters of variables VAR01 to VAR03, and because the already commented motives, it is valid just the comparison among themselves (bi-univocal relation), verifying impartial dispersions for each possible sample value, and with very low variance values.

For variables VAR04 to VAR11, an increment in the amplitude of the range of possible values to take, can be appreciated; consequently, there is an opening to considerable increments in their variance and standard deviation.

It is interesting to emphasize that these two curves, just inside the zone of these variables, present forms sensitively parabolic (to scheme them as a group) This could be interpreted with the following conjecture: when the course starts, students have a high interest in the subject, this is reflected in evaluations with the equality results obtained; that collective interest goes relaxing or eroding along the course until a minimum close to middle of it (maximum dispersion of results); from this point, probably because the pressure for the course ending, the dispersion of the evaluations improve to obtain an approved grade for the subject (behavior called "stationary performances of students")

The dispersion of VAR12 is significantly low, corroborating the already commented aspect about its centering measure, referred to the certainty by students, in their first intention, to pass the course.

For VAR13 and VAR14, dispersion is centered in a more closed range that in the case of Construction III, the same happens with deviation and variance. This, concerning to the lower level of the range, should be interpreted with caution, since two samples only include the data of the minimum grade to approve (five), the low grade that remains registered in the academic expedient of the student. Nevertheless, it is notorious that the maximum grade of the subjects does not reach values of ten. Finally, VAR15 presents low dispersion, indicating that the origin of the students is clearly directed from one or few sources or origins.

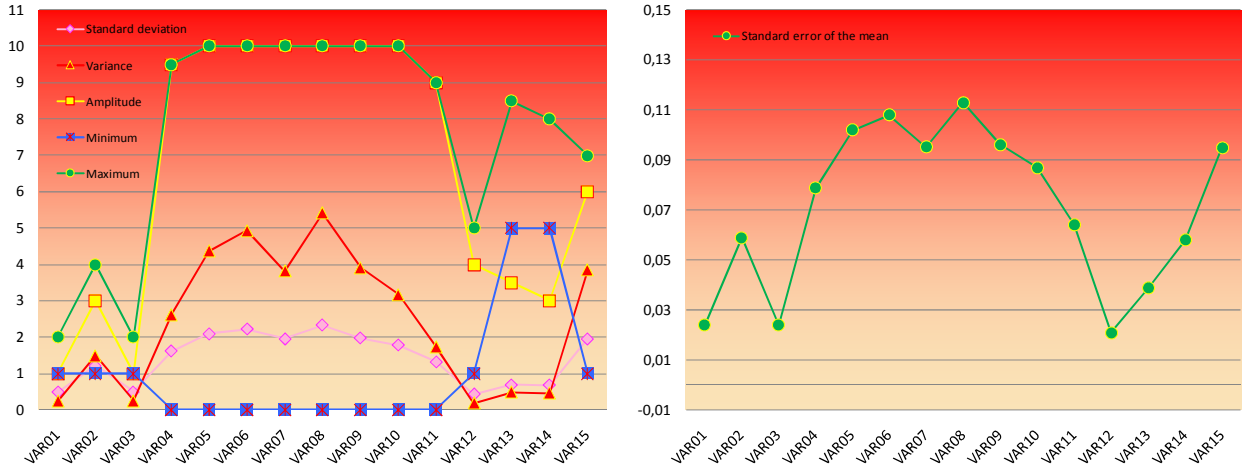

Figure 2 Graphical representation of the behavior of the dispersion measures of the variables.

In terms of distribution of samples, for variables VAR01 to VAR11, there are asymmetries close to the normal distribution or with long left parts (possible observations that do not belong to the sampling group) On the other hand, for variables VAR13 and VAR14, is the opposite (samples do not have grades under five) For the kurtosis of variables, in general terms, the observations are more concentrated, reporting greater parts than a normal distribution.

To finish, the evaluation samples of the subjects present percentiles with similar slope of curvature; this does not happen with variables VAR01, VAR02, VAR 3, VAR12 and VAR15, since they belong to groups without relation to the academic evaluation (gender, group, class schedule, number of registration and access to the university times)

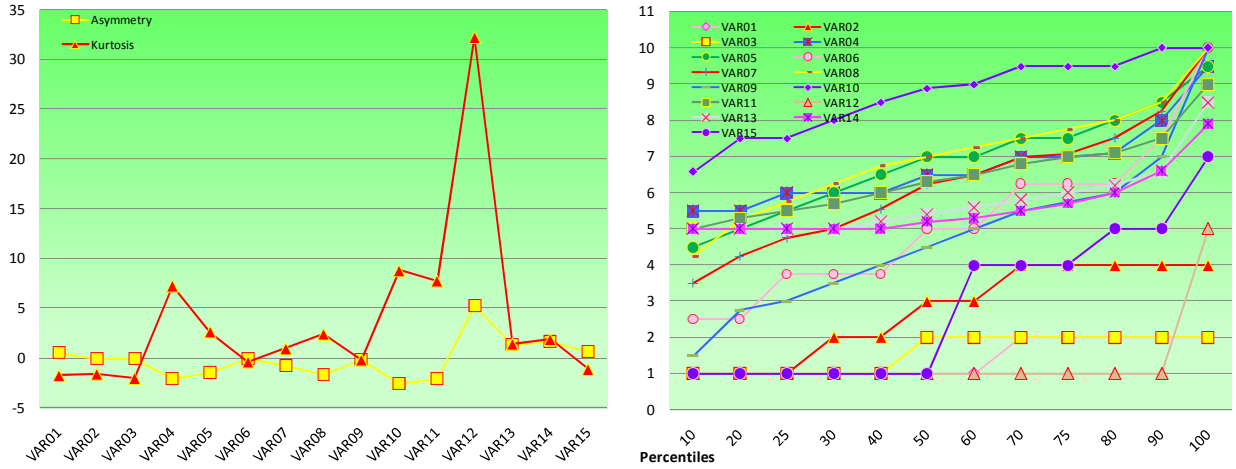

Figure 3 Graphical representation of the distribution of the samples.

From the obtained data and related to their graphic representation of frequencies distribution, a complete interpretation of the samples can be done. In Figure 4, frequency histograms of these variables and their adjustment based on a hypothetical normal distribution are presented.

As shown in this figure, the histograms of frequency present adjustments to an adequate normal distribution for variables VAR06, VAR07, VAR09 and VAR11. On the other hand, variables VAR04, VAR05 and VAR08, present anomalous bias in the left parts, to correlate them with more variables, it would be necessary to eliminate the bias by means of some mathematical filters. Nevertheless, in this research it has been elected to remain the samples close to the reality, assuming this type of avoidable problems as habitual behaviors of the sampling.

Finally, variables VAR13 and VAR14 are not adjusted to a normal distribution, but they are to one of logarithmic type. To justify this anomaly, it is necessary to remind, already commented, the lack of observations of these variables with data under a grade of five. Likewise, it is also validate the justification of the histogram behavior for variable VAR10, showed in the centering measures of it.

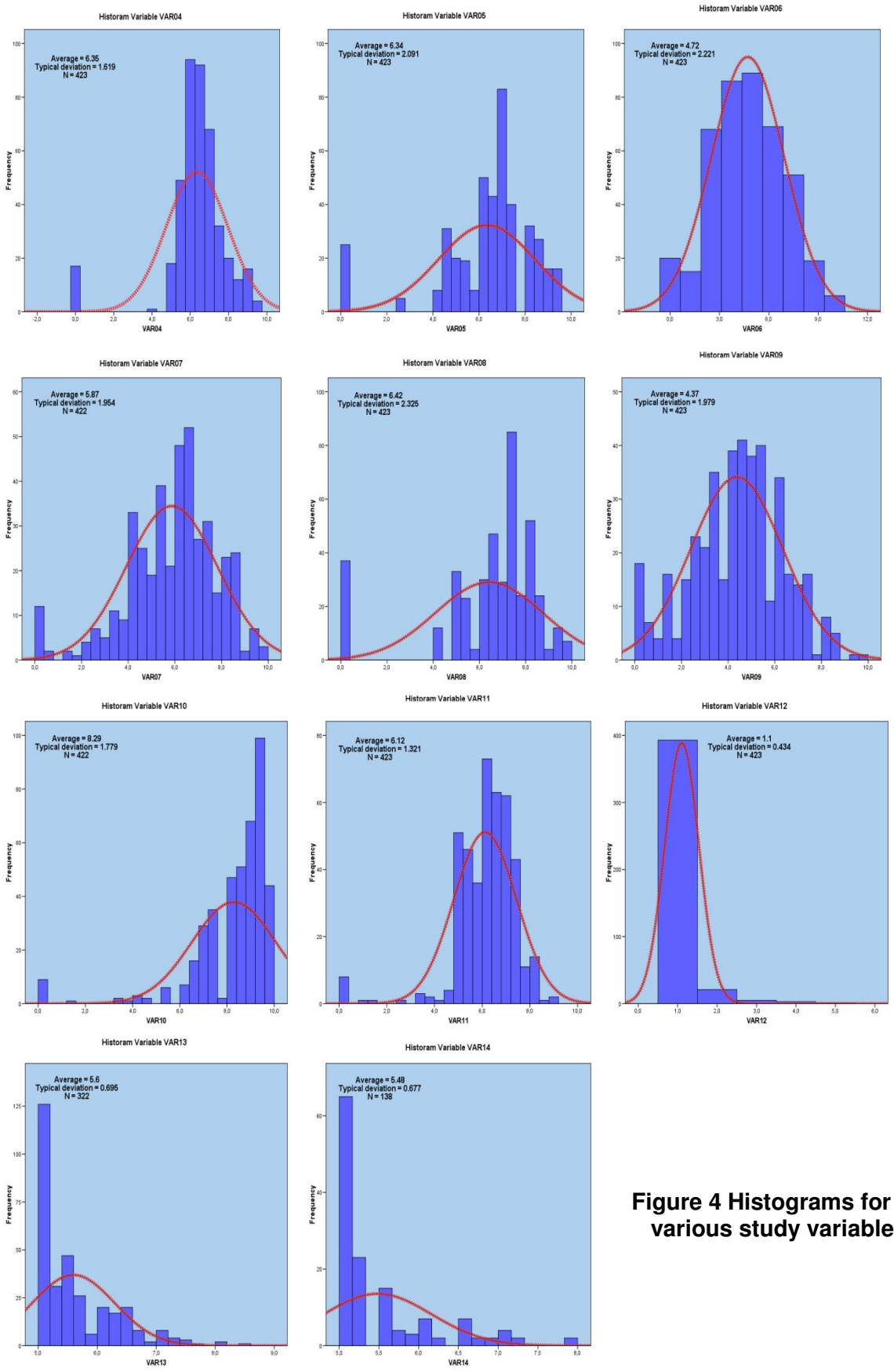

Figure 4 Histograms for the various study variables.

In order to establish correlations to be presented among the different studied variables, a bi-variable correlation study, with bilateral meaning test of all the variables, has done. This procedure has been conditioned to the criteria of lost values excluded according to pairs, and thus to obtain the correlation coefficients and their significance.

Three possible types of correlation were studied: Pearson (usual in symmetrical quantitative variables with normal distribution), Tau-b by Kendall and Rho by Sperman (for quantitative variables with orderly categories and not normal distributions)

In Table 6, the correlation matrix for Pearson coefficient correlation is presented; in this Table the results obtained with the coefficients Tau-b by Kendall and of Rho by Sperman are omitted because they presented worse significances, as it was expected in this work, since they are samples with distributions more close to a normal distribution in the majority of the variables.

In the same board, the correlation that present low significances have been identified, marking the cells in blue color (*) from those that report significance at the level of 0.05, and in red color (**) the ones that present a level of 0.01. Finally, from the previous correlations detected with significant importance, the three highest correlation coefficients of each possible variables combination, have been selected (shaded cells in the table), understanding that these correlations are the ones with important significance in all the matrix, and therefore, the ones that permit demonstration of the relation.

Table 6 Correlation Matrix bilateral Pearson coefficients.

Bi-correlation			VAR01	VAR02	VAR03	VAR04	VAR05	VAR06	VAR07	VAR08	VAR09	VAR10	VAR11	VAR12	VAR13	VAR14	VAR15
Pearson's Coefficient	VAR01	Correlation	1	0.013	0.039	0.002	0.047	-0.05	-0.074	0.074	0.014	-0.054	-0.003	-0.072	-0.001	-0.058	-0.022
		Sig. (2-tailed)		0.786	0.42	0.96	0.332	0.302	0.127	0.127	0.769	0.265	0.945	0.14	0.987	0.503	0.651
	VAR02	Correlation	0.013	1	.917(**)	-0.02	-0.046	-0.045	-0.071	-0.019	-0.048	-0.055	-0.054	0.008	-0.041	-0.031	0.007
		Sig. (2-tailed)	0.786		0	0.683	0.343	0.361	0.143	0.689	0.326	0.259	0.267	0.876	0.46	0.722	0.887
	VAR03	Correlation	0.039	.917(**)	1	0.002	-0.008	-0.055	-0.07	-0.001	-0.054	-0.053	-0.052	0.007	-0.01	-0.004	0.012
		Sig. (2-tailed)	0.42	0		0.975	0.873	0.257	0.151	0.981	0.271	0.276	0.282	0.887	0.857	0.962	0.814
	VAR04	Correlation	0.002	-0.02	0.002	1	.748(**)	.264(**)	.351(**)	.569(**)	.232(**)	.508(**)	.542(**)	-.430(**)	.144(**)	.168(*)	.170(**)
		Sig. (2-tailed)	0.96	0.683	0.975		0	0	0	0	0	0	0	0	0.01	0.049	0
	VAR05	Correlation	0.047	-0.046	-0.008	.748(**)	1	.228(**)	.359(**)	.463(**)	.258(**)	.392(**)	.501(**)	-.334(**)	.178(**)	0.159	.172(**)
		Sig. (2-tailed)	0.332	0.343	0.873	0		0	0	0	0	0	0	0	0.001	0.063	0
	VAR06	Correlation	-0.05	-0.045	-0.055	.264(**)	.228(**)	1	.218(**)	.100(*)	.236(**)	.254(**)	.415(**)	-0.028	0.049	.181(*)	.187(**)
		Sig. (2-tailed)	0.302	0.361	0.257	0	0		0	0.04	0	0	0	0.565	0.385	0.034	0
	VAR07	Correlation	-0.074	-0.071	-0.07	.351(**)	.359(**)	.218(**)	1	.183(**)	.362(**)	.454(**)	.490(**)	-.116(*)	.207(**)	.239(**)	0.003
		Sig. (2-tailed)	0.127	0.143	0.151	0	0	0		0	0	0	0	0.018	0	0.005	0.95
	VAR08	Correlation	0.074	-0.019	-0.001	.569(**)	.463(**)	.100(*)	.183(**)	1	.212(**)	.386(**)	.443(**)	-.291(**)	.119(*)	-0.012	.127(**)
		Sig. (2-tailed)	0.127	0.689	0.981	0	0	0.04	0		0	0	0	0	0.033	0.893	0.009
	VAR09	Correlation	0.014	-0.048	-0.054	.232(**)	.258(**)	.236(**)	.362(**)	.212(**)	1	.386(**)	.808(**)	0.002	.231(**)	0.043	0.063
		Sig. (2-tailed)	0.769	0.326	0.271	0	0	0	0	0		0	0	0.969	0	0.62	0.199
	VAR10	Correlation	-0.054	-0.055	-0.053	.508(**)	.392(**)	.254(**)	.454(**)	.386(**)	.386(**)	1	.754(**)	-.262(**)	0.08	.188(*)	-0.009
		Sig. (2-tailed)	0.265	0.259	0.276	0	0	0	0	0	0		0	0	0.154	0.028	0.85
	VAR11	Correlation	-0.003	-0.054	-0.052	.542(**)	.501(**)	.415(**)	.490(**)	.443(**)	.808(**)	.754(**)	1	-.144(**)	.218(**)	0.154	.098(*)
		Sig. (2-tailed)	0.945	0.267	0.282	0	0	0	0	0	0	0		0.003	0	0.072	0.044
	VAR12	Correlation	-0.072	0.008	0.007	-.430(**)	-.334(**)	-0.028	-.116(*)	-.291(**)	0.002	-.262(**)	-.144(**)	1	-.111(*)	-0.114	0.003
		Sig. (2-tailed)	0.14	0.876	0.887	0	0	0.565	0.018	0	0.969	0	0.003		0.047	0.185	0.958
	VAR13	Correlation	-0.001	-0.041	-0.01	.144(**)	.178(**)	0.049	.207(**)	.119(*)	.231(**)	0.08	.218(**)	-.111(*)	1	.384(**)	.122(*)
		Sig. (2-tailed))	0.987	0.46	0.857	0.01	0.001	0.385	0	0.033	0	0.154	0	0.047		0	0.029
	VAR14	Correlation	-0.058	-0.031	-0.004	.168(*)	0.159	.181(*)	.239(**)	-0.012	0.043	.188(*)	0.154	-0.114	.384(**)	1	.191(*)
		Sig. (2-tailed)	0.503	0.722	0.962	0.049	0.063	0.034	0.005	0.893	0.62	0.028	0.072	0.185	0		0.025
	VAR15	Correlation	-0.022	0.007	0.012	.170(**)	.172(**)	.187(**)	0.003	.127(**)	0.063	-0.009	.098(*)	0.003	.122(*)	.191(*)	1
		Sig. (2-tailed)	0.651	0.887	0.814	0	0	0	0.95	0.009	0.199	0.85	0.044	0.958	0.029	0.025	

* Correlation is significant at 0.05 (bilateral)
** The correlation is significant at 0.01 (bilateral)

In Figure 5, there are plotted the previously selected values for the case of significance and for the correlation coefficient by Pearson reported in the correlation matrix.

As it is shown, in the case of bilateral significance, variables VAR01, VAR02 and VAR03 do not have statistical link with the others studied variables, it is possible that its behavior were linked (or do not exist) to parameters not contemplated in this study.

From variable VAR04 to variable VAR11, there are some important significance crossings between them and also with reference to the others studied variables. Likewise, variables VAR12 to VAR15, present some significance crossings, but in this case in a form more related to the evaluation variables of Construction III, and with higher significance.

With respect to the Pearson correlation coefficients, the great majority of them (with important significance) are positive, and therefore they maintain a direct positive lineal relation among the linked variables. Previous observation is logic since the evaluative scales of the subjects and the eagerness in students of its achievement, are operating always in this sense.

It is important to call attention to the correlation maintained among the origin of the access at university (VAR15) with the observed grades obtained in the subjects (this correlations are the most noticeable of all the investigation) Therefore, deducing that prior adequate preparation of a student, before enrolling to university, is a guarantee to obtain good results and highly educational performance is obvious.

For variables of the subject Construction III, there are important significance and correlation among variables VAR05, VAR08, VAR09, VAR10 and VAR11; summarizing it, the evaluation process is coherent, continuous and uniform among them; being therefore adequate, the others evaluative variables of the subject (VAR04, VAR06 and VAR07) will be submitted to a review and an adaptation in the general context of the evaluative panorama of the subject.

For correlations of variables VAR13 and VAR14, there is a low correlation between them and variable VAR11; this is a not conclusive behaviour.

Finally, for variable VAR12, there are not indications of a significant correlative link with the others variables. Because of this, it is again verified the already commented aspects about continuous flow of students that accredit the subject in his or her first intent.

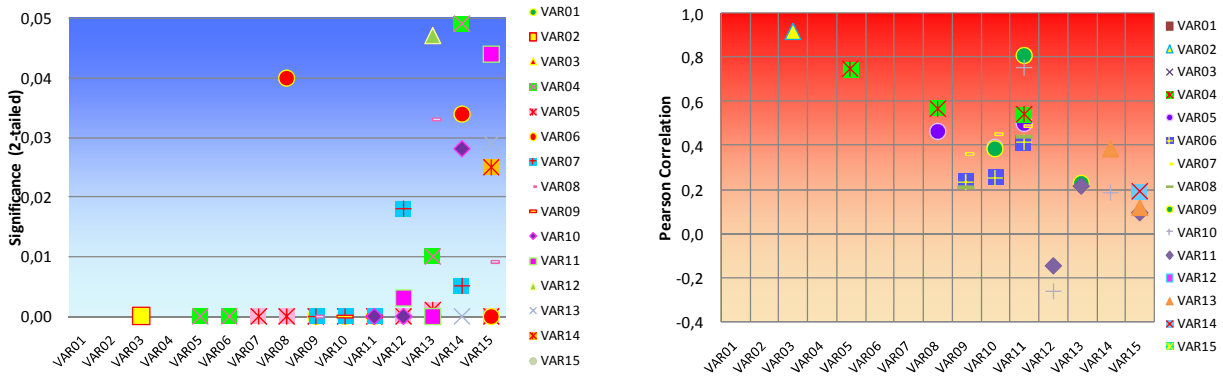

Figure 5 Graphic representation of the significance of bilateral and most representative of Pearson coefficients for the variables studied

IV CONCLUSIONS

The article particular comments are:

1. The use of alternative evaluation techniques (virtual telematic test) requires specific adaptations for its establishment inside academic subjects with more traditional evaluation systems; these adaptations should be assumed previously by professors that desire a correct system of evaluation compatible with the educational contents of their subjects.
2. The problem of the high number of students who fail, and of low historic grades obtained, in the subject Construction III, is not attributable to the rotation flow of students, neither to the possible apathy of them towards the subject. It will be necessary to develop more studies about this matter to be able to investigate the origin of these results and thus, to be able to propose methods to reduce it.
3. It will be recommendable to do a review of the contents, the educational techniques and the evaluation techniques applied to the assembly of the three subjects studied; since these subjects have related contents, and it would be convenient for students to find them coherent and cohesive.
4. The student gender, class timetable and group assigned, do not report (or at least do not detected) significant correlation among them or with the others variables. This indicates, in a very favorable form for the educational institution and professors, that they are circumstances without influence in the educational development of the student.
5. The possibility to pay more attention by the student and to improve the academic performance of him or her in the central part of the course Construction III (to catch the attention of the student or to design teaching methods that avoid that the student escape without learning them) should be studied.
6. The enrolling process to university studies is clearly a connection that will define the academic performance of a student during his or her university career. It will be correct that the educational institution establish selectivity criteria to standardize the knowledge levels, permitting thus to generalize the College

academic level and to avoid the possible failure of a student with poor prior knowledge.

The article general comments are:

1. The statistical analysis of the data generated in educational evaluations is useful to understand the behavior of variables that participate in its decision; likewise, these techniques help to take correct decisions to future actions, and permit to predict behaviors, to establish methods or techniques to reduce problems.
2. The observations of all samples have a sensitively normal distribution, linking the behavior (as a group) of the applicable variables to the teaching field with this type of distribution.
3. The analyzed data have permitted to know and to corroborate the relations of most of the variables based on initial conditions; reckoning in this way, with certainty and validity, the general behavior of the assembly of samples.
4. More investigations in this predictive and analytic teaching field are desirable, since they are productive and important for the faculty, students and the educational institution where they are accomplished.

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