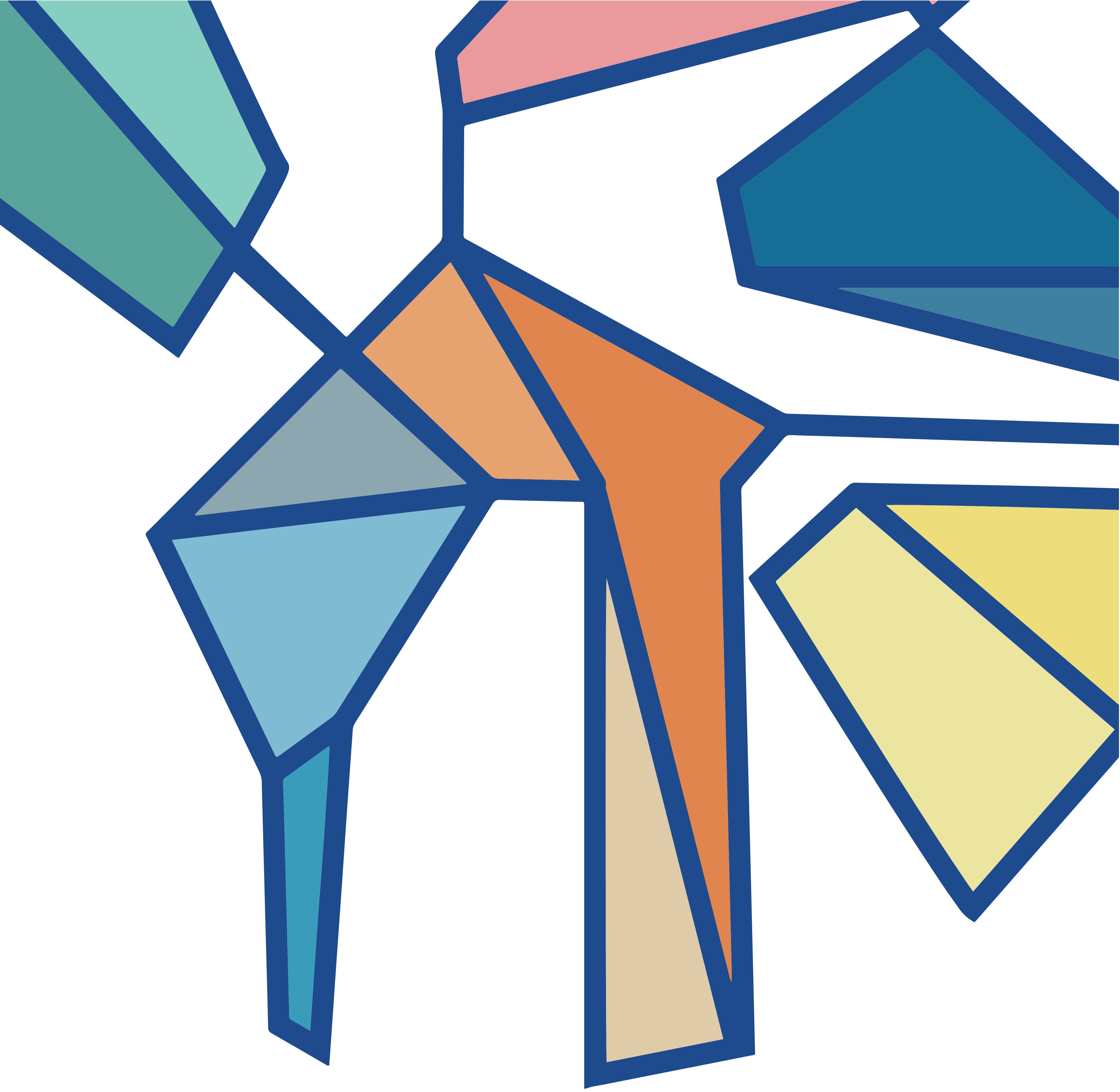

TEEM '15

Technological Ecosystems for Enhancing Multiculturality

Porto, October 7-9, 2015

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Freshman’s Perceptions in Electrical/Electronic Engineering Courses: early findings

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ABSTRACT

The present study reports early findings on freshman´s perceptions in Electrical/Electronic Engineering courses from four higher education institutions: two Portuguese (Instituto Superior de Engenharia do Porto, ISEP, and Universidade do Minho, UM) and two Brazilian (Instituto Federal de Santa Catarina, IFSC, and Universidade Regional de Blumenau, FURB).

This study was based on a questionnaire previously validated that contains two main parts: student characterization and a list of forty-four items, divided in six groups (Teacher Involvement Perception, Student Interest, Student-Teacher interaction, Course organization and functioning, Infrastructures and Overall satisfaction) classified in a 5-point agreement Likert scale: 1 (Strongly Disagree) and 5 (Strongly Agree), with the neutral point being neither disagree nor agree. The goal of the research was to look for similarities and differences regarding the course organization and functioning, students’ interest in the course, students’ findings towards teachers’ involvement and personal interaction.

In the present study only data from the first three groups of the questionnaire will be analyzed. This questionnaire was answered by a total of 257 students from the four institutions.

This is a preliminary study where only major conclusions are drawn: the results of the students´ evaluations are positive in all items analysed with a score higher than 3.0. The highest scores were obtained in two items of the factor Student Interest.

Presently the validated questionnaire has been extended to all academic years to study in the future possible differences on students´ perceptions. To assess the influence of cultural differences and identify the similarities and differences referred above it will be necessary to perform a more detailed analysis of all items/factors.

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Categories and Subject Descriptors

• *Social and professional topics~Computational science and engineering education* • *Social and professional topics~Cultural characteristics*

General Terms

Measurement, Documentation, Human Factors.

Keywords

Freshman, Electrical/Electronic Engineering Courses, Students´ Perceptions, Multiculturality.

1. INTRODUCTION

Engineering courses correspond to a significant percentage of students’ preferences when applying to higher education systems. Insights on whether these courses are meeting the first year students´ expectations have been under study [1-4].

In [1] the authors present a study performed in 2005 at the Michigan Technological University to evaluate students´ feedback/opinion regarding their first year. They attended a common first-year engineering program regardless of the major. The responses were used to assess the students’ feedback concerning the material and software used in the course, the experiences in working on a multi-disciplinary team improving the technical communication skills, and in all, their perceptions towards the time and effort spent on the course. The authors concluded that student perception of the first-year program improved from 2001 to 2004. The students in Chemical and

Electrical and Computer Engineering showed the most positive change.

[2] conducted a study on the first year of Civil Engineering at Universities of Technology in South Africa in order to explore the course content and students´ satisfaction levels. The feedback obtained from 123 students points out that generally the subject Communication Skills is the least satisfying while Mathematics is considered to be the most satisfying subject.

The transition from high school to university, especially to engineering courses, can be a challenging one [3]. In [3] the authors present some insights into the students' opinion regarding this transition (results quantified with the use of a 1-5 Likert scale). The surveys were also used to quantitatively and qualitatively evaluate the students' perceptions towards the project-based learning (PBL) model, as well as student responses to other aspects such as teamwork, open-ended problems, among others. They state that "the findings from this study can be used to improve the delivery of follow-up introductory courses and enhancement of metacognitive development".

In [4] the authors present a study (sample size of 80 respondents) conducted in the Wa Polytechnic in the upper west region of Ghana focused on the low enrolment in engineering programs. The study points out some perceptual variables and the influence of lecturers on the student's perception regarding engineering.

The use of questionnaires as an evaluation tool has been gaining significance [5-6]. Applying to other engineering academic years, surveys on the student evaluations of teaching (SETs) are a widely used metric to evaluate teacher effectiveness. The goal is not only to improve the overall performance of the course but also they are used to make promotion, tenure, and retention decisions for professors in particular and to evaluate faculty and broader academic performance.

Nevertheless, there is still space to some research. The analysis of students' perceptions about engineering courses regardless of the type of the higher education institution (Polytechnic or University) and/or nationalities (different countries and cultures) is lacking in the literature. In order to try to overcome this gap, we designed and implemented a study to find out the students' perceptions towards the Electrical/Electronic Engineering courses (from Universities and Polytechnic Institutions) in Portugal and Brazil. In this preliminary study, the survey was conducted in the 1st academic year. The goal was to identify the similarities and/or differences regarding the course organization and functioning, students' interest in the course, students' findings towards teachers' involvement and personal interaction. The overall objective is to identify patterns that could identify and guide to relevant research questions.

This article is divided in four sections besides introduction. Section 2 presents the characterization of the six courses running in the four institutions. Section 3 details the methodology followed in the study. Section 4 contains the results and their analysis and section 5 presents the final remarks.

2. COURSES CHARACTERIZATION

The study on the freshman' perceptions regarding the engineering course they are enrolled in were performed in four higher education institutions (HEIs): two Portuguese (Instituto Superior de Engenharia do Porto, ISEP, and Universidade do Minho, UM) and two Brazilian (Instituto Federal de Santa Catarina, IFSC, and Universidade Regional de Blumenau, FURB).

The questionnaires were distributed in six courses in Electrical/Electronic Engineering: two courses from ISEP and from IFSC and one course from UM and FURB.

2.1 Electrical and Computer Engineering from ISEP (ECE-ISEP)

The course on Electronics (ELTR1) is part of the 1st year/2nd semester of the course in Electrical and Computer Engineering (ECE), which has a duration of 3 academic years (6 semesters, or 180 ECTS). The course runs both with day and after work classes, and the students may opt for one or another plan. The course is structured in such a way that Math, Physics and Computer/programming-related courses are mainly delivered in the 1st year. Fundamentals of Electrical Engineering (1st semester), Circuit Theory (2nd semester), Electromagnetism (2nd semester), and Electronics (2nd semester) are the courses delivered in the 1st year that directly relate to the course core scientific area. Typically, subjects related to electrical circuits, and theory of electricity, are delivered in the three first aforementioned courses. Electronics is the 1st course where students learn about non-linear components, such as diodes, transistors and operational amplifiers. The fact students only have one course in the 1st semester that provides them with the fundamentals for analyzing the circuits studied in the Electronics course (with the additional difficulty of shifting from linear to non-linear components) is one typical reason for the relatively low success rate of this particular course. The course has 2 hours of recitation classes (T), 1 hour of classes on calculus (TP), and 2 hours of lab classes (PL).

The 2014/2015-course edition had a total of 324 enrolled students. The questionnaire was delivered to students attending day and after work classes. Typically, students enrolled in after work classes have a daytime job, although there are cases of students who work by shifts also attending day classes.

2.2 Electrical Engineering – Power Systems from ISEP (EE-PS-ISEP)

The course on Electronics (ELTRO) is part of the 1st year / 2nd semester of the course in Electrical Engineering – Power Systems (EE-PS), which has the duration of 3 academic years (6 semesters, or 180 ECTS). This course is similar to the ECE course, in particular in the 1st year, so most of the rationale presented for the ECE course applies to the EE-PS course, and hence to the Electronics course. The course has 2 hours of recitation classes (T), and 2 hours of lab classes (PL). Comparing to the Electronics course part of the ECE course, this course has no classes on calculus.

The 2014/2015-course edition had a total of 124 enrolled students. Again, the questionnaire was delivered to students attending day and after work classes.

2.3 Electrical Engineering from IFSC (EE-IFSC)

The Electrical Engineering course is based on physics, mathematics, chemistry and computer science subjects. It was created in 2012, and the first entry occurred in the first half of 2013. It comprises five years, divided into 10 semesters.

The first year courses are:

1st Semester

- Calculus A;
- General Chemistry;
- Communication and expression;

- Engineering and Sustainability;
- Analytics Geometry;
- Research Methodology;
- Introduction to Electrical Engineering;
- Integration Project I - Scientific Initiation.

2nd Semester

- Calculus B;
- Fundamentals of Physics in Mechanical;
- Linear Algebra;
- Statistics and Probability;
- Materials Science and Technology;
- Digital Electronics I;
- Complementary Training I.

2.4 Electronics Engineering from IFSC (EiE-IFSC)

The Electronic Engineering course is directed to design, implementation and maintenance of electronic systems. It was created in 2012, and the first entry occurred in the first half of 2013. It comprises five years, divided into 10 semesters.

The first year disciplines are:

1st Semester

- Calculus A;
- General Chemistry;
- Communication and Expression;
- Engineering and Sustainability;
- Linear Algebra;
- Digital Electronics I;
- Integrator Project I.

2nd Semester

- Analytics Geometry;
- Technical Drawing;
- Calculus B;
- Fundamentals of Physics in Mechanical;
- Digital Electronics II;
- Electric Circuits I.

2.5 Electrical Engineering from FURB (EE-UB)

FURB was created in 1964 by the community in the region of Blumenau (Santa Catarina State) to allow access to Higher Education. The University grew, developed, and has nowadays around 11,000 students in its undergrad and graduate courses, in the main areas of knowledge and is involved with the community and industry, in many social and scientific projects.

FURB has 4 campuses and offers language courses and laboratories, TV, Radio, hospital, gym courts, sports, social and cultural activities. The university is a public institution in essence, but the students pay a monthly fee in order to support the structure, as there is little money coming from the government. This fee is around 300 euros. It is important to note that the professors at FURB have a duty of 20h of teaching, with at least 16h "in class" and 4h of supervising activities. The other 20h can be used for research and/or administrative activities.

The Electrical Engineering Course of FURB was created in 1990 to serve a local demand, as the region concentrates many electro-mechanical related industries, such as distribution and power transformers industries. Currently it has 530 students in 11 semesters, divided into day and after work courses. Most of the students work during daytime, so they study in the after work course. In the first year of the course are offered basic training subjects such as calculus, physics, chemistry, statistics and programming. Below follows a list of subjects offered:

First semester: Linear Algebra, Differential and Integral Calculus I, General Physics I, Basic Electricity, Chemical Technology, Design Applied to Electrical Engineering, Sports Practice I and Basic Mathematics.

Second semester: Analytic Geometry, Differential and Integral Calculus II, General Physics II, Algorithms and Programming, Statistics, University Science and Research and Sports Practice II.

In the first semesters the subject "Basic Electricity" is given by a "senior" professor who has the task to show a little bit of everything in the course of Electrical Engineering, captivating the student and avoiding evasion.

2.6 Industrial Electronics Engineering and Computers from UM (IEEC-UM)

The course's main goal is to train graduates prepared to take on a professional activity in the domain of Electronics and Computers Engineering, i.e., who are able to specify, design and implement electronic systems and/or devices in several specialization areas: Automation, Control and Robotics; Electro technics and Energy Systems; Computer Technology; Micro technology and Instrumentation; Telecommunication Systems. The professionals should also be able to be integrated in the type of companies and organizations demanded by the current evolution of society, while being aware of social responsibility and work ethics.

The first year disciplines are:

1st Semester

- Calculus EE
- Circuit Analysis
- Computer Programming
- Laboratory Practicals
- Linear Algebra and Analytic Geometry
- Circuit Analysis in Alternating Current
- Complements of Computer Programming
- Digital System
- Mathematical Analysis
- Physics

2nd Semester

- Applied Mathematics
- Architecture and Computers Technology I
- Complements of Mathematical Analysis
- Applied Mathematics
- Microcontrollers
- Theory of Electricity
- Architecture and Computer Technology II
- Electronics II
- Electrical Installations
- Microprocessors
- Systems´ Theory

3. MATERIAL AND METHODS

This section presents the questionnaires developed, their validation and the methodology followed in the implementation as well as the sample characterization.

3.1 Questionnaire

The questionnaire aimed to identify and analyse the determinant factors of students' satisfaction in engineering courses.

The questionnaire was based on previous studies [7-9] with an update and contextualization of some questions to the topic under discussion.

3.1.1 Description

The questionnaire comprises two main parts: (1) student characterization (age, gender, higher education institutions, curricular year, semester, regime, number of registration in the course, and regular/working-student), (2) a list of forty-four items, divided in six groups classified in a 5-point agreement Likert scale: 1 (Strongly Disagree) and 5 (Strongly Agree), with the neutral point being neither disagree nor agree. The six groups considered allow determining the student perception regarding:

- Teacher Involvement Perception (TIP) – 8 items;
- Student Interest (SI) – 9 items;
- Student-Teacher interaction (STI) – 6 items;
- Course organization and functioning – 11 items;
- Infrastructures – 6 items;
- Overall satisfaction – 4 items.

According to the main objective of this study, only data from the first three groups (TIP, SI and STI) will be presented and discussed.

3.1.2 Methodology

The forms were printed and handed to students. The questions were applied to students of first year classes after an initial explanation of the research purposes. According to availability of the teachers and students timetable, the questionnaires were delivered at the end of one theoretical class in the 2nd semester of 2014/15 academic year. The questionnaires were answered on a voluntary basis and students took no more than 15 minutes to fulfil it.

In ISEP the same methodology was used but in three different laboratory classes by three different teachers.

3.1.3 Sample Characterization

A total of 257 questionnaires were considered valid for analysis: 12.5% from UM, 32.3% from FURB, (12.2+14.1)% from IFSC, and (6.8+22.1)% from ISEP.

The mean age is 21.2 years (SD = 5.2, range 17-55 years) and most of the students (54.9%) are aged 21 years or less.

In all HEIs the majority of students are male (UM 93.9%, FURB 91.8%, IFSC 75%, ISEP 96.1%).

Regarding classes' regime FURB and ISEP have both day and after work classes. FURB has 74.1% and ISEP has 29.7% of students in after work classes. Also, these two institutions have students with more than one registration (around 50% each).

3.1.4 Validation

The questionnaire was validated through two processes: (1) pre-assessed before the application within a group of students in order to identify any ambiguous issue and small bugs, and (2) after the collection of data evaluating the internal consistency or reliability of the instrument (Cronbach's alpha) by using the SPSS®, version 22 [10].

In order to develop the internal validation of the applied questionnaire, the sample must be representative of the population in which the instrument is to be used. Based on [11] the minimum size of the sample must be at least five times the number of items to be evaluated. In our case, a set of 257 valid answers was gathered indicating its appropriateness.

Table 1 summarizes the outcomes of the reliability analysis of the TIP, SI and STI groups' data (22 items, since the item TIP_7 was only considered in three HEIs: IFSC, FURB and UM). The values in column labelled Corrected item-total correlation represent the correlations between each item and the total score from the questionnaire. It should be noted that in a reliable scale all items should correlate with the total. So, values less than 0.3 mean that a specific item does not correlate very well with the scale and may be dropped. Considered the obtained data, all data have item-total correlations above 0.30.

The values in the column labeled Cronbach's α if item deleted are the values of the overall α if that specific item is not considered in the calculation. The overall Cronbach's α obtained is 0.89 and if any item has value of α greater than this it may be dropped from the scale to improve its readability. None of the 22 items affects the reliability if deleted. Finally, the overall Cronbach's α is above 0.8 indicating a good reliability [10].

Table 1. Internal Consistency and homogeneity analysis of the items of the questionnaire

Item	Mean	S.D.	Corrected item-total correlation	Cronbach's α if item deleted
TIP_1: In general the teachers show interest in teaching the programmatic contents	4.01	0.77	0.58	0.89
TIP_2: In general the examples used by teachers help to understand the contents	3.85	0.76	0.64	0.89
TIP_3: In general, the teachers seek to know whether the student has understood the contents taught	3.19	0.91	0.44	0.89
TIP_4: In general, the teachers aim to contextualize the contents in a professional perspective	3.57	0.87	0.51	0.89
TIP_5: In general, the teachers are available to support the students	4.04	0.82	0.49	0.89
TIP_6: In general, the teachers present challenges to be solved outside the classroom	3.75	0.92	0.33	0.89
TIP_8: In general, I assess positively teachers' performance	3.94	0.80	0.65	0.89
SI_1: I am interested in learning the contents of the course	4.48	0.65	0.59	0.89
SI_2: I attend classes regularly	4.44	0.74	0.42	0.89

SI_3: I pay attention in the classroom	4.17	0.73	0.50	0.89
SI_4: I participate in the classroom discussions	3.46	0.95	0.42	0.89
SI_5: I look for teachers outside the class	2.75	1.11	0.44	0.89
SI_6: I use the study room and library	3.71	1.13	0.37	0.89
SI_7: The course challenges me intellectually	4.30	0.72	0.45	0.89
SI_8: The course is making me more and more competent in electrical / electronic engineering area	4.35	0.78	0.50	0.89
SI_9: In general, I identify myself with the course	4.20	0.79	0.45	0.89
STI_1: The teachers encourage students to express their views and doubts	3.68	0.77	0.53	0.89
STI_2: The teachers are receptive to new ideas and different points of view	3.56	0.85	0.54	0.89
STI_3: The teachers generally encourage discussion in the classroom	3.53	0.85	0.52	0.89
STI_4: The teachers provide study materials so that students may train their skills	4.24	0.83	0.55	0.89
STI_5: The teachers assess the students accurately and with fairness	3.71	0.86	0.55	0.89
STI_6: In general, the student/teacher interaction is positive	3.89	0.72	0.68	0.88

Table 2. Summary of exploratory factor analysis results of the items of the questionnaire

Item	Rotated factor loadings		
	TIP	SI	STI
TIP_8: In general, I assess positively teachers' performance	0.80		
TIP_2: In general, the examples used by teachers help to understand the contents	0.73		
TIP_1: In general, the teachers show interest in teaching the programmatic contents	0.69		
TIP_3: In general, the teachers seek to know whether the student has understood the contents taught	0.63		
TIP_4: In general, the teachers aim to contextualize the contents in a professional perspective	0.58		
TIP_5: In general, the teachers are available to support the students	0.57		0.42
SI_1: I am interested in learning the contents of the course		0.74	
SI_2: I attend classes regularly		0.72	
SI_3: I pay attention in the classroom		0.71	
SI_8: The course is making me more and more competent in electrical / electronic engineering area	0.36	0.62	
SI_9: In general, I identify myself with the course		0.59	
SI_4: I participate in the classroom discussions		0.53	0.44
SI_7: The course challenges me intellectually	0.31	0.52	
SI_5: I look for teachers outside the class		0.41	0.38
SI_6: I use the study room and library		0.37	
STI_2: The teachers are receptive to new ideas and different points of view			0.71
STI_3: The teachers generally encourages discussion in the classroom			0.70
STI_1: The teachers encourage students to express their views and doubts	0.32		0.67
STI_6: In general, the student/teacher interaction is positive	0.51		0.54
STI_4: The teachers provide study materials so that students may train their skills			0.45
STI_5: The teachers assess the students accurately and with fairness	0.40		0.41

Total of % of variance explained	32.87	9.22	5.68
Total Eigenvalues	7.23	2.03	1.25
Cronbach's α values	0.89	0.89	0.89

In respect to analysing the internal structure of the instrument developed, a Principal Component Analysis (PCA) on the 22 items was conducted with orthogonal rotation (varimax). An initial analysis was run to obtain eigenvalues (based on Kaiser's criterion of 1) for each component in the data. Four components were found and in combination explained 53.03% of the variance. However, three components were considered based on the scree plot where the first inflection point is after three factors (sample with more than 200 participants). So, the analysis was rerun specifying to extract three factors. Three components explained 47.77% of the variance. The value of KMO=0.90 (> 0.6) indicates the sampling adequacy for the analysis [10]. Also, the Bartlett's test of sphericity $\chi^2(231)=2015.46$, $p<0.001$, indicates that correlation relations between items were sufficiently large for PCA. The three components considered follow the initial three groups of items considered: component 1 represents the TIP, component 2 SI and component 3 STI. The only exception is verified for item TIP_6: In general, the teachers present challenges to be solved outside the classroom that is not shown in the table since a factor loading below 0.3 was obtained. The final results are presented in Table 2 (factor loadings below 0.30 not displayed).

4. EARLY FINDINGS

The results of the students' satisfaction factors in electrical/electronic engineering courses based on the questionnaire developed are presented and discussed below. The SPSS statistical tool was used for the data analysis. Non-parametric tests were considered on the analysis of the primary data: χ^2 of independence, for the comparison of more than two dependent groups, and Friedman (alternative to the t-test for dependent samples) to analyze differences between students of the different higher education institutions and their perceptions. A significance level of 5% was considered.

The distributions of the answers obtained through the three factors are presented in Figure 1.

It can be observed that in all items, all the five points considered in the agreement scale were obtained: from 1 (Strongly Disagree) to 5 (Strongly Agree). However, the negative points (1, in all items, and 2, in the majority of the items) were considered as outliers showing an extreme behaviour. The majority of the students evaluate the items with score 3 or higher (Neither Disagree Nor Agree, Agree, Strongly Agree), being 4 (Agree) the median obtained except for the items TIP_3 (In general, the teachers seek to know whether the student has understood the contents taught) of the Teacher Involvement Perception, SI_5 (I look for teachers outside the class) and SI_4 (I participate in the classroom discussion) of the Students Interest group (Table 3). Notice that was also, in this group of Students Interest that the highest scores were obtained (SI_1, I am interested in learning the contents of the course and SI_2, I attend classes regularly). These results confirm that the distribution of students' score is different for the various items ($F(21)=1410.09$, $p<0.001$).

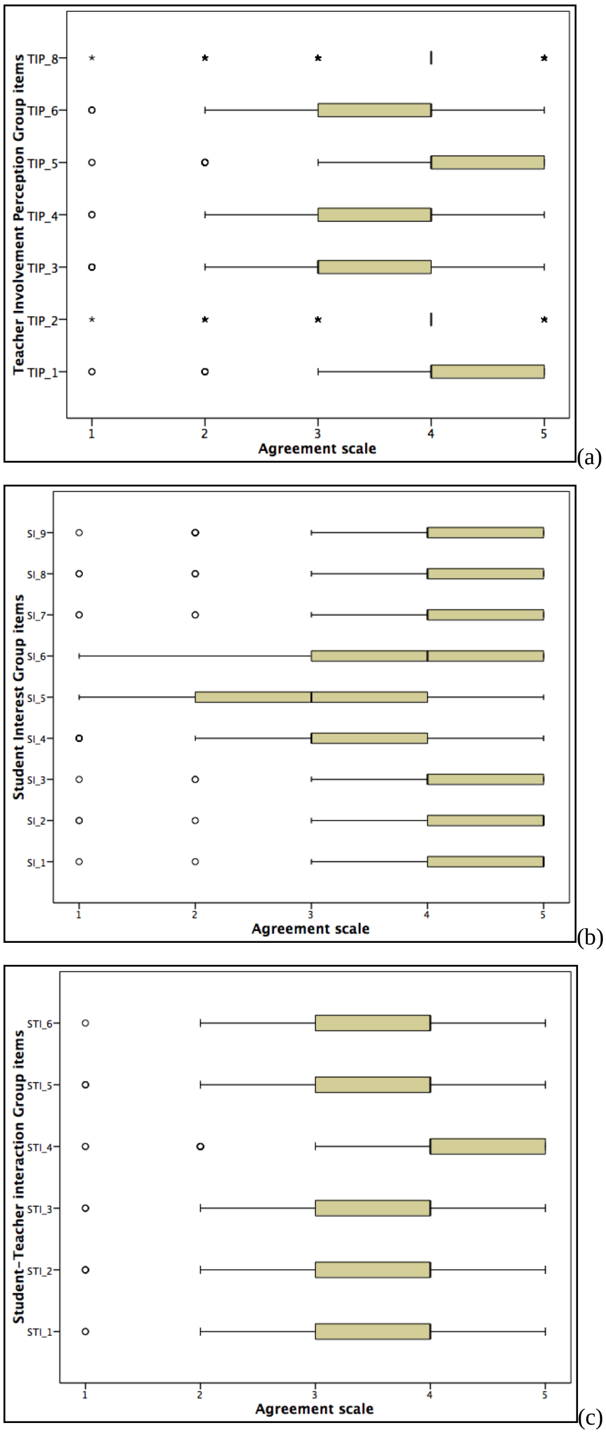

Figure 1. Students' answers distribution for the three factors: (a) TIP, (b) SI, (c) STI

When analyzing if this behavior is similar, or not, among the four HEI, SI_4 and SI_5 show similar behavior ($p>0.05$), which shows that these scores are not associated with HEI.

Notice that, for the use of this statistics test, it was necessary to recode the scale so that zero or frequencies below 5, do not occur.

5. FINAL REMARKS

This work presents early findings on freshman's perceptions in Electrical/Electronic Engineering courses conducted in four HEIs (two Portuguese - one University and one Polytechnic - and two Brazilian – one University and one Technological Institution).

Based on the internal validation of the instrument used it was possible to confirm that the items were well distributed by the factors initially identified. In this study three of those satisfaction factors were studied, namely, Teacher Involvement Perception (TIP, 8 items); Student Interest (SI, 9 items) and Student-Teacher interaction (STI, 6 items).

In this preliminary study it can be concluded that the results of the students evaluations are positive in all items (for all the considered Institutions) with a score higher than 3.0 and a median equal or higher than 4 except for the items: TIP_3 (In general, the teachers seek to know whether the student has understood the contents taught) of the Teacher Involvement Perception factor, SI_5 (I look for teachers outside the class) and SI_4 (I participate in the classroom discussions) of the Students Interest factor. The highest scores were obtained in the factor of Students Interest (a median of 5 in SI_1, I am interested in learning the contents of the course and SI_2, I attend classes regularly).

Currently, the validated questionnaire has been extended to all academic years allowing the study of the possible differences on the students' perceptions in Engineering Courses. Also, the available data will be explored in order to understand and to identify if possible differences can reflect cultural differences in the two countries using all the items/factors considered (forty four items incorporated in six factors).

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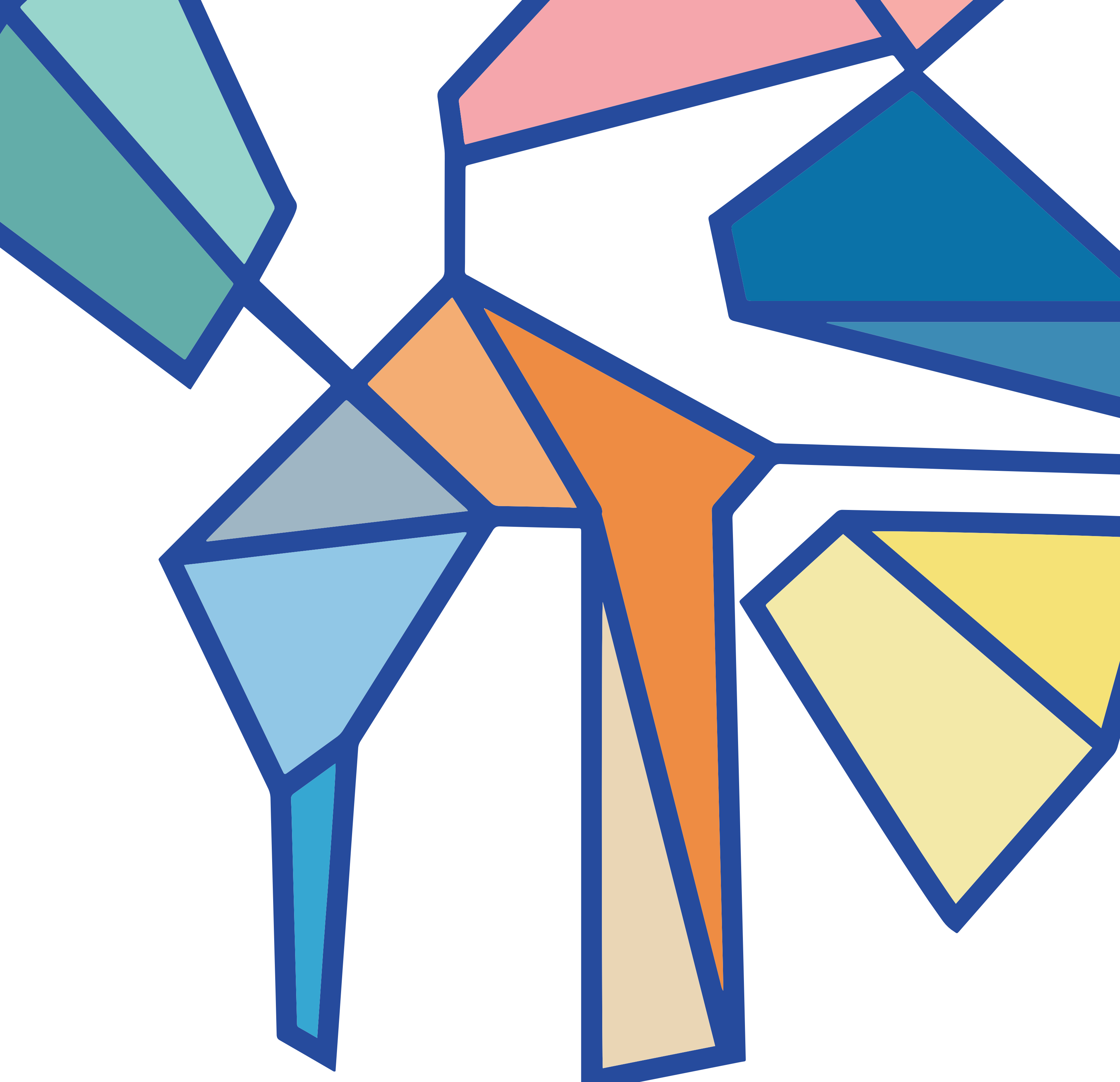

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