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**STUDENTS HAVE THEIR SAY: FACTORS INVOLVED IN STUDENTS'
PERCEPTION ON THEIR ENGINEERING DEGREE**

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ABSTRACT

Higher Education institutions strive to continuously improve to meet students' expectations. Thus, it is vital to understand the factors involved in students' perceptions on their degree and on the quality of the teaching received. Engineering degrees require specific conditions due to their complex practical lessons and the need for high applicability, and our aim is to identify what affects the quality of the teaching delivered to our engineering students.

Previous research on Higher Education focused on students' perception has been based on closed response questionnaires, which do not provide enough information. Hence, we asked students to freely make remarks, positive and/or negative on an open response questionnaire, and the qualitative analysis of their answers led to the description of a four-category figure (*Teacher, Subject, Student and Degree*) revealing students' perceptions. Open response questionnaires offer administrators valuable information, as a complement to the quantitative analysis based on closed response questionnaires.

KEYWORDS

Higher education, student perception, student experience, quality factors

1 INTRODUCTION

Measuring quality in Higher Education (HE) is extremely important both to attract and retain students, as well as to make an efficient use of all private or public funds received. In an educational context, the participants range from students or lecturers, to academic managers, or organizations, or society with varying level of interaction with and expectations from the system (Mahapatra and Khan, 2007). Although an educational set-up should satisfy the needs of all participants involved, students are at the core of HE institutions. Being the priority for HE institutions, listening to students' opinions would be the most valuable source of information for improvement and engagement (Meštrović, 2017). Considering students as the core of the system does not imply that they are always right, but that they are the most important actors in the learning process. As stated by Ortega y Gasset (2015), the aim of university can be summarized as (1) training researchers who are willing to develop new techniques and principles, (2) training professionals who know the methods and techniques of their field and (3) contributing to the personal and cultural development of society and environment. Therefore, universities cannot live isolated from their social environment and must be committed to revise their procedures and effectiveness continuously. Keeping this in mind, universities could apply continuous improvement strategies, traditionally used in other contexts such as process improvement, hence benefiting from them while their original mission remains intact.

Quality is a complex parameter to measure, since it is composed of a wide variety of factors. Among these, the perception of the actors involved (students, lecturers, administrators...) has to be considered. Therefore, students' perception is one of the factors that defines the quality of HE institutions. Students' perception is generally measured by using questionnaires in which the respondent is asked to rate numerically

the items featured. Quantitative analysis seems to be the most frequently used as it provides a wide range of objective data, which are accessible and easy to process.

Previous studies have dealt with the factors influencing the perception of HE students. However, we find that, very often, their method is limited by the use of a top-down approach as they check how students' perception fits into an existing theory of quality. Nevertheless, although this procedure allows for massive information gathering, some information (compliments, complaints, improvement suggestions...) is being left out. Thus, based on the *Grounded Theory* approach, we have studied the factors or categories, and their corresponding subcategories, resulting from students' comments based on their experience in their university degree. To this end, our information-gathering method allowed students' remarks, compliments and complaints to emerge freely, since no pre-existing coding scheme was used to interpret the data. By doing this, we gathered qualitative information about the causes for positive or negative students' perception on their engineering degree. The main aim was to check if this information will be a valuable supplement for the quantitative results obtained via surveys, and could potentially result in future actions for continuous quality improvement.

We aim to answer the following research question: *What are the factors involved in the perception of students on their engineering degree?* Hence, our research question will be answered by qualitatively studying the comments of students when being asked about any factor affecting their perception on the teaching received at their Engineering School or Faculty. This has allowed us to identify which aspects should be taken into account for continuous improvement in the degree.

2 PREVIOUS RESEARCH ON STUDENT PERCEPTION

Quality is greatly needed in HE in order to ensure the continuous improvement in HE institutions, which in turn results in gaining the confidence of the community and funding agencies, and building up trust in their graduates (Al Shafei et al., 2015). HE Institutions must keep a level of prestige as this could be considered a key factor influencing a student's decision regarding the institution where he/she would like to study (Sadeh and Garkaz, 2015). In this context, students have become more discriminating in their selection and more demanding to the universities they choose (Xiao and Wilkins, 2015). Defining quality in HE is not an easy task, primarily due to the dynamic and intangible outcomes of education. Additionally, the needs of all participants involved can differ: the student is regarded as the primary HE actor but others such as parents, employers, government and society should also be considered part of it, as well. The focus of attention for students and lecturers might be on the process of education, whereas the focus of employers might be on the outputs of HE. Accepting that different groups have different understandings of quality in HE, institutions may over-analyse whether things are being done well, but fail to assess whether the right things are being done (Van der Zee, 1990; Koch, 2003).

Different authors have reflected on the topic of quality measurement. Adee (1997) recommended several university characteristics as useful in explaining the perceived quality among students: competent teaching, the availability of staff for student consultation, library services, computer facilities, recreational activities, class sizes, level and difficulty of subject content, and student workload. Lau (2003) suggested a conceptual framework consisting of three factors based on learning, teaching and resources (Institutional Administrators, Faculty, and Students) which are considered to influence student involvement and satisfaction. Sinclair (2014) stated that the student's satisfaction is linked to improved academic performance, continued learning, the decision

to take additional classes and the recruitment of future students. In conclusion, students' perception regarding their university courses are important measures for higher education institutions (Leao et al., 2018).

Previous studies have shown research on students' opinions about the teaching received at their HE institutions (table 1), commonly using a questionnaire. This methodology poses, in our view, an important obstacle to the gathering of information, since the students are being directed as for what they have to assess and they cannot freely make remarks on any other topics.

We agree with Adams et al. (2006) when focusing attention on the need of specialised research on the principles and practices to transform curricula, making them innovative to meet the needs of present society. From a practical perspective, educating engineering students requires some particular conditions to be met, given mainly the complexity of the practical lessons and the need for high applicability of the knowledge. This is why we consider that, only by asking our engineering students, it will be possible to find out the factors they consider relevant in their degree.

3 MATERIALS AND METHODS

3.1 CONTEXT OF THE RESEARCH

This research was conducted in an Engineering School at a public university founded in 1968 in western Europe. The degree where this study was carried out has obtained different international accreditations such as EUR-ACE; 96 teachers were involved, the number of core subjects in each semester was 14, and there were 8 elective subjects in the first semester and other 10 subjects in the second one. Concerning students, 378 were

involved in this research, distributed in four different courses (90 in the first year, 79 in the second year, 81 in the third year and 128 in the final year).

Only one of the three authors of this paper is currently teaching at this Engineering School. Authors one and two in this paper were not teaching at the Engineering School where the questionnaire was delivered. They were responsible for codification and analysis of data, and literature review and proposal of categories, respectively. Author number three was the person to solve discrepancies when required, and the reviewer of global methodology. All decisions were totally agreed among the three authors.

3.2 DATA COLLECTION

A two-part open response online questionnaire was used. The first part was designed to collect the basic information about students, i.e., their academic year, age, gender; no personal data were asked for. In the second section, students were asked open questions about their courses, thus positive and negative remarks about each of the courses were gathered. Enough space was provided to allow extensive comments.

All 374 students were sent an invitation to complete the questionnaire during the months of September 2017-January 2018. In total, 131 usable responses were received from them, representing a 35 per cent return rate. 66 % of the respondents were male and 65 % were female. Concerning age, 43 students were 18 to 19 years old, 38 students were between 19-20 years old and 50 students were over 20 years old. The academic year they were enrolled was 2017/2018, along day class sessions.

Students were invited to participate and informed that in case they did not have either a positive or negative comment to make, they could simply log in and then close the questionnaire without adding anything.

3.3 DATA ANALYSIS AND DATA REDUCTION

The *Qualitative Research* approach focuses on rich descriptions of lived experiences (Walther et al., 2017), which makes it perfectly suitable for our goal. The students' answers were uploaded to Atlas.ti (2018), the qualitative research software package inspired by *Grounded Theory*, to manage and analyse all data more efficiently. The students' answers were scanned and a large number of positive and negative comments appeared. Small chunks of the texts contained in the students' answers showed identifying key words, which were extracted and then tagged into codes. Those codes were associated to concepts which were grouped and classified into categories, hence accomplishing the data reduction step. All that information has served our purpose to construct the theory of our study.

4 RESULTS AND DISCUSSION

4.1 WHICH FACTORS ARE INVOLVED IN THE STUDENTS' PERCEPTION ON THEIR DEGREE?

According to the comments provided by students, and as a result of the analysis and subsequent data reduction, four different categories have proved to have influence on the perception of our students. These categories are *Teacher*, *Subject*, *Student* and *Degree*, and will be discussed below. Figure 1 shows the results from the qualitative analysis, featuring these categories and the corresponding subcategories associated to them.

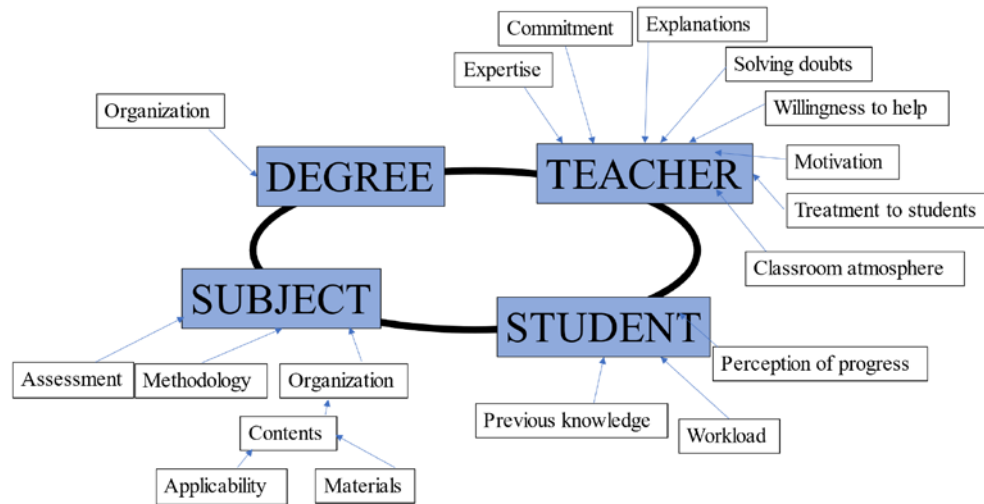


Figure 1: Factors involved in students' perception on their engineering degree

The findings of the present study are fairly aligned with those reported by previous studies, even considering the fact many of those studies were based on closed-type questions. Sinclair (2014) reported on a study where 560 business students were asked about the importance of different factors on their satisfaction. The results of this study pointed out that (1) factors relating to instructor characteristics (such as being available, having working knowledge of the subject, being committed to student learning and being passionate about the subject), and (2) methods of both instruction and grading were considered important or very important for student satisfaction. Moreover, 86% of the respondents rated student-oriented course factors (such as student's interest in the subject, perception that course subject applies to work, course in student major) as important or very important.

Despite the coincidence of relevant factors between the present study and those in which closed response questionnaires were used, it is a fact that not all students share the same thoughts about the same dimensions when asked about their engineering degree in an open way. We have observed that students talk about dimensions that they have in mind,

which, on other occasions, have not been included in other closed response questionnaires they have filled in; creativity arises and the feedback that can be obtained from the comments is surprisingly rich. Students give answers supported by comments and reasoning, thus making open response questionnaires a really valuable tool, not only for teachers but also for members of any Faculty board.

4.2 FACTORS ASSOCIATED TO *TEACHER*

According to Figure 1, students associated a number of subcategories influencing the performance of the teaching staff. In tables 2 and 3 we have listed some representative negative and positive remarks on *Teacher* performance.

Many of the teacher's positive traits arising from our analysis are coherent with those previously described by Bain (2004). Previous research has shown positive impact of good student-teacher interactions on student satisfaction. Micari and Pazos (2016) studied the satisfaction of engineering students and found that instructor connectedness, together with self-efficacy and peer alignment, predicted student satisfaction with the teacher. In a study reported by Cronje and Coll (2008), the interaction between students and their lecturers/tutors was consistently reported as important.

Students certainly appreciate the appropriate performance of their teachers, very often stating that they master their subject and give concise answers when questions arise. They also value the positive atmosphere that the teachers create in the classroom, where they feel free to pose their questions, as well as the motivation they get from the teaching staff. They also comment on the adequate pace of explanations and lectures. All these matters are usually reflected in the closed response questionnaires traditionally used to measure

students' satisfaction. Yet some other interesting remarks were made by the students and observed in our further analysis:

a) Explanations.

The fact that the teacher explains the concepts sufficiently may seem obvious and hence not significant to be taken into account. However, this may not always happen. In fact, students very remarkably appreciate sufficient explanations, and complain when they lack of them. Students' comments using adjectives as "wonderful", "superb" or "precise" concerning explanations give evidence of a factor that should be inherent to teaching, but that may not always be present: effective communication.

b) Helping attitude.

Students commented on the willingness that they found on some of their teachers, who showed themselves as extremely supportive or collaborative. In the past, it seemed that teachers were very demanding and the distance between students and themselves was too wide. Students have very much appreciated a different attitude in some teachers also showing readiness, quick response, which makes the learning process more satisfactory. Other students' comments also showed the things they do not feel comfortable with: they feel that teachers who also work as researchers or professionals for other companies may not have a helping attitude, simply because their workload is excessive and do not have much time to share with them.

c) Commitment.

Some teachers were described as deeply involved in their students' learning process. Obviously, these teachers were also described as "good teachers". The level of commitment makes the difference compared with the average teacher, and this factor has generated a lot of comments. Students have expressed the attitude they have observed in teachers really focused on the learning process, making efforts to encourage students to learn and discover. We find adjectives such as "devoted", "excellent", "fantastic". We have also observed comments related to expertise where students recognise inspiring teachers, their gift and passion for teaching, etc. Inevitably, negative remarks also appear in the analysis: a dull voice, a slow pace in the lectures, old-fashioned methodology, or even lack of respect to students may also be a negative influence on students' satisfaction.

d) Treatment to students.

Students also appreciate the way they are treated by the teacher, both in the classroom and in any other situations, and consider this as an important quality factor. There will always be students who are not satisfied with their teachers but it is interesting to observe the way students describe those teachers who really can transform the classroom atmosphere: because they are close, kind to them, do not behave with arrogance, and let students be part of the learning process, not only posing questions.

It could be noticed that some of the sub-categories included in *Teacher*, such as commitment, motivation, treatment to students and even willingness to help, have yielded a very wide range of students' comments, because they have the opportunity to give more details in an open response questionnaire than in a closed response one. Chen et al. (2008)

found that satisfaction with one's instructors contributes positively and significantly to students' confidence in their Maths and Science skills, and is negatively related to student disengagement.

4.3 FACTORS ASSOCIATED TO *SUBJECT*

Table 4 shows the most representative negative remarks on the subjects of the students, whereas the positive remarks are shown in table 5. As depicted in Figure 1, the subcategories affecting the category *Subject* are assessment, methodology, organization, contents, applicability and materials/sources.

Assessment plays an important role in the quality of learning, and has an influence on the ways in which students perceive their own learning process (Pereira et al., 2016). We need to keep in mind that the ultimate goal of Engineering Education assessment (and in fact, any type of assessment) should be supporting the student learning process (Olds et al., 2005). Therefore, assessment should be treated as an integrated component of the educational process. We observed a large number of complaints regarding the assessment of the students; there were more negative comments than positive ones. It seems that students identify perfectly well what should not be done. These entail different aspects such as the lack/inconsistency of assessment criteria, as well as the inadequate scheduling of the assessment tasks. Another factor that causes some problems is a wrong way to assess where wording may pose problems, the weight on mistakes is excessive or cheating is not controlled sufficiently (table 4). On the other hand, in the positive remarks, the assessment received has been described as adequate, well distributed and coherent, particularly when students find the contents coherent and the level of difficulty matches the demands of the subject.

Students appreciate participation in their classes and “learning by doing”. This methodology is especially advisable in engineering studies, where effective engineering skills have to be acquired (working in teams; applying scientific and engineering theory and principles; solving unstructured practical problems, and communicating with others). As pointed out by Terenzini et al. (2001) active and collaborative approaches to learning are more effective than conventional instructional methods (i.e., lectures/discussions) in helping students develop their basic engineering skills. This finding is also coherent with Cronje and Coll (2008), where students fiercely defended the retention of practical work. Concerning methodology, there are some controversial issues that arise in the students’ comments, i.e. flipped teaching sometimes makes students feel isolated with theory, having few opportunities to receive direct explanations. Their perception of the inapplicability of the subject rises as they use memory to pass their exams because of the excess of theoretical contents. On the other hand, when an innovative method breaks into the classroom, there is a significant change in the students’ attitude and causes satisfaction. They describe as “great” the visits to the companies and organizations, thus learning by getting more involved, by doing practical tasks directly related to their subjects; students enjoy a more dynamic teaching, also seen in Cronje y Coll (2008) where they express preference for a more interactive learning community, which is also consistent with the literature (Buntting et al. 2006; Dalgety and Coll 2006; Dalgety et al. 2001, 2003). Moreover, from the students’ perspective, interactive practical classes seem to facilitate the learning of practical science and engineering skills (as supported by Nakleh et al., 2002).

The organization of the subject is also present in students’ answers in a closed response questionnaire but probably will not include many details that seem relevant for them, for

instance, the fact that there are too many teachers involved in the subject, practice groups are crowded, or even the lack of problem solving sessions.

As knowledge rapidly expands in some engineering fields, the debate raises on what contents to include or leave out of engineering studies curricula (Cheville et al., 2019). In fact, the amount of content deemed necessary for graduates of engineering degree programs has steadily increased over the last decades (Bourne et al., 2005). Many of the students' complaints about contents were associated to the excess of theoretical concepts, which in some cases were not interesting enough for their professional future. Not many students found contents well-designed or essential.

Students appreciate the applicability of their courses, while also complain about their lack. As found by Concannon et al. (2019), the absence of clear connections poor applicability of the courses) is one of the main factors causing attrition in undergraduate engineering students.

In general terms, they can show to what extent they agree or not with the applicability of their subjects in terms of usefulness or relation with real life, but in the case of an open response questionnaire, they can express many more opinions, i.e., comments about the challenge of certain activities, or about how meaningful the subject is for their future job. They feel grateful to teachers who prepare stimulating projects and bring real life to class; they feel prepared to enter the professional world and the vision oriented to their future professional life offered by their teachers is welcome.

The Internet provides unique capabilities for multimedia, interactive, collaborative, and distance learning, and engineering education would benefit from appropriate

implementation of such capabilities (Paterson, 1999). Teachers should try to use all these materials and sources available and leave aside the static presentation slides as the only suitable tool. Engineering students need to have an extensive view of practical cases and real life materials in their subjects, which make them feel satisfied with the tools they have been given to learn. Materials and sources are vital for the learning process and for our present engineering students, as the role of teachers is changing and the learning process is becoming more and more autonomous.

The most controversial issues arise when talking about assessment and organization. On the other hand, it seems obvious that the level of satisfaction with the subjects is deeply influenced by the methodology used with the students, and innovation is appreciated as students' comments reveal. Another component that contributes to success is the applicability that students perceive, which is one of the most relevant elements that help to define their level of satisfaction with the product they receive.

4.4 FACTORS ASSOCIATED TO *STUDENT*

Students consider themselves as a factor influencing on their own satisfaction (tables 6 and 7). According to their comments, in order to feel satisfied, students need to meet three requirements, namely (a) have sufficient previous knowledge, (b) have an adequate workload and (c) perceive their own learning process.

Among the factors depending of *Student*, the lack of basic knowledge from high school is one of the most important causing engineering student dropout (Salas-Morera et al., 2019). In their study about retention of engineering undergraduates, Hall et al. (2015) pointed out that 'high school academic performance and conscientiousness were also significant predictors'. As we can see from their comments, students recognise their poor

entrance level in engineering studies, and this affects their general satisfaction as it makes it difficult for them to follow the subject adequately, whereas having enough background knowledge is appreciated.

An excessive workload has also been pointed out as one of the main factors causing engineering students dropout (Salas-Morera et al., 2019). It could be hypothesised that either students plan too optimistically their schedule, either they lack the information to do it adequately, which results in an excessive workload causing overwhelming stress and bad academic results. Meyer and Marx (2014) pointed out that being unaware of the amount of work required by engineering courses, students may mistakenly sign up for more credits than they are capable of completing. This is probably caused by misconceptions about the branch they have chosen to take before starting their engineering studies. This problem could be solved by giving students a clear idea about the difficulty level and workload of each class, in such way that they will be able to decide appropriately how to spread course loads across semesters. Advising may help students interested in engineering determine what types of courses to pursue and how much they might be able to handle (Cruz and Kellam, 2018).

On the other hand, there is a positive point of view, i.e., students only accept a reasonable workload when they have the perception that the subject is demanding, but it is of a great contribution for their formation. Hence, they feel satisfied and they have the idea that they can handle the subject easily.

4.5 FACTORS ASSOCIATED TO *DEGREE*

Tables 8 and 9 show the subcategories and outstanding remarks on the category *Degree*.

Even though students were asked about positive and negative remarks on each of their subjects, some comments about the organization of the degree arose. Most of them dealt with the lack of applicability of some of the subjects and others showed complaint about a certain number of filler subjects with little or no connection with their degree.

However, examples of positive remarks are found when students recognise a clear relation between the subjects included in their degree and their applicability for their professional future, which is what most of them look for when they choose their degree.

Future comments of this nature could enhance a number of initiatives and improvement actions, which would be led on a short term by the members of the administration board. This type of observations made by the students never appears in a closed response questionnaire.

4.6 SOME ADDITIONAL REMARKS

Having commented in this paper on the four categories proposed, some additional remarks on the process and findings should be made.

Firstly, we have offered a representative and balanced view of comments, including both the negative and the positive factors involved in the students' perception on their engineering degree, in all four categories, but it has been observed that there has been a large number of negative comments in the category *Subject* and many more positive comments in the category *Teacher*.

The bottom-up approach provided rich in-depth and detailed information about students' perception. Having the opportunity to openly comment on any matter they consider

relevant, students delivered surprising unexpected sincere comments that would have been neither expressed nor rated in a closed response questionnaire.

As we coded and processed the data, we noticed that the same cause could trigger both negative and positive comments in some cases, depending on the student asked. For instance, a teacher being described as “highly demanding” could be considered both a positive and a negative matter. This leads to an interesting reflection about the approach of our study (and in fact any study on how the students perform) and that is the importance of the diversity of students, which is reflected in the diversity of the comments that they generate. This is probably linked to the diversity of personality traits and learning styles that students show. Chen et al. (2019) confirmed the important role of general personality traits on the academic performance of engineering students. As stated by Felder et al. (2002), students with different type preferences tend to respond differently to different modes of instruction: for instance, whereas extrovert students prefer to work in settings that provide for activity and group work, the introvert ones like settings that provide opportunities for internal processing.

Very often, the response of the students was literally “*nothing*”. This can be interpreted in different ways. On the one hand, it could be deduced that these students have no comments to make, and hence everything is adequate from their point of view. On the other hand, it could be inferred that students giving no answer, neither positive nor negative, do not have anything significant to comment.

5 CONCLUSIONS

The research question “*What are the factors involved in the perception of students on their engineering degree?*” has been answered in this study; students have offered their own vision.

Students showed satisfaction with the commitment and motivation of the *Teacher*, while being extremely precise about the bad delivery of explanations and lessons along the course, and their disapproval with this situation. On the positive side of *Subject*, students put their emphasis on their satisfaction with an innovative methodology, applicability of the subject and the materials and sources used. On the negative side, for instance, there was much detail in the description of the assessment procedures, which is also directly related to the organization and the contents of the subject. A surprising element that appeared in the students’ comments is their perception of progress, within the category *Student*. They consider themselves a factor to be taken into consideration and express their satisfaction when both the subjects taken and the design of their degree, fulfil their expectations: they feel they are making progress and that they are taking steps in the right direction. When considering the category *Degree*, students mostly mention the subjects or contents they do not consider applicable or necessary, providing enough details to support their comments.

The negative comments of the students provide enough information to consider the improvement actions that should be done, whereas the positive comments describe the reasons why they are satisfied. Moreover, thanks to the students’ answers in an open response questionnaire we have been able to analyse their personal view on their engineering degree supported by their own reflection and comments. With a closed

response questionnaire a large amount of significant information would be missing and random answers could have been used on purpose, thus providing incoherent results.

It is also necessary to consider, from our point of view, the use that teachers, Departments and administration boards can make of the comments made by students in an open response questionnaire. It is not only a matter of how detailed the information they give us will be, nor the reasons why things may happen or how, but the actions that can be carried out after the analysis of students' comments.

The applicability of open response questionnaires delivered to students can provide us with a large list of evidences, i.e., the fact that teachers can receive a congratulation letter from the administration board, with their support for their achievements; the detection of new generational models that show the changes in a developing society, which have to be taken into account when designing university curricula; the evidence that updated contents need to be implemented and included in the new teaching guides; the detection of subjects that may overlap their contents with other subjects; the tracking of teaching proposals aligned with the demands from students and the needs of employers.

Additionally, we have observed a more and more frequent concern for promotion among HE teachers, where the presence of good practice or good teaching in their academic role is a crucial factor, so evidences need to be revealed. Hence, contrast of information from different sources is necessary, and open response questionnaires have proved to be a valuable and reliable tool to complement the information gathered from closed response questionnaires.

6 LIMITATIONS AND FUTURE RESEARCH

The primary limitation of this study is that it has been carried out with data collected in one university. We should then point out that the conclusions reached should not be considered as generalizable in terms of the demographic, gender or ethnic backgrounds of students. Replication in different contexts is therefore proposed as future research.

Another limitation is the fact that the students' response and comments were stated in their mother tongue (Spanish). Once the analysis was finished completely, a number of quotations were selected for our corresponding tables and translated into English, which may imply a little loss of meaning when compared to the original ones. However, it should be pointed out that the loss of meaning takes place in the reporting of the results in this paper, not in the analysis.

Another limitation in our research has been the number of students who have not participated in the survey. Our conclusion on those students could be that they are leaving a "blank space" because of apathy, or because there is such a large number of surveys to be filled in that they skip some of them. In a future research, our job could be to improve the details included in the invitation to the open questionnaire so that they could observe the significance of participation.

Previous studies reported on the impact of strong relationships with peers on the perceived satisfaction of engineering studies (Flynn et al., 2016; Micari and Pazos, 2016). In the present study, students were not asked about their university life or academic environment, thus, any matter concerning installations, for example, is not included in their response. Our aim with this paper has never been a global service quality enquiry. In further questionnaires, this topic could be taken into account and included to check the

influence of installations, infrastructures and services offered, on their learning process and their level of interaction with their peers.

Additionally, it could be of relevance to introduce a couple of items in future open response questionnaires on: proposals for improvement and the students' level of involvement in the subject. That could provide, for future curricula revisions, relevant information on students' expectations and quality factors, thus future research would become richer.

As stated in the introduction, Quality in Higher Education affects different actors, among which the student is considered the primary one. For this reason, students' perception has been the focus of this study, whereas the perspective of other interested parties could be considered in future research. Hence, we consider the delivery of this type of questionnaire to teachers or even members of the administration board in the future, as they also have a say being actors in HE.

Qualitative research is typically context-specific and not generalizable to broader populations (Kellam and Cirell, 2018). Hence, the findings reported here should be treated with caution. As previously stated (Akareem and Hossain, 2016), the students' perception of HE quality is heavily influenced by the university they study at. The environment created by HE institutions has an influence on the students' perception of quality in such way that students studying in so-called "high quality universities" generally have a higher level of perception (or expectation) of education quality. Therefore, this model is valid in the context of our study and time frame, and it should be periodically revised since Engineering Education is involved in a constant change.

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BLINDED FOR PEER REVIEW

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TABLES

Table 1: Previous Studies on Higher Education Students' Satisfaction since 2004

Reference	Area	Tool	Context
Leao et al. (2018)	Engineering	A 44 item questionnaire on six areas. Likert scale	Two universities from Portugal and two from Brazil
Sinclair (2014)	Business	A closed survey using items previously identified as relevant	A public university in the Southeast region of the United States
Tasirin et al. (2015)	Engineering	A closed questionnaire based on 5-point Likert scale of SERVQUAL instrument	Universiti Kebangsaan Malaysia (UKM).
DeShields et al. (2005)	Business	A modified version of the questionnaire developed by Keaveney and Young	A state university in South Central Pennsylvania.
Alves and Raposo (2007)	Various scientific areas	A questionnaire subdivided in 7 parts: Sample Characterization, Expectations, Quality of service, Value, Global satisfaction, Loyalty and Word of Mouth actions	Portuguese state universities

Gruber et al. (2010)	Education	A questionnaire to measure 15 dimensions of student satisfaction at an institutional level covering most aspects of student life	A University of Education in Germany
Wilkins and Stephens Balakrishnan (2013)	Marketing	A questionnaire developed by the authors, which consisted of 49 items relating to student perceptions, experience or satisfaction.	International Branch campuses in the United Arab Emirates (UAE).
Mai (2005)	Business	A questionnaire to quantify the perceptions, measured against the expectations of the service, based on the framework of SERVQUAL	US and UK postgraduate Business school students
Aldemir and Gülcan (2004)	Business	A questionnaire of 63 questions prepared by the authors	The Faculty of Business which was established in 1992 at Dokuz Eylül University, Izmir, Turkey.

Douglas et al. (2015)	Business	Asking individual students to focus on those service encounters that had been particularly satisfying or dissatisfying from their point of view (critical incident technique)	Undergraduate students across two north-west university Business schools in the UK
Soni and Govender (2017)	Random sample of students	A structured questionnaire based on the popular SERVPERF measuring scale	A large South African institution
Napitupulu et al. (2018)	Computer Science	A survey-based questionnaire that measures perception and expectation.	Blinded
Martinez-Caro and Campuzano-Bollarín (2011)	Engineering	A survey filled in by the students	Graduate and postgraduate students enrolled in the Universidad Politécnica de Cartagena (Spain)
Faganel (2010)	Business	A SERVQUAL based survey in the HE sector	Students and professors of Slovenian business school

Akareem and Hossain (2016)	-	A two part traditional survey containing closed-ended questions	Five top private universities of Bangladesh
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Table 2: Subcategories and negative comments associated to *Teacher*

1_EXPERTISE	<ul style="list-style-type: none"> • Lack of mastery and expertise • Lack of preparation 	<p>“On some occasions, it seemed that the teacher did not know what to do”</p> <p>“We have the impression, sometimes, that teachers do not master the subject”</p> <p>“The teacher has not prepared the session sufficiently”</p>
2_COMMITMENT	<ul style="list-style-type: none"> • Lack of commitment • Lack of punctuality 	<p>“The teacher does not show any interest”</p> <p>“The teacher neither comes to classes nor to exams on time”</p>
3_EXPLANATIONS	<ul style="list-style-type: none"> • Incomplete / shallow / quick / incoherent / repeated • Lack of explanations • Lack of clarification • Lack of real / practical cases 	<p>“I think it would be necessary to have key concepts clear”</p> <p>“Explanations are a bit shallow”</p> <p>“Explanations are quick and do not solve our doubts”</p> <p>“Sometimes, explanations were incoherent”</p> <p>“Concepts have not been explained in depth; only videos have been used”</p> <p>“Most students who have passed the subject have had to attend additional private classes”</p> <p>“I miss real projects, being carried out nowadays”</p>

4_SOLVING DOUBTS	“Teachers try to help the students but they do not master the subject and do not solve doubts correctly on many occasions”
<ul style="list-style-type: none"> • Inefficiency in solving doubts • Difficulty 	<p>“It is difficult to understand the sessions and the exams”</p>
<hr/>	
5_WILLINGNESS TO HELP	“The teacher refused to review my exam”
<ul style="list-style-type: none"> • Refusal to review work • Unavailability • Highest demands • Excessive minimum requirements 	<p>“Due to the teacher’s excessive workload in his private profession, there is no opportunity to have tutorial sessions”</p> <p>“The teacher is extremely demanding”</p> <p>“The minimum requirements are too high and teachers are not likely to help”</p>
<hr/>	
6_MOTIVATION	“Sessions were held without any motivation at all”
<ul style="list-style-type: none"> • Lack of motivation • Indifference 	<p>“The teacher does not make any effort to get the students’ attention”</p>
<hr/>	
7_TREATMENT TO STUDENTS	“The teacher neither convinces anybody nor transmits anything”
<ul style="list-style-type: none"> • Lack of affinity with students • Archaic behaviour • Injustice, strictness, favouritism, arrogance, shouting 	<p>“Teachers are old-fashioned”</p> <p>“The teacher’s behaviour is too strict”</p> <p>“Behaves with arrogance”</p> <p>“The teacher kept on shouting at us about our mistakes instead of correcting them”</p> <p>“Sometimes, the teacher shows favouritism”</p>

8_CLASSROOM	“I expected more dynamic sessions, with debates
ATMOSPHERE	and practice”
<ul style="list-style-type: none"> • Unlively sessions • Lack of interaction with students • Boredom 	<p>“The teacher did not allow students to participate”</p> <p>“The teacher does not make the subject attractive for us, should not use a dull voice and should try to keep students awake”</p>

Table 3: Subcategories and positive comments associated to *Teacher*

1_EXPERTISE	“The teacher is brilliant”
<ul style="list-style-type: none"> • Abilities • Expertise • Mastery 	<p>“The teacher is inspiring”</p> <p>“The teacher has got a real ability to transmit knowledge”</p> <p>“The teacher shows an enormous gift for teaching and is a specialist in the subject”</p> <p>“The teacher absolutely masters the subject”</p>
2_COMMITMENT	“I have discovered the teachers’ interest and respect for all
<ul style="list-style-type: none"> • Interest • Focus on learning • Effort • Involvement 	<p>students’ learning circumstances”</p> <p>“My congratulations to the teacher for an excellent job. The teacher is focused on the students’ efficient learning”</p> <p>“I would like to offer my congratulations to the teacher. The teacher is committed to students and works hard”</p>

“The best teacher we have ever had (this is what we all think). The teacher really cares about us”

“Very dedicated teacher. Fantastic”

3_EXPLANATIONS “Explanations are superb”

- Detail “Detailed explanations with additional materials for a better understanding”
- Clarity
- Accuracy “Explanations are very clear and precise”
- Correctness “The teacher’s explanations are wonderful”
- High satisfaction “The way the teacher explained concepts attracted our interest”

“Best teacher so far. Very good explanations”

“I would like to offer my congratulations to the teacher for all explanations. The teacher is so good at explaining concepts”

4_SOLVING “The teacher showed readiness to solve any doubt”

DOUBTS “Answers have been given to all types of doubts”

- Ability
- Clarification
- Efficiency

5_WILLINGNESS “The teacher has really helped me to learn”

TO HELP “The teacher was always ready to give us all help”

- Real help “Teachers at the Lab are very collaborative and try to help all time”
 - Readiness
 - Collaboration
-

<ul style="list-style-type: none"> • Response 	<p>“Quick response to emails, doubts solved in all tutorial sessions”</p>
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<p>6_MOTIVATION</p> <ul style="list-style-type: none"> • Interest • Encouragement • Passion for teaching • Involvement 	<p>“Very devoted teacher”</p> <p>”Motivation to teaching”</p> <p>“It is obvious the teacher loves the subject”</p> <p>“My congratulations to the teachers for their involvement, effort, kindness and willingness to teach at any time”</p>
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<p>7_TREATMENT TO STUDENTS</p> <ul style="list-style-type: none"> • Kindness • Support • Availability 	<p>“The teacher is very kind to students”</p> <p>“Thank you for your constant support”</p> <p>“Teachers show sincere readiness”</p> <p>“Charming teacher”</p> <p>“Exceptional teacher, both from the academic and personal point of view”</p> <p>“Great professionals. Not only interested in teaching but also in students’ progress in their Degree. It is much appreciated!”</p>
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<p>8_CLASSROOM ATMOSPHERE</p> <ul style="list-style-type: none"> • General satisfaction 	<p>“Very good classroom atmosphere”</p> <p>“The teacher is very close to us”</p> <p>“The teacher transmits good vibrations”</p>
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Table 4: Subcategories and negative comments associated to *Subject*

1_ASSESSMENT	
• Lack of assessment criteria	“Assessment criteria were not provided to the students”
• Incoherent assessment criteria	“There was an excessive weight on mistakes in the exams”
• Inconsistency between contents and assessment	“Learning contents are not related with the contents of the exams”
• Insufficient assessment tasks	“A single test as an only assessment tool is insufficient”
• Inadequate scheduling of assessment tasks along the learning process	“The Practice Test should be done immediately after the practice sessions, not after two months”
• Incoherent tasks	“We cannot program with EXCEL without a previous practice”
• Ambiguous wording	“There are too many ambiguous questions in the exams”
• Excessive requirements	“The content of the exams shows a higher level than the contents of the course”
• Wrong assessment	“Continuous assessment is not correctly implemented”
• Obstacles	“Exams are difficult even if you study hard; it seems that teachers want to challenge us”
• Lack of control in the assessment room	“Cheating should be controlled more strictly”

2_METHODODOLOGY	“I have not enjoyed this methodology: the teacher did not explain anything and only solved some doubts”
<ul style="list-style-type: none"> • Clear separation between methodology and learning 	
<ul style="list-style-type: none"> • Obsolete methodology 	“Computers should be used more frequently”
<ul style="list-style-type: none"> • Use of memory 	“There was an excess of theory to memorise”
<ul style="list-style-type: none"> • Incoherent activities 	“Simply having speakers does not contribute to learning”
<ul style="list-style-type: none"> • Unperformed scheduled tasks 	
<ul style="list-style-type: none"> • Unassessed activities and assignments 	“We hardly practised some scheduled tasks and our learning was weak”
<ul style="list-style-type: none"> • Disorganised lectures 	“Some assignments were never assessed nor given back to us”
<ul style="list-style-type: none"> • Use of videos without explanations 	“The teaching of the subject has been chaotic”
<ul style="list-style-type: none"> • Insufficient assessment tasks 	“Flipped teaching by using only videos is not enough to learn”
<ul style="list-style-type: none"> • Luck 	“There has been just one exam”
<ul style="list-style-type: none"> • Perception of inapplicability 	“You need some luck to pass the subject”
<ul style="list-style-type: none"> • Low students participation 	“The methodology used is not productive, we do not learn anything”
	“I have studied the subject simply by using my memory”
<hr/>	
3_ORGANIZATION	“Practical sessions are not coordinated with theory”
<ul style="list-style-type: none"> • Lack of coordination between Theory and Practice 	

-
- Disorganised planning “Contents are not well distributed as most of
 - Disorganised weight assigned to activities them were included in the first assessment section”
 - Intermittent changes in Lecturers “The weight assigned to some contents is not well balanced”
 - High number of students in Practice Sessions “There are too many teachers in the subject, they have been changing all the time”
 - Insufficient practical sessions “The Practice groups are crowded with
 - Chaotic sessions students and it is difficult to learn anything”
 - Unnecessary activities “More Practice sessions are needed”
 - Chaotic contents in sessions “The learning plan varies frequently”
 - Slow pace in sessions “Too many assignments but a small number of problem solving sessions”
- “Contents are neither well-structured nor organised”
- “The pace was extremely low”

4_CONTENTS

- Unnecessary contents “Programming in EXCEL is unnecessary, as there are other programs which are more interesting”
 - Uninteresting contents
 - Ambiguous contents “The content of the subject is not interesting for any of us”
 - Excess of contents
 - Too much emphasis on theory “Some contents required are ambiguous and we will never use them”
- “There are too many contents”
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- Inconsistency between contents and planning of the course
“There has been too much weight assigned to Theory”
 - Need of external support classes
“Taking into account the number of hours assigned to the subject, there is an excessive amount of Theory”
“Many students need to look for external additional classes”

5_APPLICABILITY

- Unrealistic subject
“It is useless to have sessions with contents we will never need in real life”
- Detachment of real life
“We miss issues oriented to our future profession”
- Perception of useless subject
- Unnecessary contents
“It seems that we will not use anything we have learnt”
- Useless learning
“We cannot find the aim of many of these contents in our Degree”
“I can’t see how I will implement in my future job the things I have learnt”

6_MATERIALS AND SOURCES

- Insufficient materials
“Slides had no text and there were no other materials to consult”
 - Useless slides
“Slides contain exactly the same information as those in the book”
 - Bad slides
“PowerPoint slides are awful”
 - Lack of additional materials
“Materials and resources for study are really scarce”
-

Table 5: Subcategories and positive comments associated to *Subject*

1_ASSESSMENT	<ul style="list-style-type: none"> • Consistency between contents and assessment • Adequate scheduling of assessment tasks • Sections • Satisfaction • Number of assessment tasks • Level • Requirements 	<p>“The contents of the exams are coherent and meet the contents of the subject”</p> <p>“Assessment is perfectly well distributed along the subject”</p> <p>“The weight of the different sections in the assessment tasks corresponds to the time and effort dedicated to them during the sessions”</p> <p>“The assessment procedure is excellent”</p> <p>“There are sufficient assessment tasks”</p> <p>“Exams are not so difficult”</p> <p>“The exams have an adequate level”</p>
2_METHODOLOGY	<ul style="list-style-type: none"> • Method • Learning “by doing” • Practical sessions • Theoretical sessions: interest, fun, dynamic activities • Usefulness of theoretical sessions • Participation • Involvement 	<p>“Modern methodology”</p> <p>“The methodology used in the subject should be implemented onto other Degrees”</p> <p>“We have learnt by doing, with practice and real cases brought to the classroom”</p> <p>“Visits to companies and organizations have been great”</p> <p>“The activities done in the classroom have been useful and really interesting”</p> <p>“The subject has been practical and very dynamic”</p> <p>“Practical sessions are realistic and very well designed”</p>

“Practical sessions have proved to be productive and students’ participation has increased”

“Classroom sessions are attractive for students and the teacher keeps us awake”

“The teacher stimulates participation”

“This methodology makes us learn”

“The teacher has made attendance to classroom sessions extremely worthwhile”

“The classes have made me get involved in the subject. In the beginning, I was not at all interested”

“I want to have this teacher again”

3_ORGANIZATION

- Structure

“The syllabus is well structured and designed”

- Design

“The schedule and time required have been planned correctly”

- Schedule

“Contents are very well distributed”

- Planning

“There is a good coordination between theory and practice”

- Distribution

“The syllabus is really organised”

- Coordination between

Theory and Practice

“Theory and Practice sessions keep the balance”

- Pace

“The pace of the teaching has been excellent”

4_CONTENTS

- Interest

“The content of the subject is interesting for many of us”

- Adequacy

“The contents are well-defined and adequate”

- Variety

“There is a wide variety of contents”

-
- Necessary “The contents required are important for our professional future”
 - Useful
 - Sufficient “The contents we have received are essential”
 - Unnecessary contents “The contents are a bit demanding but coherent to meet the requirements of the subject”
“Many of the contents of the subject are really applicable”

5_APPLICABILITY

- Challenge “Challenging”
 - Usefulness “The subject is useful and interesting”
 - Relation with professional future “Applicable to real life”
 - Real life brought into teaching “The subject has been meaningful and full of logic”
 - High satisfaction “Subject oriented towards our profession”
 - Interest “Visits to organizations and speakers have been great”
“I feel I am better prepared to enter the professional world”
“My congratulations to teachers, who give us a broader vision and bring real life to the class”
“The formation on how to prepare a project will be extremely useful for our future”
“The teacher has stimulated our interest in the subject”
“I will implement the things I have learnt in my future job”
-

6_MATERIALS AND SOURCES	“All materials are well organised at PoliformaT”
• Accessible	“Additional resources are extremely useful to
• Organised	pass the subject”
• Useful	“Materials from practical cases have proved to
• Documents from	be vital”
real/practical cases	“Good materials provided by the teachers”
• Sufficient materials	“PowerPoint presentations are really clear”
• Good slides	“Materials and resources for study are available
	at PoliformaT”

Table 6: Subcategories and negative comments associated to *Student*

1_BACKGROUND KNOWLEDGE	“The lack of previous knowledge makes it
• Lack of previous knowledge	difficult for us to follow the subject”
or background	
2_WORKLOAD	“It is impossible to be up-to-date. A lot of
• Students’ excessive workload	extra time is needed”
	“It has been really a workload”
3_PERCEPTION OF PROGRESS	“I passed the exam but I did not understand
• Perception of failure in	what we were doing”
learning	“I think I have not learnt anything”
• Perception of waste of time	“On occasions, I think we could say it is a
	waste of time”

Table 7: Subcategories and positive comments associated to *Student*

1_BACKGROUND	“No problems with background knowledge”
KNOWLEDGE	“Subjects easy to handle”
<ul style="list-style-type: none"> • No problems shown 	
2_WORKLOAD	“It has been demanding but corresponds to the requirements and level of the subject. Absolutely excellent teacher!”
<ul style="list-style-type: none"> • High but necessary demands 	
3_PERCEPTION OF PROGRESS	“There is plenty of information and we learn a lot”
<ul style="list-style-type: none"> • Satisfaction • Positive perception 	<p>“A great contribution to improve our formation”</p> <p>“Absolutely satisfied”</p> <p>“It is incredible. The best progress in a long time”</p> <p>“Most of us are really satisfied and we have learnt a lot more than in any other subject”</p> <p>“The subject has brought a great deal to me”</p>

Table 8: Subcategories and negative comments associated to *Degree*

DESIGN AND CONTENTS OF THE DEGREE	“There are unnecessary subjects overlapping really important ones”
<ul style="list-style-type: none"> • Overlapping with relevant subjects 	“Some subjects should be redesigned, as they are not productive and useless”
<ul style="list-style-type: none"> • Unnecessary subjects 	“It seems that we have useless “filler” subjects to meet the requirements of the
<ul style="list-style-type: none"> • Poorly designed subjects 	total number of credits in our Degree”
<ul style="list-style-type: none"> • Subjects with imbalance in weight and applicability 	“There are a large number of subjects with theoretical contents closely related to
<ul style="list-style-type: none"> • Too many Subjects from the Physics field 	Physics, which we consider unnecessary”
<ul style="list-style-type: none"> • Subjects with minor importance 	“Too many students per group in the Practice Sessions”
<ul style="list-style-type: none"> • Too many students per group in Practice Sessions 	“Too many credits in subjects with little or no impact for our professional future”

Table 9: Subcategories and positive comments associated to *Degree*

DESIGN AND CONTENTS OF THE DEGREE	“Subject deeply connected to our Degree”
<ul style="list-style-type: none"> • Relevant subjects 	“One of the most important subjects in our Degree”
<ul style="list-style-type: none"> • Necessary subjects 	“I think the subject is absolutely necessary in our Degree”
<ul style="list-style-type: none"> • Subjects with great applicability 	“It is a very important subject in the syllabus”

FIGURES

- Figure 1 Factors involved in students' perception on their engineering degree
(figure embedded at its appropriate location within the manuscript)