IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Received April 16, 2021, accepted April 27, 2021, date of publication April 30, 2021, date of current version May 7, 2021.

Digital Object Identifier 10.1109/ACCESS.2021.3076751

Analysis on the Lack of Motivation and Dropout in Engineering Students in Spain

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This work was supported by the University of Alcalá under Project UAH/EV881.

ABSTRACT The dropout rate of engineering students is a concerning problem at the present time in many countries, resulting in difficulties to follow the demand of professionals in certain technological sectors as well as an associated negative economic impact. This study identifies a number of factors affecting the motivation degree of current electrical and computer engineering students, as well as the main reasons behind the dropout. A survey was completed by 624 students belonging to 8 different Spanish universities, rating the factors that could influence them to abandon their studies and those affecting their motivation to continue studying. Non-parametric analyses were performed in order to test the association of motivation as well as self-reported likelihood of dropping out with several variables. According to the research results, 23 of the 40 analyzed factors are correlated with the degree of motivation and 14 factors are correlated with the self-reported probability of dropping out. About 46% of the students declared to have thought about dropping out at some point in the past. Difficulty, followed by bad academic performance and negative relationships with professors are the main reasons for dropping out given by the students. Lack of vocation and distance to their home address were less frequent reasons.

INDEX TERMS Attrition, dropout, engineering education, higher education, motivation, survey.

I. INTRODUCTION

Dropout is a complex problem entailing serious consequences that has been profusely investigated in the scientific literature [1], [2]. More specifically, dropout in electrical and computer engineering related degrees has been an important concern not only in Spain [3], [4], but in many other countries (Estonia [5], United Kingdom [6], Latvia [7], Bangladesh [8], South Korea [9]) in the last decades due to the lack of qualified workforce required to meet the high demand of professionals in this particular sector. In fact, obtaining an engineering related degree is notably valued in the labor market as a consequence of the ongoing technological changes of modern society.

The motivations for the study of this topic are well-known public policy matters, such as having equal opportunities to graduate regardless of the students' social class background, helping institutions to identify the factors that influence students to abandon in order to reduce dropout rates, helping potential students, increasing the current lower proportion of graduates in the engineering field, or saving public resources avoiding the waste of taxpayers' money. The estimated cost of the global dropout of students in Spain enrolled in undergraduate courses offered by the Spanish university system considering the 2013/2014 cohort was 399.1 million euros [10].

According to the main report on dropout and completion in higher education published by the European Commission in 2015 [11], one of the goals of the Europe 2020 strategy is to have at least 40% of 30-34–year-olds complete higher education. Increasing completion rates and reducing the dropout in higher education is one of the key plans to achieve this goal, which is considered crucial for the creation of the high-level skills that Europe's knowledge-intensive economic sectors need as well as for Europe's capacity to innovate and foster social justice and productivity. In Spain, workers with higher education improve their employability by 17.4% compared to the job market in general (11.3% in the OECD and 12.4% in the EU-23), and their unemployment rate is 39.2% lower than that suffered by workers with higher secondary education [10].

In order to reduce dropout rates, it is important to identify the factors that may influence students to abandon their studies. The aim of this paper is to analyze the reasons why electrical and computer engineering students in Spain would

The associate editor coordinating the review of this manuscript and approving it for publication was Martin Reisslein.

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drop out and the factors that reduce their degree of motivation to continue studying. The rest of the paper is organized as follows. Section II presents the related works about dropout and motivation in higher education. Section III describes the current situation in Spanish universities. The methodology of the study is described in Section IV. Results are discussed in Section V. Limitations are shown in Section VI and the conclusions and future work are included in Section VII.

II. RELATED WORKS

According to the existing literature, several works trying to explain the causes of students' attrition have been already published. Although the profile of the students who tend to abandon their studies depends on each specific degree, there are certain factors that appear repeatedly in the dropout explanations affecting many different faculties.

A. DEMOGRAPHICS

The first factor is related to demographics: gender, age, civil status, leaving the parental home, father's and mother's studies, etc., [12]–[14]. Stratton *et al.* [13] conclude that older male students are more likely to dropout. A similar conclusion is obtained in [15]. Concretely, the authors state that the dropout risk for males is 1.5 times higher than for females. On the other hand, the parents' educational level is also identified in [16] as a factor that determines the persistence and dropout of students, together with their academic performance.

B. FINANCIAL SITUATION

The second factor is related to the financial situation of the students: receiving economic support from their parents, scholarships, the need to find a job as quickly as possible, working and studying at the same time, etc. [17]–[20]. In Spain and France, tuition fees are increased if students enroll for a second or third time. According to [21], in Latvia, the Czech Republic, Slovakia and Poland, courses that are normally free are charged for if students enroll a second or third time. The CRUE-report 'La universidad española en cifras 2017/2018' [10] reports that 73% of Spanish university students pay tuition fees, a proportion only surpassed by Italy, Belgium, Holland, Portugal and the United Kingdom in the EU-23 panorama. Spain maintains a level of tuition prices that ranks in the highest third of those 23 countries. This can push students with fewer economic resources to look for employment. It must be noted that this early employment is a potential threat to the completion of the studies, since dependence on paid employment may have a negative effect on engagement in studies and study success.

C. ACADEMIC PERFORMANCE

Another very important factor is related to the academic performance: high school point average, university results, unexpected and excessive workload, inability to manage time and stress, etc. [24]–[26]. It has been found that, in general, students who are low achievers in high school are more likely to dropout. The study presented in [26] was carried out in a Spanish university. The authors found that academic preparedness is one of the major influences on student completion. Fig. 1 shows the dropout rate in Spanish public face to face universities depending of the average grade obtained in high school. It can be clearly seen that the dropout rate decreases at the same time that the average grade increases.

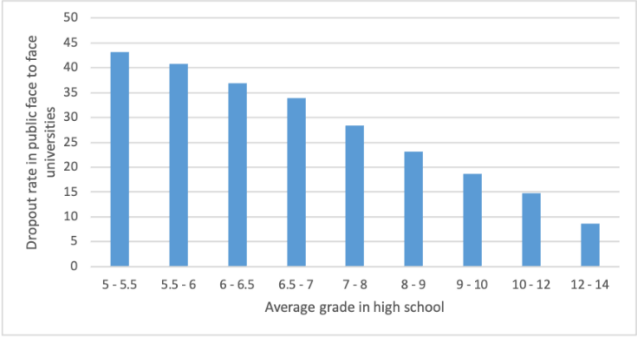

FIGURE 1. Dropout rate in public face to face universities. 2012/2013 new admission cohort. Source [27].

A literature review [28] also revealed that the reasons for such attrition include a lack of preparation in calculus and physics, pressure due to the transition from a high school environment to a college environment, a lack of interest in the chosen major, and inadequate teaching techniques. There are more researchers who point out that students who lack adequate math preparation are more likely to depart from engineering degrees [29], [30].

D. MOTIVATION

Motivation is a general factor that affects all students regardless of their discipline. Interest in what they have to study, future professional opportunities and incorrect prospective student orientation that may lead them to study something they dislike have been analyzed in several works [31]–[33].

Other research work from the University of Extremadura (Spain) [34] evaluated the motivation that guides the learning process of engineering students through an exploratory analysis. According to several studies, both from Spanish universities [35] and from non-Spanish universities [36], intrinsic motivation (self-efficacy, willingness to improve, accomplishment feeling and self-confidence) is the strongest significant factor that influences the intention to drop out.

E. INSTITUTIONAL FACTORS

Institutional variables such as infrastructure, resources and services provided to students are factors that have also been studied [13], [17], [37]. It has been found that dropout rates are higher in public universities than in private universities [38]. In addition, STEM (Science, Technology, Engineering and Mathematics) degrees are mostly taught in publicly owned face to face university centers. In Spain, these registered 82.4% of the total enrollment for new entrants, 88.2% of the total enrollment and 93% of the total number of graduates

for the academic year 2017/18. According to [10], public university funding in Spain is 14.5% below the average for the European Union and the OECD. This means that higher education in Spain presents an insufficient public resources of 1,600 million euros. In terms of total spending, public and private, the value remained at 1.3% of GDP compared to 1.5% of GDP for the OECD average, presenting a global resource availability differential of 2.4 billion euros in 2016.

Salas-Morera *et al.* [4] identified the following institutional factors as causes of dropout in engineering studies: bad course planning, excessively high level of the course's starting point, syllabus too long, too many targeted activities, exams too difficult, inadequate class timetables, and inadequate examination calendars. A different study [39] also found that lack of interaction with the faculty, poor instruction, and large class sizes also contribute to students' negative experiences.

According to [40], the key to understanding why students leave engineering is at the confluence of institutional factors, such as disappointment with engineering advising, and individual factors: loss of confidence due to poor performance and unwillingness of students to adapt to the rigor of the engineering program.

F. SOCIAL INTEGRATION

The last factor to consider is the social integration of students in the new academic environment, mainly through their relationship with professors and with the rest of the students [41]–[43]. The adaptation to the university lifestyle constitutes a challenge and a personal commitment for some students. Related to this, Kirton [43] identified five factors that influence the students to continue: academic self-efficacy, educational values, perception of the university environment, university support and attachment to peers. In [44], Tinto described the main theoretical framework for considering factors in academic success. Tinto also associates the degree of social integration in the new academic environment (from high school to university) with the probability of study completion. Other works include poor quality of teaching, lack of student-faculty interaction, advising, and lack of belonging [45]–[47].

III. SITUATION IN SPANISH UNIVERSITIES

STEM degrees in Spain register high overall dropout rates ranging from 37.4% to 49.9% [10]. In addition, the engineering related degrees have experienced a decrease of 15.6% associated to the new enrollment in the most recent period. On the other hand, although the enrollment of new entrants to ICT related degrees has increased 15.3% in recent years, they record high dropout rates year after year [10].

As it can be observed in Table 1, dropout is very pronounced in online universities. 62.1% of students drop out of the degrees in which they are enrolled and more than half of those enrolled (51.5%) do not finish any type of university studies. The high percentage of students who combine studies with a job and the difficulty of interacting with other students and teachers influence the high dropout rate of this teaching modality. The dropout rates in face to face universities are quite lower, but in any case they are high, since for one in four students the initial choice does not offer the expected results, leading to a change in degree or abandonment of university studies. Of the 26.5% of face to face students who drop out of the degree in one of the four courses following their admission, 14.3% leave the university system and 12.2% change degrees.

TABLE 1. Dropout rates depending on the type of university. 2012/2013 new admission cohort. Source [27].

	Public universities	Private universities	Total
Face to face universitites	27.4%	19.8%	26.5%
Online universitites	65.2%	48.5%	62.1%
Total	34.1%	28.7%	33.3%

The dropout rates of degrees in private universities are lower than in public universities by almost 8 percentage points, reducing this difference to four points in the rates of definitive abandonment of university studies. The lower dropouts in private universities are likely to be associated with their entry criteria, which are less restrictive than those of the public system based on an order by grade for entrance exams (which sometimes makes it difficult for students to pursue the degree they want). The higher level of family income of students from private universities can also curb dropout, by moderating the impact of the higher cost of repetitions due to poor performance (the tuition fees of second and subsequent enrollments are higher). This impact, and that of economic crises such as the one recently experienced, can force a student without resources to abandon their studies. It is also possible that private universities are better managing academic performance and close monitoring of their students, preventing dropouts, but information on this is limited.

Most dropouts occur in the first year of studies, indicating that students quickly perceive if their choice has been wrong. But the percentage of dropouts in the second or third year is not negligible (8.6% and 4.3%, respectively, in the case of the degrees, and 5.5% and 3% considering the whole university system). Since this kind of dropout involves a consumption of resources that does not return results for a longer time, it aggravates the economic cost of abandonment, both public and private. According to Table 2, the differences in the dropout rates of face to face universities depending on the discipline exceed twenty percentage points. The disciplines of Engineering and Architecture (36%), Arts and Humanities (33.4%) and Sciences (31.1%) have significantly higher dropout rates than Social and Legal Sciences (23.8%) and Health Sciences (15.5%). An explanatory factor for these dropouts may be the intrinsic difficulty of the content of degrees in certain disciplines. An approximation to this

TABLE 2. Dropout rates for face to face universities depending on the discipline and on the type of university. 2012/2013 new admission cohort. Source [38].

	Public universities	Private universities	Total
Social and Legal Sciences	24.5%	18.8%	23.8%
Engineering and Architecture	37.1%	22.6%	36.0%
Arts and Humanities	33.6%	27.6%	33.4%
Health Sciences	14.7%	18.6%	15.5%
Sciences	31.1%	31.6%	31.1%

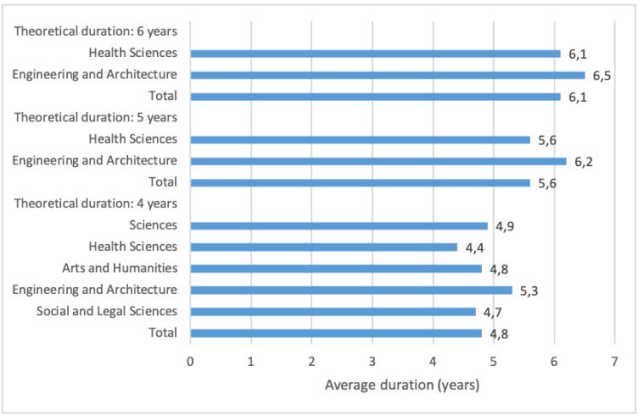

FIGURE 2. Average duration of the degree according to their theoretical duration depending on the discipline. Source [27].

difficulty is the percentage of enrolled students who pass the exams. This performance rate shows a strong inverse relationship with dropout rates depending on the discipline: the lowest performance is in Architecture and Engineering (66.7%), followed by Sciences (72.3%), distanced both from Arts and Humanities (80.2%), Social and Legal (81.4%) and especially Health Sciences (87.3%). It is important to point out that this performance (and the abandonment) may be conditioned by the prior preparation of the students, their effort and the quality of the training received.

The dropout study included in the U-Ranking 2019 [38] confirms that a high percentage of those who start university studies in Spain do not finish them. The analysis has been carried out by following the trajectory of the enrollment of the students who entered the university in the 2012-2013 academic year for four years, until the 2016-2017 academic year. In twenty-five face to face universities, the dropout rates for the Engineering and Architecture degrees are especially serious, exceeding 40%. In 9 universities they are in a range of 40-45%, in 7 of 45-50% and in another 9 they exceed 50%. Thus, there are universities where one in two students drop out of the engineering degrees in which they enrolled. The highest dropout rates occur in Computer Science, Mathematics and Statistics, Physical, Chemical and Geological Sciences, that is, in STEM specializations. This is particularly worrying because these are fields in which technological change is driving the demand for the professionals needed to transform the country's productive sector. The decrease in enrollment rates in these degrees has been significant in the last decade and, together with the dropouts, predicts a shortage of the supply of professionals who are increasingly needed.

As mentioned before, the high number of students who drop out also has another relevant implication: an estimated loss of almost 1,000 million euros per year [38], which has been contributed by public administrations and families and will not lead to obtaining the expected degree. This indicates the wastage of 12% of expenditures on public and private universities in Spain. According to Fig. 2., the average duration of engineering related degrees in Spain is higher than in other disciplines: 5.3 years in degrees whose theoretical duration is 4 years, 6.2 years in degrees whose theoretical duration is 5 years and 6.5 years in those degrees which are expected to be completed in 6 years. This extra-long duration could also influence the students' motivation.

IV. METHODOLOGY

This study is guided by two research questions: 1) What are the factors that affect the degree of motivation of current electrical and computer engineering students to continue studying? and 2) Why would they drop out? A total of 624 students (459 males and 164 females) from eight different Spanish universities (seven public and one private institutions) participated in this study. These universities were selected because they provide a broadly representative sample of the entire population of engineering students in Spain and also because they are located in different geographic regions far from each other: one is located in the north of Spain, two are located in the south, one in the center, two in the east and two in the west. In Spain, the public face to face universities register 88.2% of total enrollment in the engineering field [10]. The gender ratio (74% vs 26%) was similar to the gender ratio in engineering degrees in Spain, where 23.7% of the students are female [45], under the OECD average (27,2%) and the European Union (28,1%). There were first-year students (28%), second-year students (31%), third-year students (21%) and fourth-year students (21%) involved in twenty different electrical and computer engineering degrees. The average age of the students was 21±2.9 years.

An online survey platform [48] was used to prepare the questionnaire that was sent to the engineering students in order to allow them respond electronically. The questionnaire was administered from September 2019 to December 2019 at the eight universities involved. The students participated voluntarily in this study and decided whether or not to complete the questionnaire. It is important to point out that the questionnaire was anonymous and confidential. The response

rate was 15.4%. An Excel file with the responses of the students was provided by the online survey platform. Two questionnaires with incomplete and missing responses were identified and discarded. The dataset was analyzed using IBM SPSS Statistics 27 (License of the University of Alcalá). The questionnaire asked students to rate the factors that could influence them to abandon their studies and the factors that affect their motivation to continue studying. In order to build on work already done in the field, the questions were based on published sets from research on factors affecting dropout. A large number of potential explanatory variables have been considered in this study. As it was identified in [40], personal characteristics, previous academic performance and interactions between students and professors have been also included in the questionnaire. Some questions helped us to examine whether student dropout is influenced by labor market conditions. These factors were also studied in [26]. Most items were evaluated on a 5-point Likert-type scale (5: very important; 4: important; 3: average importance; 2: little importance; 1: not important at all). An open answer box was also included for the students to explain their reasons. The Cronbach's alpha value yielded 0.79, higher than 0.7, which means that the questionnaire is reliable [49].

In the first place, students were asked about demographic information: university, degree, course, age, gender, how many years they have been studying the degree, who they live with, and whether they have received a scholarship. Next, the following questions were included:

Were you well informed when you chose the degree?

Did you have enough time to decide?

Did you think it was a difficult degree?

Do you organize yourself well and do you know how to control stress?

Have you noticed the change from high school to university?

Indicate your average grade obtained in high school.

Have you become independent when starting university?

Have you studied / worked before on something related to engineering?

Have you started working once the degree started?

Do you work to pay for your studies?

Do you have relatives who depend on you financially?

Do you have a pc / laptop?

Regarding motivation, the following questions were included:

Indicate your degree of motivation to continue studying (from 1 to 10)

What factors motivate you to continue studying?

- I am interested in what I have to study
- I think what I have to study is useful in real life
- University lifestyle
- Relationship with professors
- Relationship with students
- My academic performance is good
- University is my number one priority
- Self-realization

Do you think you will complete the degree? If no, why?

Have you thought about dropping out? If yes, why?

Do you know someone who has dropped out or is considering it? If yes, why? Has he/she abandoned / is considering it?

What is the likelihood for you to drop out?

The survey also asked students to rate between 1 and 5 points (5: very important; 4: important; 3: average importance; 2: little importance; 1: not important at all) the following reasons why they would drop out.

- To start working
- To take care of relatives
- The degree is too difficult
- It is not what I expected
- I do not like what I have to study
- Bad integration in the university environment
- Personal reasons
- Health reasons
- I cannot afford the tuition fees
- I do not have enough time to study
- The university resources are not adequate

Nine interviews were carried out in January 2020 mainly at the University of Alcalá by the authors. The objective of the interviews was to allow students to express their opinion about the research questions in order to obtain a deeper understanding of the results. All the interviewed students had already completed the questionnaire and stated that they had found the questions complete, clear and concise, without pointing out any specific issues related to the questionnaire itself or the applied methodology.

V. RESULTS AND DISCUSSION

Even though only 5% of students think that they will not complete their studies, 46% of the students have thought about dropping out. Moreover, 84% of them admit knowing someone who has already dropped out. There is a high percentage of students (25%) who work and study at the same time and only 3% acknowledge to have relatives who depend on them financially. A total of 98% of the students have a pc or laptop. This extremely high value is not surprising because computer tools are required in the vast majority of the subjects included in the electrical and computer engineering syllabus. From the economical point of view, 18% of the students report to be scholarship holders and 19% manifest to have left their parental home. In addition, a quite remarkable finding is that the 90.5% of students have noticed the change from high school to university.

This work analyzes the factors that affect the motivation degree of engineering students and also the factors that could influence in the abandon of their studies.

First, hypothesis contrasts were conducted to determine if there are significant differences in the motivation degree depending on several variables. This hypothesis is related to the first research question: What are the factors that affect the degree of motivation of current electrical and computer

engineering students to continue studying? Second, hypothesis contrasts were conducted to determine if there are significant differences in the self-reported likelihood of dropping out depending on the same variables. This hypothesis is related to the second research question: Why would current electrical and computer engineering students drop out?

Table 3 shows the Kolmogorov-Smirnov and Shapiro-Wilk normality tests that were carried out to select the most appropriate statistic to test the mean differences. The normality test results suggest that the analyzed items do not follow a normal distribution because the significance is less than 0.05. Thus, the normality hypothesis is rejected and a non-parametric statistical analysis must be used for the hypothesis contrast.

TABLE 3. Results of the normality test.

Kolmogorov-Smirnov			
Item	Statistics	df	Sig.
Degree of motivation	,176	624	,000
Self-reported likelihood of dropping out	,199	624	,000
Shaphiro-Wilk			
Item	Statistics	df	Sig.
Degree of motivation	,917	624	,000
Self-reported likelihood of dropping out	,800	624	,000

Table 4 shows the results of the analyses related to the motivation degree. Mann-Whitney U test is applied when the variable has two categories (gender, being or not a scholarship holder, etc.) and Kruskal Wallis test is applied when the variable has more than two categories (age, course, etc.). In both tests, a significance level less than a critical value $\alpha = 0.01$ suggest statistical significance. Since the sample is large and multiple hypotheses are tested, we consider a low Type I error threshold of 0.01 instead of the typical value of 0.05.

The results suggest that there is not a probable correlation of the motivation degree with being a scholarship holder, nor the following factors: high school performance, who students live with, working to pay enrollment fees, having dependents, having a computer, working in the engineering field, having previous contact with engineering, becoming independent, knowing someone who dropped out, difficulty, noticing change from high school to university, future professional opportunities, future salary, family recommendation, not preferred option when choosing degree and having acquaintance who works in engineering field. However, there is a highly probable correlation of the motivation degree with gender, age, course, years spent at the university, being self-determined to finish the degree, thinking about dropping out, self-reported likelihood of dropping out, career choice with enough information, enough time to choose, stress control, interest in engineering field, importance of ICT, job stability, job promotion, interest in engineering jobs, self-realization, interest in the subjects, usefulness of the studies in real life, university lifestyle, relationship with professors, relationship with students, good academic performance and considering university as their number one priority. The latter items corroborate what was stated by Tinto in [44]: there seems to be an association between the degree of social integration in the new academic environment (university lifestyle, relationship with professors and relationship with students) and the motivation degree.

TABLE 4. Mann-Whitney U and Kruskal-Wallis analysis to test association of motivation degree (from 1 to 10) with listed variables.

Variable	Sig.
Scholarship	0.194
High school point average	0.267
Gender	**0.003**
Family members	0.942
Age	**<0.0001**
Course	**<0.0001**
Years spent at the university	**<0.0001**
Work to pay enrollment fees	0.358
Have dependents	0.381
Have a computer	0.842
Self determination to finish the degree	**<0.0001**
Work in the engineering field	0.088
Previous contact with engineering	0.020
Become independent	0.752
Think about dropping out	**<0.0001**
Know someone who dropped out	0.121
Self-reported likelihood of dropping out	**<0.0001**
Career choice with enough information	**<0.0001**
Enough time to choose	**<0.0001**
Difficulty	0.623
Stress control	**<0.0001**
Change from high school to university	0.020
Future professional opportunities	0.022
Future salary	0.052
Family recommendation	0.841
Interest in engineering field	**<0.0001**
Not preferred option when choosing degree	0.836
Importance of ICT	**<0.0001**
Job stability	**0.004**
Job promotion	**0.001**
Interest in engineering jobs	**<0.0001**
Acquaintance works in engineering field	0.383
Self-realization	**<0.0001**
I am interested in what I have to study	**<0.0001**
I think what I have to study is useful	**<0.0001**
University lifestyle	**<0.0001**
Relationship with professors	**<0.0001**
Relationship with students	**<0.0001**
My academic performance is good	**<0.0001**
University is my number one priority	**<0.0001**

The relationship between the self-reported likelihood of dropping out and demographics (and the other variables) was also examined. The results of the Mann-Whitney U tests and the Kruskal Wallis tests are summarized in Table 5. The results suggest that there is not a probable correlation of the

self-reported likelihood of dropping out with the high school performance, nor the following factors: gender, who they live with, age, working to pay enrollment fees, having dependents, having a computer, working in the engineering field, having previous contact with engineering, becoming independent, knowing someone who dropped out, career choice with enough information, difficulty, noticing change from high school to university, future professional opportunities, family recommendation, not preferred option when choosing degree, importance of ICT, job stability, job promotion, interest in engineering jobs, having acquaintance who works in engineering field, self-realization, university lifestyle and considering university as their number one priority. However, there is a highly probable correlation of the self-reported likelihood of dropping out with the following items: being a scholarship holder, course, years spent at the university, being self-determined to finish the degree, thinking about dropping out, degree of motivation, enough time to choose, stress control, interest in engineering field, interest in the subjects, usefulness of the studies in real life, relationship with professors, relationship with students and good academic performance.

The numerical results for the possible associations between the research questions (degree of motivation and self-reported likelihood of dropping out) and the analyzed items are shown in Figs. 3-14. On the other hand, results where the association is suggested just between the analyzed items and the self-reported likelihood of dropping out are shown in Table 6. Finally, Table 7 includes the results where the association is suggested just between the analyzed items and the motivation degree.

Male students seem to be more motivated than female students (see Table 7). A probable reason for that is that women are vastly underrepresented; they are a minority in most engineering related degrees. Younger students are more motivated than older students. This is particularly worrying in those students older than 23 years old (see Table 7). This finding is aligned to what is shown in Fig. 3: the motivation degree

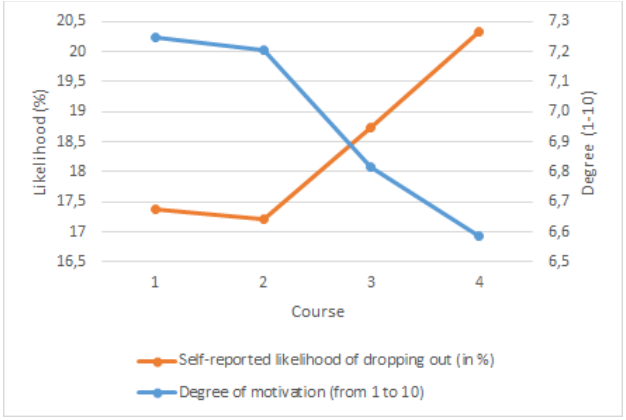

FIGURE 3. Survey results where association is suggested between the research questions and course.

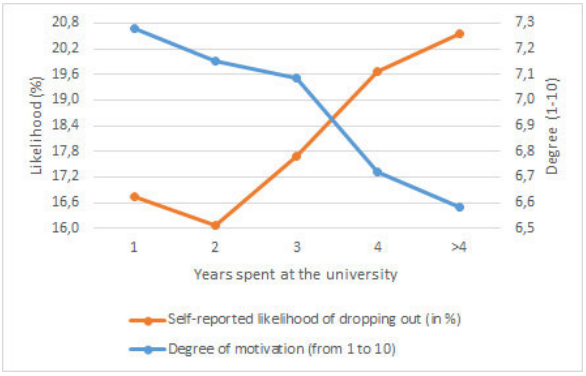

FIGURE 4. Survey results where association is suggested between the research questions and the item 'Years spent at the university'.

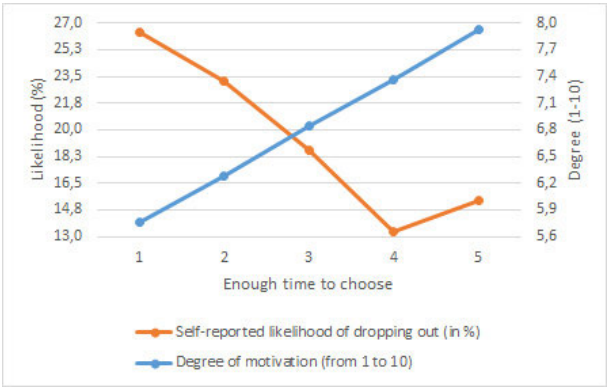

FIGURE 5. Survey results where association is suggested between the research questions and the item 'Enough time to choose'.

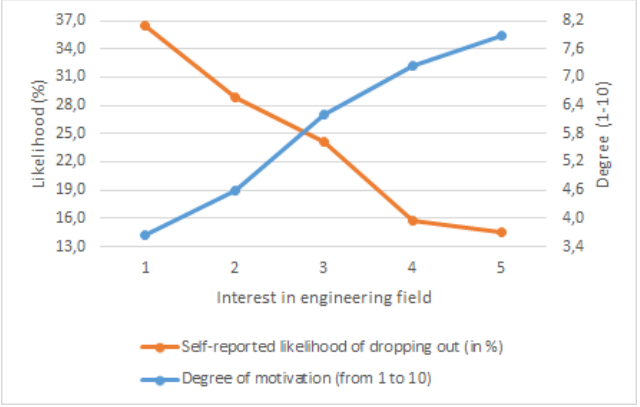

FIGURE 6. Survey results where association is suggested between the research questions and the item 'Interest in engineering field'.

decreases as the course increases. Fig. 3 also shows that the students in higher courses report a high probability of dropping out. Curiously, there is not a correlation between high school performance and motivation degree, neither between high school performance and self-reported likelihood of dropping out. This fact seems to contradict what shown in Fig. 1, which indicates that the lower the average grade is, the higher the dropout rate is. The explanation to this finding could be

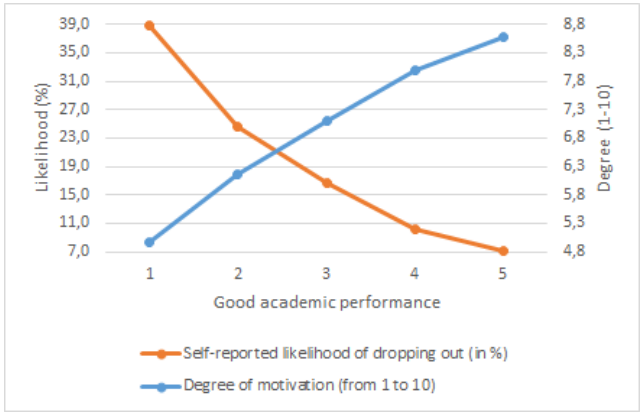

FIGURE 7. Survey results where association is suggested between research questions and the item 'Good academic performance'.

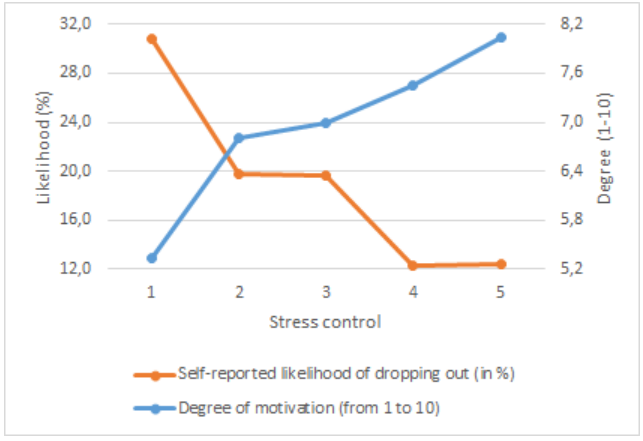

FIGURE 8. Survey results where association is suggested between the research questions and the item 'Stress control'.

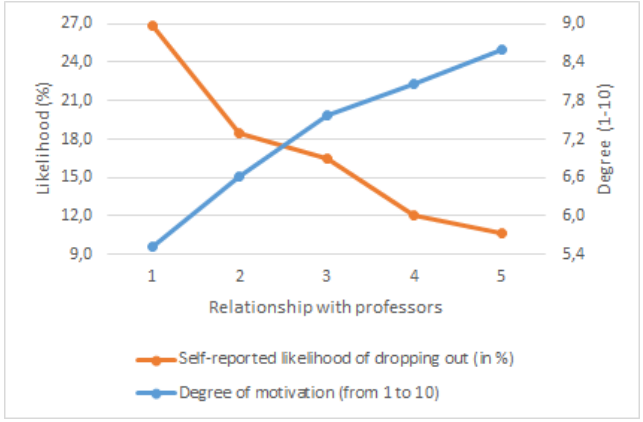

FIGURE 9. Survey results where association is suggested between research questions and the item 'Relationship with professors.

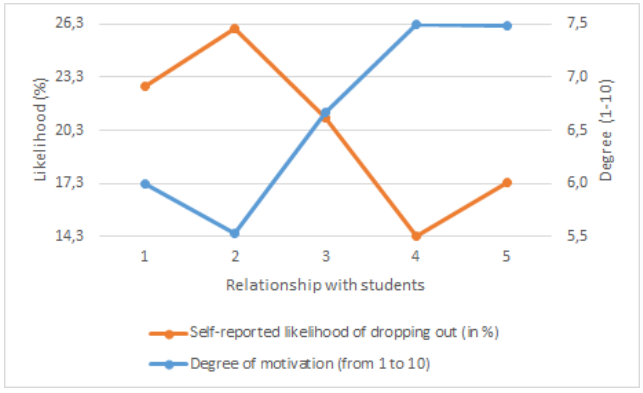

FIGURE 10. Survey results where association is suggested between research questions and the item 'Relationship with students.

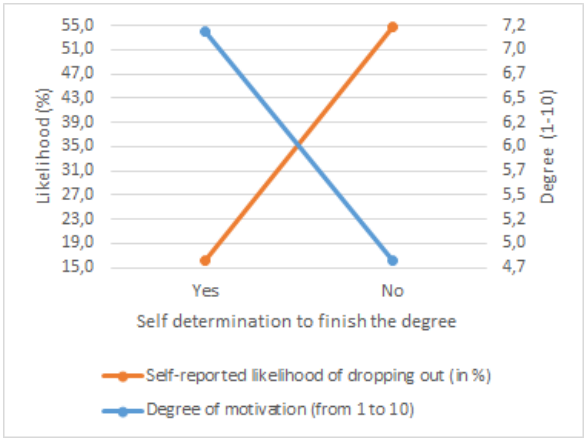

FIGURE 11. Survey results where association is suggested between the research questions and the item 'Self-determination to finish the degree'.

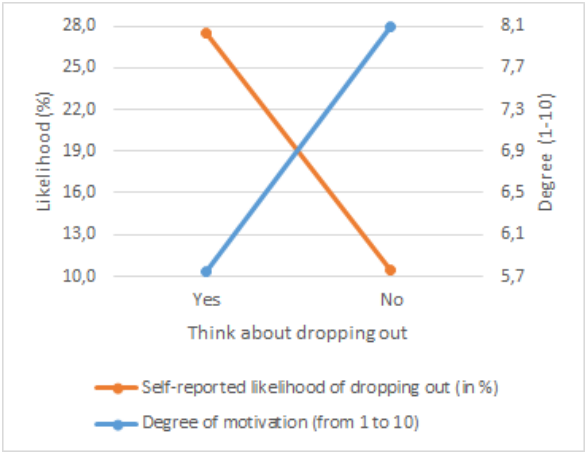

FIGURE 12. Survey results where association is suggested between the research questions and the item 'Think about dropping out'.

related to the fact that engineering students generally have a considerably low average grade. These results also contradict what was reported in [22]–[26], in which the authors found that students who were low achievers in high school were more likely to dropout. If we focus on financial related items such as ''work to pay enrollment fees'' and ''have dependents'', the present study concludes there is not a relationship between those variables and the motivation degree nor the self-reported likelihood of dropping out. This finding also

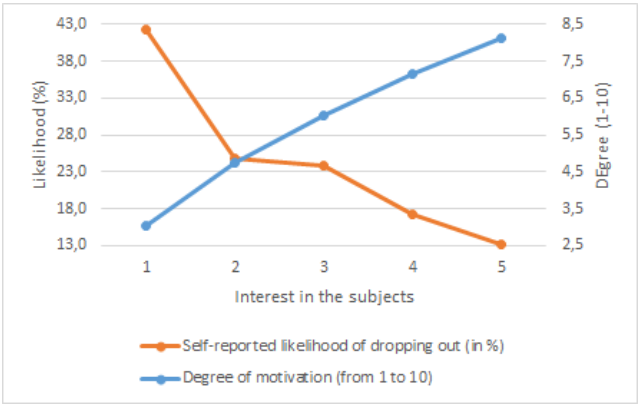

FIGURE 13. Survey results where association is suggested between research questions and the item 'I think what I have to study is useful'.

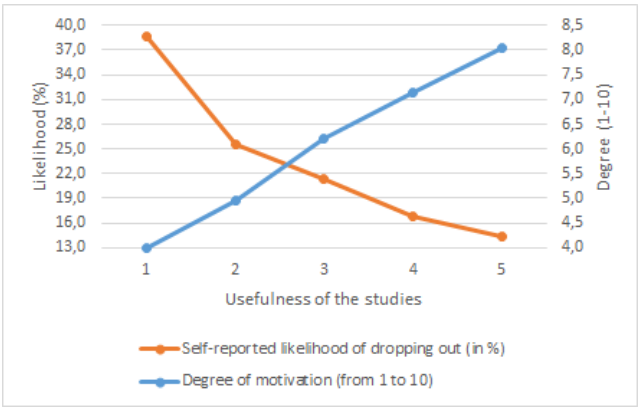

FIGURE 14. Survey results where association is suggested between research questions and the item 'I am interested in what I have to study'.

contradicts what Hovdhaugen found in [20]: students who work full time are less likely to complete their degree than students working short part-time or not working at all. Being a scholarship holder is the only financial related item associated to the likelihood of dropping out. Concretely, students who receive financial support from the government are less likely to abandon than students who do not (see Table 6). This fact is aligned with works [17]–[19], which found that receiving economic support from scholarships or parents were factors that could influence students to drop out.

On the other hand, a correlation has been found with the factor ''years spent at the university'' and motivation degree and with that factor and the self-reported likelihood of dropping out (Fig. 4). This finding confirms what was shown in Fig. 2 and Table 2 in which it was explained that engineering related studies take more time to complete (see Fig. 2) and that this discipline has a higher dropout rate compared to other disciplines (see Table 2). An obvious result is that the motivation degree decreases when the probability of dropping out increases and vice versa, as shown in Tables VII and VI respectively.

According Table 7, students who chose their degree with enough information are more motivated than those who did not. Also, the degree of motivation is higher and the likelihood of dropping out is lower in those students who had enough time to choose their degree (see Fig. 5). These findings lead us to suggest that universities should make more efforts in informing high school students about the engineering degrees. Regarding not having enough time to choose

TABLE 5. Mann-Whitney U and Kruskal-Wallis analysis to test association of self-reported likelihood of dropping out (from 1 to 100) with listed variables.

Variable	Sig.
Scholarship	**0.007**
High school point average	0.102
Gender	0.542
Family members	0.013
Age	0.041
Course	**<0.0001**
Years spent at the university	**0.001**
Work to pay enrollment fees	0.784
Have dependents	0.090
Have a computer	0.062
Self determination to finish the degree	**<0.0001**
Work in the engineering field	0.335
Previous contact with engineering	0.136
Become independent	0.864
Think about dropping out	**<0.0001**
Know someone who dropped out	0.841
Degree of motivation	**<0.0001**
Career choice with enough information	0.115
Enough time to choose	**<0.0001**
Difficulty	0.160
Stress control	**<0.0001**
Change from high school to university	0.159
Future professional opportunities	0.019
Future salary	0.014
Family recommendation	0.916
Interest in engineering field	**<0.0001**
Not preferred option when choosing degree	0.142
Importance of ICT	0.906
Job stability	0.439
Job promotion	0.443
Interest in engineering jobs	0.013
Acquaintance works in engineering field	0.066
Self-realization	0.166
I am interested in what I have to study	**<0.0001**
I think what I have to study is useful	**<0.0001**
University lifestyle	0.05
Relationship with professors	**<0.0001**
Relationship with students	**0.007**
My academic performance is good	**<0.0001**
University is my number one priority	0.027

TABLE 6. Survey results where association is suggested between variables and the self-reported likelihood of dropping out.

Variables	Values	Likelihood of dropping out (%)
Scholarship	Yes	14.7
	No	18.9
Degree of motivation	<2.5	41.5
	2.5-5	33.6
	5-7.5	21.9
	>7.5	10.1

TABLE 7. Survey results where association is suggested between variables and the degree of motivation.

Variables	Values	Degree of motivation (1-10)
Gender	Male	7.2
	Female	6.6
Age	18	7.4
	19	7.3
	20	7.3
	21	7.2
	22	7.0
	23	6.8
	>23	6.1
Self-reported likelihood of dropping out	<25%	7.5
	25%-50%	6.3
	50%-75%	4.7
	>75%	4.1
Career choice with enough information	1	5.3
	2	6.0
	3	7.2
	4	7.6
	5	8.2
Interest in engineering jobs	1	4.6
	2	5.3
	3	6.4
	4	7.2
	5	7.8
Importance of ICT	1	6.2
	2	6.5
	3	6.4
	4	7.2
	5	7.7
Job stability	1	6.6
	2	6.7
	3	7.0
	4	7.4
	5	7.6
Job promotion	1	6.6
	2	6.7
	3	6.9
	4	7.4
	5	7.7
University is my priority	1	5.0
	2	6.3
	3	6.7
	4	7.5
	5	7.6
Self-realization	1	5.5
	2	7.0
	3	6.6
	4	7.3
	5	7.7
University lifestyle	1	4.7
	2	5.9
	3	7.0
	4	7.7
	5	7.8

the degree, a solution could be to extend the enrollment period, so that students can have more time to think about that important decision.

Fig. 6 shows that students who are not interested in the engineering field are more probably to drop out than students who are really interested in the field. Also, their motivation is lower. In fact, in Table 7 it can be seen that the most interested in engineering (jobs) are the students, the higher is their motivation. This finding confirms what was found in the Estonian work reported in [5]: students were guided mostly by intrinsic motivation to continue their Information Technology studies (''I am interested in computers'', ''I like being involved in the Information Technology field'', etc.). The second most important factor found by the authors in [5] was the reputation of the field, which is aligned to what is shown in Table 7 regarding the variable 'Importance of ICT'. The most motivated students are those who rate higher that variable. On the other hand, it can be seen that students who have good prospects in the labor market (items 'Jon stability' and 'Job promotion') are more motivated than students who have not. Obviously, students with a better academic performance report a higher level of motivation and also a much lower probability of dropping out (Fig. 7). The same occurs with students who are able to control their stress (Fig. 8).

According to Table 7, students who consider that university is their priority report a higher degree of motivation than students who do not. In addition, students who report ''self-realization'' as a reason to continue their studies are more motivated than those students who do not consider it. The same occurs with students who admit feeling comfortable in the university environment. This factor is related to the factors 'Relationship with students' and 'Relationship with professors' (see Figs. 9 and 10). The Estonian study presented in [5] also found that the item ''Learning atmosphere'' is an important factor that can influence engineering students to continue their studies. In relation to Figs. 9 and 10, students who consider important the relationship with professors and students are more motivated and report a lower probability of abandonment than students who do not consider it. These results match with the results of the studies in Spain about the perceived supports and barriers for engineering students [50]–[51]. In these works, the authors concluded that peers and family are the most important supports, while teaching staff and institutional support have lower rates.

Fig. 11 shows that students who admit being determined to complete their degree report a higher level of motivation and are much less likely to abandon than those students who do not report it. Moreover, students who have thought about dropping out at some point in the past are less motivated and are more likely to drop out than students who have not (Fig. 12).

According to Figs. 13 and 14, students who are interested in the subjects they study and students who consider that their studies are useful in real life report a higher degree of motivation and a lower probability of dropping out. This finding highlights the need of focusing on the practical side of the subjects so that students can see the utility of what they are studying. This is particularly important in electrical and computer engineering degrees, where every subject has a theoretical part and a practical part.

Fig. 15 shows the reasons why students would drop out. The highest rated item is ''To take care of relatives'' (2.65) followed by ''Personal reasons'' (2.63) and

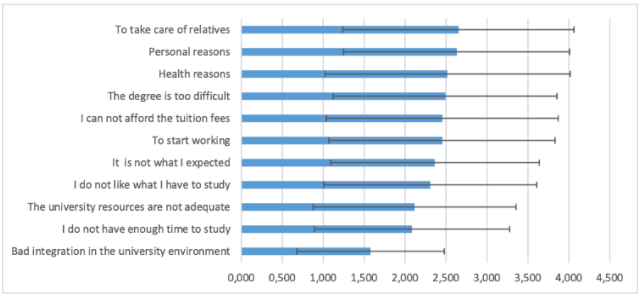

FIGURE 15. Student's evaluation (mean and standard deviation) of the reasons why they would abandon their studies.

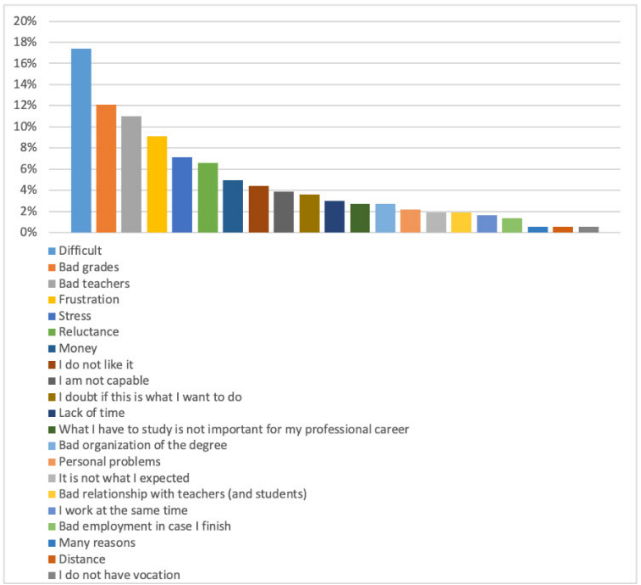

FIGURE 16. Reasons why students would abandon their studies.

"Health reasons" (2.52). The lowest rated item is "Bad integration in the university environment" (1.57). However, it can be seen that all items have a similar punctuation and that there is not a clear remarkable item which stands out over the rest. This is why the answers given in the open answer box, in which students explained their own reasons to abandon their studies, have also been analyzed. These reasons were given only by the students who had thought about dropping out (285 students of 624). Their reasons are shown in Fig. 16. In this case there is a reason that stands out over the others: difficulty. It is followed by bad academic performance and bad relationship with professors. The next three reasons are related between themselves: frustration, stress and reluctance. They seem to be the consequence of achieving bad grades without feeling the support of the university staff. These results confirm what was found by other authors: poor quality of teaching and poor student-faculty interaction were the main reasons reported in [37]–[39]. A study carried out in Spain [4] also identified similar reasons: exams too difficult, syllabus too long, and stress. Lack of money, lack of time nor interest in the field seem not to be especially important factors. Lack of vocation and long distance to the university are the least important reasons.

TABLE 8. Comparison between the factors correlated to the two items analyzed: degree of motivation and self-reported likelihood of dropping out obtained in the non-parametric analyses.

Variable	Degree of motivation	Self-reported likelihood of dropping out
Scholarship		✓
Gender	✓	
Age	✓	
Course	✓	✓
Years spent at the university	✓	✓
Self determination to finish the degree	✓	✓
Think about dropping out	✓	✓
Self-reported likelihood of dropping out	✓	
Degree of motivation		✓
Career choice with enough information	✓	
Enough time to choose	✓	✓
Stress control	✓	✓
Interest in engineering field	✓	✓
Importance of ICT	✓	
Job stability	✓	
Job promotion	✓	
Interest in engineering jobs	✓	
Self-realization	✓	
I am interested in what I have to study	✓	✓
I think what I have to study is useful	✓	✓
University lifestyle	✓	
Relationship with professors	✓	✓
Relationship with students	✓	✓
My academic performance is good	✓	✓
University is my number one priority	✓	

VI. LIMITATIONS

The first limitation refers to the study design. The vast majority of the data were gathered through questionnaires. Only few interviews were carried out, especially in the classroom environment. Wider explanations were gathered with the aim of helping to obtain a deeper understanding of the results. Nevertheless, no new items were found in the interviews. More interviews could be incorporated in a further study. Secondly, the study was carried out in Spanish universities. The reasons why current electrical and computer engineering students would drop out and the factors that reduce their degree of motivation to continue studying in other countries could be different. However, the results of this study could be useful in other countries to understand this complex problem. Third, only face-to-face universities were included in the study. In order to cover a wide variety of institutions, distance learning universities could also be added.

VII. CONCLUSION

It is a well-known fact that recruiting and retaining motivated engineering students at the university is an important concern due to the high dropout rates in Spain and in the rest of the world. The goal of this work has been to determine the factors that influence the motivation of engineering students and

the possible reasons that would force them to abandon their studies. In this study, 624 electrical and computer engineering students in Spain evaluated a questionnaire focused on two research questions: 1) What are the factors that affect your degree of motivation to continue studying? and 2) Why would you drop out? Non-parametric analyses (Mann-Whitney U tests and Kruskal Wallis tests) were applied in order to find possible correlations between these items and several variables. According to Table 8, 23 of the 40 analyzed factors are correlated with the degree of motivation and 14 factors are correlated with the self-reported probability of dropping out.

The study also revealed that 46% of the students declared to have thought about dropping out at some point in the past. Difficulty, followed by bad academic performance and bad relationship with professors are the main reasons given by those students. Lack of vocation and long distance to the university were less frequent reasons. According to these results, recommendations for universities offering engineering related degrees could be the following: 1) Reviewing the content of the syllabus in case they are too dense, 2) Offer extra optional lessons to those students who need additional help understanding some topics, 3) Offer basic lessons of mathematics and physics to the first-year students who are not well prepared, and 4) Raise awareness of professors and academic managers in order for them to be supportive with students if necessary.

ACKNOWLEDGMENT

The authors would like to thank Susana Loredo for her assistance with the collection of data.

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