Comparison Between Electromechanical Engineering and Electrical Engineering Students in the Motivation to Choose the Higher Education Study Field

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Abstract: - The motivations with which students choose the higher programme to follow have a high impact on their academic performance throughout the programme and on the dropout rate. The type of motivation (intrinsic or extrinsic) that leads them to choose the programme area is very important in their resilience in the face of difficulties they may encounter during the programme. It is also important to attract students to a particular area of higher education. In Portugal (in line with other countries), the demand for higher education programmes in the field of Electrical Engineering has been decreasing among students applying for higher education. This decrease occurs despite the area have high employability. On the contrary, the demand for Mechanical Engineering and Electromechanical Engineering programmes has been growing.
Given this, it is important to try to understand the motivations that lead students to apply for programmes in the field of Electrical Engineering. For a better understanding of the reasons that differentiate the demand for programmes in the electrical area and the mechanical area, it was considered important to study whether there are relevant differences between the motivation profile for choosing the programmes between Electrical Engineering and Electromechanical Engineering
Thus, this study aimed to understand and analyse the motivations that led students from a Portuguese Polytechnic higher education institution to choose the field of Electrical Engineering or of Electromechanical Engineering. To this end, a questionnaire survey was used to collect the students' perceptions about why they chose the programme. The results show that students highly value the fact that it is a broadband area, with high employability and a wide variety of potential professional activities. The comparison between the programmes shows that the area of mechanics is a factor that motivates students to apply for the Electromechanical Engineering.
The results obtained help to understand the motivation profile of students who choose the field of Electrical Engineering and of Electromechanical Engineering, potentially contributing for the higher education institutions to promote actions with a view to enhancing the attractiveness of Electrical Engineering area.

Key-Words: Electromechanical Engineering; Electrical Engineering; Students Motivation; Students Dropouts; Students Perceptions
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1 Introduction

Electrical area, mechanical and electromechanical areas are traditional training areas in the field of engineering [1] that over time have contributed to the great technological and economic development [2]. These areas have become fundamental in industrial production and are present in almost all production systems [3]. Whether through production systems or in the development of products and services provided, these areas of engineering also underlie almost all human activities and are present in individual and collective daily life [4], [5]. These areas are essential for industrial and economic development and are associated with economic competitiveness [5], so they have high employability.

However, despite continuing to be a professional area with high employability [6], demand for Electrical Engineering programmes is decreasing [7]. The decrease in demand for Electrical Engineering programmes can be seen both in Portugal [8] and in several countries where demand and interest in this

area of engineering is also decreasing [7]. This is an important problem, since there is a great lack of professionals in the field of electrical area in the labour market [9], [10].

In recent decades, there have been major changes in the field of Electrical Engineering that have led to a great diversification of its fields of action and in the fragmentation by areas of specialization [9]. Such fragmentation led to the creation of several higher education programmes and specializations [12], [8], namely Computer Engineering, Electronic and Telecommunications Engineering and Electromechanical Engineering. In the opinion of [9], this fragmentation and transformation of the area of Electrical Engineering resulted in a process of expansion that has led to the disintegration of the area itself.

The professional practice of Electrical Engineering encompasses areas as diverse as the electric energy production, transport and distribution; the telecommunications systems; the industrial maintenance, automation and control; the programming (computers, programmable automats, etc); the robotics; the electronics; the energy management; the electrical installations; the lighting systems; etc [9], [1], [11]. All these areas and subareas are interconnected with other engineering domains, highlighting a strong interrelationship with Mechanical Engineering. This interrelation and interdependence of the two areas (electrical and mechanical areas) is materialized (for example) in the Electromechanical Engineering programme and is recognized by the credibility of graduates in this area and by the high demand in the job market [12].

In recent years, there has been an increase in the attractiveness (understood as the increase in the number of candidates for the programme and placements) of Mechanical Engineering and even Electromechanical Engineering [13]. But the attractiveness of Electrical Engineering has decreased [8].

Given this, it is important to understand the reasons that lead students to choose the Electrical Engineering programmes and compare these reasons with the Electromechanical Engineering programmes. The choice of comparison with the Electromechanical Engineering was based on the fact that this programme is very close to the Electrical Engineering programme (50% of its curricula is in the area of Electrical Engineering and is taught by professors from the Electrical Engineering department), however, unlike Electrical Engineering, its attractiveness has been increasing. For this study, programmes from the same Higher Education Institution were chosen, so that the Institution was not a relevant factor in the choice between the 2 programmes (since this factor is in fact relevant [8]).

Knowing the reasons that lead students to choose the programme can help to understand what is most valued and thus adapt the information and design available to potential candidates (namely online); as well as to understand whether their motivations have a more external or internal character (intrinsic or extrinsic), which may influence their commitment and performance in the learning process during their academic path and until the dropout [14].

2 Objectives and Methodology

In this context, this article presents a study that aimed to understand and analyse the motivations that led students from a Portuguese Polytechnic higher education institution to choose the field of Electrical Engineering or the field of Electromechanical Engineering.

The aim of this study was to understand whether the reasons that lead students to choose the Electrical Engineering programme differ significantly from the reasons for choosing the Electromechanical Engineering programme, as well as what the main reasons are. Also noteworthy is the objective of understanding whether the current high attractiveness of the Mechanical Engineering programmes (in Portugal [13]) is felt in the reasons for choosing between Electrical Engineering and Electromechanical Engineering.

Another objective was to understand if students already enter the programme with preferences and engagement with any of the sub-areas of Electrical Engineering. This objective is very important, as the preference for one of the electrical sub-areas may be a motivating factor to engage in their learning process, as well as to avoid dropout [14].

To this end, a questionnaire survey (anonymous) was used to collect the students' perceptions about why they chose the programmes. The survey included closed (demographic aspects) and open questions about the motivation for choosing the programme.

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The answers were analysed using content analysis using non-exclusive categories that emerged from response analysis and then from a statistical point of view.

The questionnaire was applied in the academic year 2021/2022 to students of the Electrical Engineering and Electromechanical Engineering programmes of a Portuguese Polytechnic higher education institution.

3 Results

The survey was answered by 91 students, whose distribution by programme is shown in Fig.1. The proportion of students of Electrical Engineering and Electromechanical Engineering is similar (about 45%), and the number of students of Electrical Engineering (after-work regime) is much lower (about 9%). This programme, of the 3 studied, is the one that currently has the least attractiveness [15], [16].

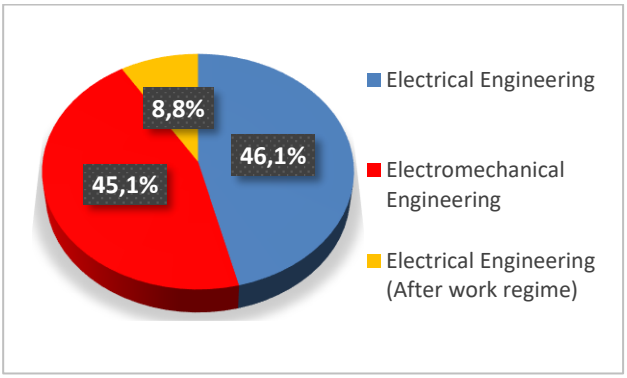

Fig.1 Distribution of students by programme.

The students who responded to the study are mostly in an age group up to 23 years old, which indicates that they are traditional higher education students [17]. Only 3.3% of students are over 30 years old. The age distribution is shown in Fig.2.

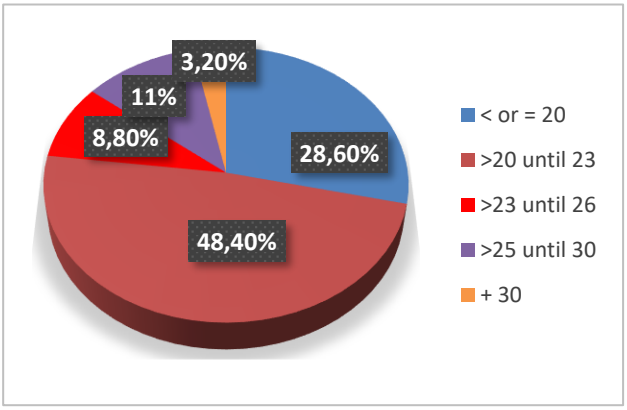

Fig.2 Distribution of students by age group.

Despite many efforts to increase the number of women attending engineering programmes in general, the number of women has not increased in Electrical Engineering and Electromechanical Engineering programmes [15]. Engineering programmes in more traditional areas (such as Electrical and Mechanical Engineering) have remained with a low percentage of women and tend to be stable in Portugal [15]. The Electromechanical Engineering programme also has a low frequency of women (in 2021/2022 only 6 women attended the programme – 3 students in the 2nd year, 1 student in the 3rd year and 2 students in the 1st year [13]). This discrepancy between men and women in the Electrical Engineering and Electromechanical Engineering programmes is very evident in Fig.3 which shows the percentage of men and women who answered the survey.

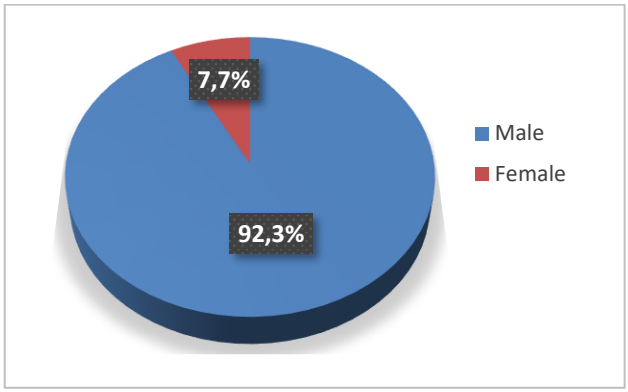

Fig.3 Distribution of students by gender.

Most of the students who answered the survey attended the 2nd or 3rd year, with only 2.2% attending the 1st year, as shown in Fig.4. In the analysis of the results, it was found that the answers given by the 3rd year students were more complete, serious, and structured. This would be expected, since the maturity of the students is expected to evolve with age [18], and as such, with the academic year they attend.

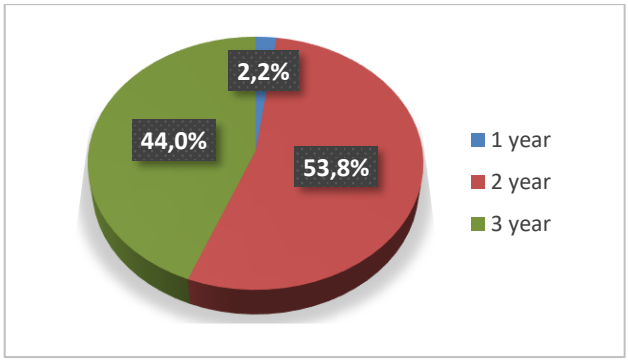

Fig.4 Distribution of students by academic year.

3.1 Motivation for choosing the Electromechanical Engineering programme

To find out what was the main motivation for choosing the programme in the field of electromechanics, students were asked why they chose this programme. The analysis of the answers made it possible to obtain a synthesis of the (non-exclusive) categories that emerged from the

responses themselves. Some answers had more than one motivation. To this question, 37 students answered.

The most frequently mentioned words in the answers were: I like, interest, electrical and mechanical areas. The non-exclusive categories that emerged from the analysis of the answers given by students of Electromechanical Engineering were:

- Have training in both areas, electrical and mechanical (answer example: "*Because it has the mechanical and electrical field*");
- High employability (answer example: "*Have a good professional output*");
- Be a broadband programme (answer example: "*Due to the wide range of areas covered in the programme*");
- By personal like/interest (answer example: "*By instinct or even out of curiosity, at the time of choosing the programme aroused my interest*");
- By guidance from family members (answer example: "*On the advice of a family member*");
- For not having been able to enter the first option programme (answer example: "*Because I did not enter the first option (Computer Engineering)*");
- Natural continuity of the academic path (answer example: "*Because I came from the Professional Higher Technical Course in Electromechanical Maintenance*".

Table 1 shows the percentage of students who reported each of the aforementioned categories.

Table 1 – Percentage of students (depending on the total number of answers) who mentioned each of the categories.

Category	Frequency
Have training in both areas, electrical and mechanical	35,1%
High employability	27,0%
To be a broadband programme	16,2%
By personal like/interest	54,1%
By guidance of family members	2,7%
For not being able to enter the first option programme	2,7%
Natural follow-up of the academic path	2,7%

The students' answers show that the majority only recognize personal like or interest in the area as motivation. Many students recognize that their main motivation was the fact that this programme covers the two electrical and mechanical areas. Some students identify as having been more relevant the fact that this programme has a high employability and the its wide scope.

Of the various answers, the reference to the fascination for the area stands out, which a student mentioned ("*Because it is the area that most fascinates me, because of its versatility*"); the reference to curiosity associated with some random just in time aspects, mentioned by a student ("*By instinct or even by curiosity, at the moment of choosing a programme*").

Of the 37 responses, 4 were not considered in the analysis, as they did not contain any relevant or understandable information.

Most students gave very short answers (example: "*It seemed interesting*"), and only one student detailed and gave reasons for his choice. This student mentions in detail his tastes that led him to choose this programme: "*Interest in energy and the various things we can do with it, for example using home automation. And I'm interested in renewable energies and because I didn't want to limit myself only to electricity because I'm also interested in air conditioning (thermodynamics and heat transfer). The programme gave me the opportunity to have a basis for all my interests.".* This response shows concrete interest in some areas of the programme, and awareness of the different areas that the it addresses. It also refers to the awareness of the multiple potentialities that the knowledge provided by the programme can allow to be carried out.

But the fact that most students gave short and generic answers may indicate a weak involvement or like / interest in one (or several) specific area of the programme. This may be associated with a circumstantial or external motivation to attend the programme, and/or the students' lack of engagement with the programme. This aspect is also strengthened by the fact that a high percentage (83.9%) of students refer as the main motivation for choosing the programme, the fact that the programme has high employability, that it is broadband (which is also related to employability), and the guidance provided by family members or the fact that they did not take the first option programme. This can have strong consequences on the way students engage (or not) in their learning and academic path [14], on their ethical behaviour (or not) during the programme [18], [19], on student dropout [14], as well as their future professional performance [19].

3.2 Motivation for choosing the Electrical Engineering programme

To the open question about the reasons that led to the choice of the Electrical Engineering programme, 49 students answered this question.

The analysis of the answers made it possible to obtain a synthesis of the (non-exclusive) categories that emerged from the answers themselves. Some answers had more than one motivation. The categories obtained were:

- Proximity to the informatics field (answer example r: "*Among the programmes that cover the informatics field in terms of software, firmware, and hardware, this is the one where I can get more resources in terms of learning these 3 subfields"*);
- High employability (answer example: "*It is an area in which it is very easy to find a job*");
- Be a broadband programme (example: "*It covers a large area at a professional level*");
- By personal like/interest (answer example: "*I like the field of electricity*");
- For guidance from family members (answer example: "*Decision based on the interests I acquired before university and family counselling in addition to professional opportunities*");
- Expand knowledge in the area/complementary training (answer example: "*To complement the degree I already have (Biomedical Engineering)*");
- Natural follow-up of the path taken (answer example: "*I took a professional programme in mechatronics and the area that aroused my interest and that I liked the most was electricity and electronics. So, I decided to take the next step, the bachelor's degree*");
- Not having entered the programme that was the 1st option - Computer Engineering (answer example: "*Because I did not enter Computer Engineering*").

One of the most mentioned words in the responses was "interesting/interest" referring to the area of Electrical Engineering. This word was, in many cases, associated with the word "I like".

Table 2 shows the percentage of students who referred to each of the categories that emerged from the analysis of the answers.

Table 2 - Percentage of students (depending on the total number of answers) who mentioned each of the categories

Category	Frequency
Proximity to the field of Computer Engineering	8,1%
High employability	32,6%
Be a broadband programme	12,2%
By personal like/interest	67,3%
By guidance of family members	10,2%
Expand knowledge in the area / complementary training	12,2%
Natural follow-up of the educational journey	10,2%
Not having entered the programme that was the 1st option (Computer Engineering)	6,1%

The analysis of Table 2 allows us to conclude that most students refer to personal like or interest in the area of Electrical Engineering as the reason (or one of the reasons) why they chose the Electrical Engineering programme. In addition to this reason, the high employability of graduates is also mentioned. Although the reason "Not having entered the programme that was the 1st option" is the least mentioned, it is quite relevant, since the two areas of Electrical Engineering and Computer Engineering are very close (Computer Engineering originated in Electrical Engineering). This aspect is even more relevant considering that in Portugal the Computer Engineering programmes usually have a very high number of candidates and students not placed. This reality contrasts with the current situation of the decreasing number of candidates for Electrical Engineering programmes and a surplus of positions to be filled [8].

The fact that few students mention the proximity between Electrical Engineering and Computer Engineering and even the fact that they were not placed in Computer Engineering may result from the fact that the Electrical Engineering programme at the higher education institution in which the study was carried out only designate "Electrical Engineering" and not "Electrical and Computer Engineering". The inclusion of "and Computers" in the name of the programme can better demonstrate the proximity between the two programmes/areas,

and therefore, exert greater attractiveness for students who are not placed in Computer Engineering.

Of the various responses submitted by the students, the following stand out:

- By reference to curiosity in the face of electrical phenomena ("*I have always found the electrical part of technology interesting and curious*");
- The reference to a circumstantial aspect (being a programme operating on an after-work regime). This aspect was mentioned by only 1 student, despite the fact that 16% of Electrical Engineering students who answered the questionnaire attended the programme after work. It can be inferred that the programme being on an after-work regime was not the most relevant reason for choosing the area of Electrical Engineering. It should be noted that the after-work programme has a very low attractiveness (measured by the number of applicants and enrolees) [8].
- A response was not considered as it did not contain any relevant or understandable information.
- One of the answers recognizes the role of one of the close relatives, his professional activity, and the fact that he grew up in an environment where the area of Electrical Engineering was very present. This may have contributed to an awakening of interest and even the development of an engagement with this area, associating it with discovery, but also with pleasure (associated with the use of the verb to play). The answer says: "*I chose this programme because of the environment in which I lived. My father is an appliance repairman and in my childhood, I spent my days working with him "playing" with the machines*". This motivation profile was more likely in the past, when children interacted more with the professional practice of their parents (or other close relatives), and is less common nowadays. However, this way of getting in touch with an area of knowledge and professional can develop a sense of inner/intrinsic motivation and even the playful/pleasure dimension, both in learning and in professional practice. This enhances the involvement during the learning process and the sense of belonging to the area [20].
- There is also the case of a student who mentioned that the choice of the programme implied a process of indecision and that the reasons that led to the choice were external: "*I was still undecided, and it was the programme with the most [professional] output*".

3.3 Comparison between the two programmes

When comparing the reasons for choosing the programmes, it can be seen that students who chose the Electrical Engineering programme refer less external reasons (the sum of high employability, being broadband, influence of family members and not having entered the programme that was their first option) is still lower (61.1%) than students who mention "For personal like/interest".

Due to the greater proximity between Electrical Engineering and Computer Engineering (than between Electromechanical Engineering and Computer Engineering), there is an increase in students who, having not entered Computer Engineering, choose to enter Electrical Engineering.

The second main factor that seems to lead students to choose the Electromechanical Engineering programme is the fact that it has a very wide bandwidth, since it encompasses two different areas (Electrical and Mechanical). This factor is also associated with employability, so 78.3% of the responses refer to one of these aspects as the main reason for the choice. This value is only 44.8% in the case of Electrical Engineering students.

Seeing separately the reason for "being broadband" and "high employability", it appears that the students of the two programmes recognize the high employability of graduates, but the Electrical Engineering students still recognize it more as a reason for choosing the programme. Electromechanical Engineering students seem to value more the fact of being "broadband" and of uniting two areas that in professional practice are interconnected.

The high number of students (35.1%) of the Electromechanical Engineering programme who mentioned "Having training in both electrical and mechanical areas" seems to indicate that their choice is also strongly influenced by the component in the mechanical area. The fact that in recent years the attractiveness of Mechanical Engineering programmes has grown in Portugal can also be reflected in the increase of applicants to Electromechanical Engineering programme. As the number of potential candidates for Mechanical, Electrical and Electromechanical Engineering programmes is limited by the number of candidates who passed the mandatory national exams for these areas (Mathematics and Physics/Chemistry), the growing attractiveness of the Mechanical Engineering area has reduced the number of candidates for Electrical Engineering programmes.

The reference to "I like" for a specific area of Electrical Engineering or of Electromechanical Engineering was only mentioned by 1 student in each

programme, which leads one to consider that most students do not enter the programmes with a preference or engagement for a specific area of the programme. It will be interesting to evaluate whether they develop this during the programme.

4 Conclusion

The results allow us to conclude that the factor "personal interest" is decisive in the process of choosing the programme to follow. In view of this, and since fewer young people have previous contact with the area of Electrical Engineering, the importance of contact with this area being promoted among young people (non-higher education) so that they can develop interest in this area is highlighted.

Another very relevant reason is the high employability. This aspect should be highlighted, namely in the dissemination of programmes in online or face-to-face actions.

The fact that the Electrical Engineering programme is broadband also seems to be an element of attraction for the students, which should be highlighted in it dissemination. Based on these results, it can also be equated that students do not value narrowband programmes, either because they are more monotonous in their content, or because this can reduce their employability. This result is important to guide higher education institutions when creating or configuring the programmes they make available to students.

In the case of the Electrical Engineering programme, its designation also seems to be relevant to show its proximity to Computer Engineering. This result helps higher education institutions in choosing the names of programmes and is associated with the importance of programmes being comprehensive in the training provided to students.

Considering the current problem resulting from the decrease in demand for Electrical Engineering programmes (both in Portugal [8] and in other countries [7]), the present study contributes to a greater knowledge of the reasons that lead students to choose a programme in the area of Electrical Engineering and Electromechanical Engineering. This can help higher education institutions in their decisions and teachers in formulating a curricula plan that meets the motivations of potential candidates and students.

In future investigations, we intend to investigate what are the expectations that students have about their future professional activity, trying to understand if during their academic path, students developed some like/interest in one (or several) sub-areas of the programme, or even a sense of belonging to the field of knowledge.

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