

Fomento de vocaciones en ingeniería en educación secundaria en Portugal

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PLAN DE INVESTIGACIÓN

PROGRAMA DE DOCTORADO FORMACIÓN EN LA SOCIEDAD DEL CONOCIMIENTO

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INTRODUCTION

The 21st Century Engineer constantly deals with challenges and uncertainty, incomplete data, and competing/conflicting demands from clients, governments, environmental groups, and society. It requires skills in human relations and technical competence (Mills and Treagust, 2003). With so many demanding requirements, qualities, and skills, how can the education system captivate the engineers of tomorrow? Learning is by no means a simple or linear process. It is a complex human experience that must be exciting and enjoyable (Kapranos, 2015). With these assumptions, students should prepare for a university path in Engineering. That in this career, they will stimulate and acquire new skills, knowledge, and ingenuity, achieving the much-desired right result after so many failed attempts and. It will not always be easy, often tiring, but they will be part of something bigger: professionals of an elite of technicians who serve and respond to the needs and issues of society.

A decade ago, Bodogna, Fromm, and Ernst proclaimed that engineering education's primary goals should be to develop, in as individualized a way as possible, in each student the following capabilities: Integrative capability, analysis capability, Innovation and synthesis capability and contextual understanding capability (Shuman et al., 2002). And how can they acquire these skills? Through Education, theoretical and practical. But what is the exact definition of Education? We can equate even more questions about Education, such as "Is education, as should be, a fundamental human right"? "Is the most expressive and correct way to gain knowledge and acquire the right skills for my future"? "Is it the development of the ability to argue and practice critical thinking"? Or "Is it a ticket to the economies and markets of the 21st century"? Perhaps education not only stimulates the development of intellectual capacity but also provides economic benefits for the students and the greater society, and therefore the main goal of a university should be education and preparation for global citizenship (Kapranos, 2015).

There are indicators that engineering degrees are experiencing a decrease in the number of students and a discrepancy between female and male students. This fact should be cause for concern since society needs solutions and answers to the many dilemmas and challenges it faces today and those that are yet to come. In the case of Portugal, and consulting Portuguese statistical data, even though the number of Engineering students has registered an increase towards the highest number of students enrolled in Engineering courses since 1995, we conclude that the relationship between the number of students enrolled in Engineering courses Engineering and the total number of vacancies made available in higher education shows the lowest value ever recorded and with a negative trend since 2012. The reasons may be based on a loss of motivation among students to begin a problematic career, despite the great expectations Jobs proposed from society (Blázquez and Castro, 2011). Dropout is also a complex phenomenon of concern in the context of university education, which can have several reasons. Although there are many researches on the study success of students, the focus on study success policies and their effectiveness is rare, showing that the data available is diverse regarding availability, data collection methods, definitions, and usage (European Commission, 2015).

One of the obstacles to interest and success in attending Engineering courses, especially in underperforming schools that represent students with economic difficulties and minorities, is their lack of awareness of academic and career options available to them in STEM fields (Enriquez et al., 2018). One approach to solving the problem is the increase of pre-college engineering programs, exposing high school students to engineering content and practices (Salzman and Lafayette, 2020). Engineering is a hands-on profession where doing is key. Before the existence of engineering schools, engineering was taught in an apprenticeship program modeled in part after the British apprenticeship system, where engineers had to design, analyze, and build their own creations— learning by doing (Watson and Science, 2020). So why not take Engineering to those who haven't experienced it yet?

From a scientific and educational point of view, stimulating and implementing definitions of Engineering in secondary school students may encounter several obstacles, so it is imperative to adapt the complexity and methodology of the themes to the knowledge already acquired by these students (Enriquez et al., 2017). It is crucial and urgent that an answer be given to this problem, since it is believed that the application of science and engineering-based education is able improve the quality of human resources to face the challenges of the next century(Performance & Reading, 2009).

WORKING HYPOTHESIS AND PRINCIPAL OBJECTIVES

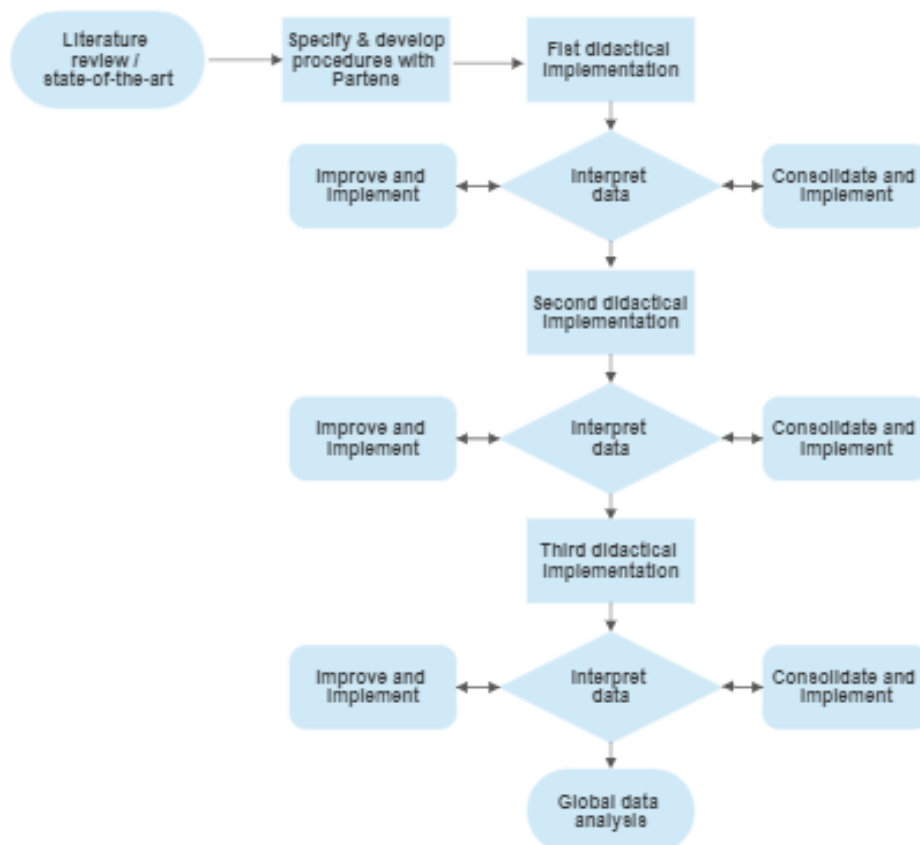
Considering that the tendency of pre-university students to choose careers in Engineering is negative and appears to be getting worse, this thesis project will investigate the current national landscape of Engineering, trying to find out what the interest is and how to entice pre-university students into careers in Engineering and the probability that they apply for a vacancy in higher education in an Engineering course. In the present study, other variables are highly relevant since they present significant variations at the national level regarding gender and the geographic location of students before entering higher education. The development of this study focuses on a proposal for intervention in Portuguese secondary schools through engineering activities to analyze the perception of students about engineering and the impact on which they choose engineering careers, as well as to analyze possible variations or anomalies within the study population. After verifying these conditions, the variations that may possibly exist will be analyzed, measuring the impact that the activities had on the students.

The main objective of this doctoral thesis is, through actions with secondary students, to try to understand the negative trend of students who opt for a career in Engineering, the impact that engineering activities may have on secondary school students, and on choosing a career in engineering and understanding the phenomenon that leads to these students not finding Engineering attractive as a future professional career.

Considering the problem, the main goal of this work aims to study the following Research Questions (RQ):

- ❖ RQ1: What is the students' perception about the current status of the Engineering career?
- ❖ RQ2: What is the interest of high school students in the career of Engineer?
- ❖ RQ3: Why do pre-university students not choose Engineering?
- ❖ RQ4: How to attract students to Engineering?

The planning and streamlining of processes is represented in the following flow chart.



METHODOLOGY

Educational research consists of applying the scientific method to the educational problem study to explain, predict, and/or controlling educational phenomena ((Gay, L., Mills, G. E., & Airasian, 2012). Scientists seek knowledge away from personal perceptions and beliefs through the scientific method. This is achieved by empirically verifying ideas through a procedure open to public inspection. The reliability of the data obtained will depend on objective observation (Gilberto, 2022). To counteract the negative tendency of students to enroll in engineering courses, actions related to Education and Engineering should be taken, focusing on activities that involve more hands-on learning, efficient use of computers and their software, better textbooks that contain realistic examples and more efficient and simplified communication with students (Baruh, 2015).

A systematic review of the literature will be carried out to conduct this research work. A systematic review aims to identify knowledge gaps and research needs in a particular field. This requires a precise specification of the problem area and a critical review of the literature within that domain to present a fine line of argument that identifies the knowledge gaps and research that needs to be addressed (García-Peñalvo,2022).

We will use a mixed methods approach, collecting or analyzing data from the quantitative and qualitative approaches (Creswell, 2007). There is a diverse range of techniques employed in these approaches. Each adapted to the problem to be answered. However, it is advisable that the researcher dedicates time and resources to interacting with the students who will be studied, and the data collection must be extensive and drawn from multiple sources such as direct or participant observations, interviews, questionnaires, archival records, physical artifacts and audio-visual materials (Williams, 2007).

The samples will be used from students from the target courses where the didactical implementations will occur. The present research work outlined the objective of covering schools mainly in the northern region of Portugal. This methodology will make it possible to obtain various data on possible differences between schools in the interior or

coast, public and private education, within large metropolitan areas or remote areas, and the mismatch between the gender of students in these groups. Establishing partnerships with public and private entities defines a strategy that, by expanding contacts, makes it easier to obtain data, disseminate information, and facilitate contact with groups of individuals from different geographical areas.

After defining and fine-tuning the strategies and methodologies, the first activity - two classes per institution - will take place during the entire school year to reach the largest Portuguese educational institutions. The data obtained to answer the research questions (RQ) is summarized in the table below.

| Collected Data | | RQ1 | RQ2 | RQ3 | RQ4 |
|-------------------|--|-----|-----|-----|-----|
| Quantitative data | Attendance in activities (quantity and distribution over time) | x | x | x | x |
| | Interest in the proposed recreational activities (quantity and distribution over time) | x | x | x | x |
| | Participation and conclusion in short courses of Engineering – number of accesses and distribution over time | x | x | | x |
| | Students final grades in short courses of Engineering | | x | | x |
| | Students grades per component/task in short courses of Engineering | | x | | x |
| Qualitative data | Participation and/or delivery of proposed tasks (in due time) | x | x | x | x |
| | Short courses of Engineering – contents accessed, participation in forums | | x | | |
| | Students questionnaire | x | x | x | |
| | Interviews and/or informal comments | x | x | x | x |
| | Types of assessment tools and its distribution along the semester | | x | x | x |
| | Time used in giving feedback and type of feedback given to each assessment task | x | | x | x |

Finally, the statistical tool SPSS (Statistical Package for Social Sciences) will be used for the data analysis. It will be done with a qualitative and quantitative cross-analysis, considering the various study variables defined and mentioned above.

In all scientific studies, it is essential to abide by ethical guidelines to promote accountability by informing those who rely on any aspects of the statistical practice of the standards they should expect, especially in research related to Education (BERA, 2018).

MATERIAL MEANS AND RESOURCES

This work is carried out in the Ph.D. Programme: Education in the Knowledge Society (García-Peñalvo, 2013; 2014), with its portal being the main tool for communication and visibility of progress (García- Peñalvo et al., 2019b). This thesis is developed in the GRIAL Group of the University of Salamanca (García- Peñalvo et al., 2019a; GRIAL Group, 2019), in collaboration with CIETI-LABORIS Research Group (Centro de Investigação em Engenharia e Tecnologia Industrial – Núcleo de Investigação em Sistemas de Testes).

All databases made available by the University of Salamanca and the Polytechnic of Porto – School of Engineering will be used for the literature review phase. According to the partnership with the Portuguese Order of Engineers, the data will be available, complying with the General Data Protection Regulation (GDPR).

All resources available at CIETI-LABORIS Research Group (Centro de Investigação em Engenharia e Tecnologia Industrial – Núcleo de Investigação em Sistemas de Testes), are available for the research work and can be used in the different phases of the research.

Some resources will be made available by the Portuguese Professional Association of Engineers, Ordem dos Engenheiros, according to its initiative and program "There is Engineering in me".

Most of the required data will be provided through Moodle platform, Interviews and questionnaires. We will use the statistical tool SPSS (Statistical Package for Social Sciences) for data analysis.

TIMING SCHEDULE

This research is expected to be completed in five years as the registration in this PhD Program is part-time. Thus, the activities developed to fulfil the research objectives are scheduled for a period of 5 years, as shown in the table below:

- 10th edition (I. Pearson Education (ed.)).
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- Feisel, L.D. & Rosa, A.J. (2005), The Role of the Laboratory in Undergraduate Engineering Education. *Journal of Engineering Education*, 94, 121-130. <https://doi.org/10.1002/j.2168-9830.2005.tb00833.x>
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