trends in higher education

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In Search of a More Balanced Engineering Curriculum: The Perspective of Students, Teachers, Alumni and Employers

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Abstract: The purpose of this paper is to raise important issues in engineering education in the face of contemporary challenges and demands through the voices of different stakeholders in engineering curricula and in the practice of professional engineering. Several challenges and future perspectives are based on important skills, like soft skills, which are required by employers and include communication, decision-making, problem-solving, leadership and emotional intelligence, as well as the ability to work with people of different backgrounds and apply technical knowledge. A qualitative data analysis of interviews with students, alumni, teachers and employers revealed the demand for more balanced qualified curricula for higher education institutions in the field of engineering. This includes the promotion of collaborative learning spaces, authentic learning experiences based on engaging students in real situations, project-based learning, industrial visits, guest lectures and problem-solving methodologies that are perceived by these stakeholders as essential in the construction of a curriculum, in line with the specific technical competences of each area.

Keywords: curriculum; engineering education; challenges and demands; soft skills

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Citation: Ferreira, C.; Gabriel, B.; Valente, R.; Andrade-Campos, A.; Dias-de-Oliveira, J.; Neto, V.; Soares, S.; Carvalho, T.; Figueiredo, C. In Search of a More Balanced Engineering Curriculum: The Perspective of Students, Teachers, Alumni and Employers. *Trends High. Educ.* **2024**, 3, 142–154. https://doi.org/10.3390/higheredu3010008

Academic Editors: Nataša Erceg and Ivica Aviani

Received: 29 December 2023
Revised: 15 February 2024
Accepted: 19 February 2024
Published: 22 February 2024

1. Introduction

The demand for quality in engineering remains high, and employers are increasingly looking for talented and resourceful professionals who can combine knowledge, skills and attitudes [1,2]. These demands force higher education institutions to develop innovative approaches that support the aspirations of the industrial world [3]. According to Buhari et al. [2], "the purpose of engineering education is to build knowledge, skill and attitude to enable the graduate to proceed to train and experience that will develop the competencies required for independent practice in professional role" (p. 441), which are materialized in a curriculum plan. However, in recent decades, the focus of learning has been mainly on the technical/hard skills and know-how required by the labour market. Nevertheless, there is no doubt that, today, engineering graduates need to develop and acquire a combination of skills—namely, hard skills and soft skills [4]. Soft skills, also synonymous with designations such as "21st Century Skills", "Key Competences", "Generic Competences" and "Core Competences", find their greatest references in the concepts of creativity, problem-solving, communication skills, empathy and teamwork [5,6]. However, soft skills are difficult to define and measure, and there is no consensus as to what they are. Authors like

Wentz [7] and Cimatti [8] associate them with social, emotional and behavioural skills that are indispensable in the world of work. Soft skills should complement technical and scientific information [9], and, therefore, it is important to prepare students to develop the skills required not only by companies but also by society. Hence, the need for higher education institutions (HEIs) to evolve and adapt to the quality of training is required. The interpersonal and social skills currently demanded by employers are not recognised in graduates, where undisputed technical knowledge mainly predominates [1,10]. More than defining the concept of competence, the formula that seems to please students, teachers, graduates and employers is the one that combines technical competences with soft or transferable skills, with a view of their success [9]. They demand a type of engineer who is socially connected and can work both within and outside the boundaries of their own discipline. But how can we incorporate skills into an engineering curriculum that are intangible from the outset, such as behavioural, personal and interpersonal skills, as well as personality traits, attitudes and behaviours—all of which are intangible but visible as behaviours that are perceived as appropriate and desirable in the job market—ranging from leadership qualities to facilitation, mediation and negotiation?

Always bearing in mind the possibility of effective teaching and development in graduate and post-graduate students, Almeida and Morais [9] list a set of soft skills in the following interpersonal, cognitive and emotional dimensions:

(i) Interpersonal skills: assertive, efficient or effective communication; interpersonal trust; cooperation; empathy;
(ii) Cognitive abilities: problem-solving, critical thinking, decision-making, self-evaluation;
(iii) Emotional control: emotional management skills.

This set of soft skills is recognized in higher education institutions by the growing importance of innovative teaching methods that integrate the teaching of soft skills into subjects, with a strong emphasis on the development of hard skills. The development of interdisciplinary competences is also emphasised as important in the development of soft skills, in subjects common to several courses, for example.

On the other hand, the growing importance given to internships by HEIs has been a facilitating element in the development of "Generic Competences" in students throughout engineering courses, and there is also growing concern about encouraging pedagogical methodologies that promote the development of "21st Century Skills". According to Katz et al. [3], "The complex sociotechnical nature of today's grand challenges requires engineers to have the capacity to recognize and reflect critically upon ethical situations, analyze them by applying multiple frameworks (e.g., utilitarian, deontological, virtue ethics, etc.), generate creative courses of action, and make deliberate, thoughtful decisions" (p. 3). For teachers, it is precisely through opportunities for teaching practices that fully integrate theory and application that engineers learn critical thinking and reflective action, for example. But for this to happen, it is necessary to realise that teaching processes depend on the existence of conditions and resources that facilitate their development and operation, such as infrastructure and institutional support, including available classrooms and laboratories; learning management systems and other information and communication technologies, tools and techniques; practice-based management; resources for developing teachers' skills (teacher training); incentives; and time allocated to curriculum development [11]. On the other hand, students need to be challenged not only in their knowledge construction process alone but also through intertwining it with the development of personal, social and professional competences that will enable them to operate in a more open and interconnected engineering environment [12]. This puts pressure on HEIs and, consequently, on engineering teachers to design and implement curricula that can achieve these learning objectives. It is essential to emphasise not only the challenges facing today's higher education systems but also the challenges of engineering in a rapidly changing global environment.

The purpose of this paper is to identify and explore the perceived challenges engineers are expected to face in the job market and society and how the curriculum can respond to these challenges. The qualitative data collection focused, as an example, on the degrees of two engineering fields, namely, mechanical engineering and biomedical engineering. These two engineering fields were considered from the point of view of including a more classical field of training, together with a new field with a very high recruitment profile.

This paper outlines specific strategies and solutions in curricula, according to the students, alumni, teachers and employers that were interviewed, as they considered curriculum design principles that could help address the challenges faced by these stakeholders in developing graduate competences.

2. Materials and Methods

2.1. Participants

Qualitative data collection focused on the degrees of two engineering fields, namely, mechanical engineering and biomedical engineering. These two fields of engineering were chosen considering their distinct nature and the time of existence in higher education institutions. Mechanical engineering is a more traditional degree, with a more well-defined field of activity and a majority of male students. Biomedical engineering is a more recent bachelor's and master's programme, with very competitive entry grades and with a professional field still to be well defined and chosen in a more balanced way in terms of gender.

Participants from four different stakeholders were invited to participate, constituting a purposive sample covering different group characteristics and associated with three different higher education institutions to ensure a better understanding of the research problem. The main aim was to select participants who would bring distinct perspectives on the topic in order to generate a wide variability of views and insights on the topic. Interviews were held with privileged actors who were asked to provide recommendations of colleagues or other stakeholders who could bring a unique perspective, and these were afterwards invited to participate.

The three institutions chosen cover three different regions of Portugal (north, centre and south), are different in terms of type (university and polytechnic) and include old institutions and a more recent one. The three institutions offer both mechanical and biomedical engineering and already have graduates in the labour market.

A total of 17 teachers at different career positions were interviewed (10 female—58.8% and 7 male), with ages between 37 and 58 years old and with an average age of 50 years old. Of the 17 teachers interviewed, 11 (64.7%) belonged to mechanical engineering courses and six belonged to biomedical engineering courses.

Twenty-nine (29) students from the second and third year of the bachelor's and of the master's course participated in the study—16 from biomedical engineering (55.2%) and 13 from mechanical engineering. The students' ages ranged from 19 to 24 (M = 20.8%) years old, with 15 of them being women (51.7%).

Thirteen (13) alumni were interviewed (2 female and 11 male—84.6%), with ages ranging from 23 to 60 years old (with a mean age of 32 years old). Of the total alumni interviewed, seven (53.8%) had a degree (bachelor's or master's) in mechanical engineering, and six held a master's degree in biomedical engineering.

From the fourth stakeholders' group, the **employers**, representatives from the top management or human resources departments of eight small and medium-sized enterprises ($n = 4$) and large companies ($n = 4$) participated—six from the mechanical engineering field (66.7%) and two from biomedical engineering.

2.2. Data Collection Procedures and Instrument

An extensive data collection phase was developed from April 2022 to June 2023, considering both in-person and online individual and collective interviews and focus groups, following what would be most convenient for the participants.

Individual interviews were conducted with teachers and alumni, and collective interviews were led with employers' companies, gathering the shared views of different participants with different roles (top management, human resources management, technical and production managers). Focus groups were carried out with students from different academic years, genders and institutional involvement. The participants were chosen after considering different personal and institutional characteristics to enable a more diverse discussion and problematisation of the research topics.

All of the participants who were involved were adult volunteers who were invited to this study due to their role as a member of one of the stakeholders' profiles considered in the research design—namely, students, alumni, teachers and employers. Before the start of each interview or focus group, the participants were thoroughly informed about the scope and objectives of the project and the ethical procedures underway. After the briefing, the participants signed a declaration of informed consent, which included the aims of the research and ethical procedures, a guarantee of confidentiality and the assurance about the possibility of leaving the interview or the focus group at any point without any setback.

The average length of the interviews was one hour and thirty minutes, and the average length of the focus groups ranged between two hours and two hours and thirty minutes. All these moments of data collection were transcribed in full after being recorded with the explicit prior authorisation of the participants.

The semi-structured interview protocol that was equally conducted in the four groups of participants (either for the individual and collective interviews and the focus groups) included four large groups of questions, two of which stand out for this article, designed to answer the following research questions:

- What challenges are engineers expected to face in the job market and in society?
- How can the curriculum respond to the challenges identified?

Four focus groups were conducted with students enrolled in bachelor's and master's degrees, divided by mechanical and biomedical engineering—two at the University of Aveiro, one at Instituto Superior Técnico (University of Lisbon) and one at Instituto Superior de Engenharia do Porto.

2.3. Qualitative Data Analysis Procedures

Thematic analysis was used as a procedure for qualitative data analysis, being a methodological procedure that enables the identification of themes and patterns both for individual and collective data collection procedures [13].

3. Results

The results highlight the various interviewees' perspectives, clearly emphasizing a set of future demands and challenges, based above all on the curriculum and the development of soft skills, which complement each other to respond to society's demands. For the interviewees, soft skills were synonymous with the "Transversal Competences", "Transferable Competences", "Key Competences" and "Generic Competences" that are essential for the 21st Century. The uncertainty of the future, coupled with the repercussions of the present (for example, the energy crisis, the technological advances, the pandemics, the sustainability of the planet and armed conflicts), underpin the need for an engineering curriculum that is more aligned with competences that are difficult to measure and evaluate, such as interpersonal competences, for example. The engineering profession is seen as a profession that is close to society, and especially to its needs, in terms of the ability to deliver a quick and effective response—particularly the ability to anticipate scenarios. This condition places a responsibility on HEIs to provide training that combines specific and technical competences with soft skills. In this sense, what can HEIs do? By way of example, the University of Aveiro mentioned in this study has created the "Transferable Skills" course, with the aim of developing a set of skills and knowledge that, while not part of the specific competences of each of the engineering disciplines, represent generic hard skills, as well as the soft skills that are considered relevant to professional practice. In this course, students are given the opportunity to acquire the foundations of knowledge and the basis of skills in three modules, each corresponding to a third of the academic semester. As a result of an extensive consultation process among the current course leaders of the undergraduate engineering degrees at the respective university, a set of topics of interest were identified, corresponding to different modules. Students are able to choose from a set of three modules from an extended list, which includes content on the themes of Entrepreneurship and New Business; Project management; Design Thinking; Communication and Presentation Techniques; and Economics I or Business Finance, among others. The student can choose from a wider range of modules, albeit with a certain degree of guidance, flexibility and autonomy, inducing the student to reflect on their training profile. The consistency of teaching methodologies with learning objectives is firstly ensured by a careful definition of learning objectives. On the other hand, the consistency of the syllabus with the curricular unit's objectives is guaranteed primarily by the careful definition of the learning objectives and the respective syllabus. The learning objectives and syllabus were developed by teachers who have advanced knowledge and experience in the topics to be addressed in the various modules, since these objectives and contents are developed in other study cycles of the institution. The modules are taught by professors of the teaching and learning units who specialize in the topics to be addressed, and, as such, there is the necessary degree of specialization and experience to ensure the consistency of the syllabus and the objectives of each of the modules that comprise the degree. The evaluation results from a combination of the evaluations of each of the modules that the student attends. Considering that each student is to attend a set of three modules throughout the semester, the grade of each of the modules has a weight of one third in the final grade. The assessment methods to be adopted in each of the modules is consistent with the theoretical–practical typology of the curricular unit and with the workload associated with it, being the responsibility of the teacher responsible for each module. At the "Recurso" ("Resitting") season, students who did not pass one or more modules, or those who, having passed, intend to improve their classification, may take the exam.

3.1. Alumni

In the analysis of the interviews conducted with alumni, twelve categories (Figure 1) and sixty-one subcategories were identified. It should be noted that the categories and subcategories identified converge towards a comprehensive scenario of an engineering curriculum that meets the expectations and needs of the various stakeholders, as well as the building of an engineering student's profile and, consequently, the modelling of a professional, the engineer.

The alumni recognise the existence of "current challenges" that arise not only from the needs and consequences imposed by COVID-19, the war in Ukraine and the consequent energy crisis but also "future challenges" that are assumed as outcomes of the designs of the present. These challenges relate to the acquisition of skills in programming, communication and simple, effective and quick problem-solving.

These ideas are expressed in some of the following citations:

- *"In the future, they have to have these skills very well defined in terms of programming and all that because it will give an added value in everything";*
- *"It is also important, and being linked to the part of electronics, programming, I believe that it is really a job of the future for those who want a job";*
- *"I feel there's a lot of lack, and I know a lot of people talk about soft skills";*
- *"There have been some changes in some universities, for example, including more humanities, history, science and technology, and it is also important";*
- *"The engineers I would like to look for are people who can be given a certain problem, can find a solution through simple methods and solve that problem. I believe that more and more is going to be the role of the engineer and I also believe more and more that the engineer has to know how to communicate a lot, make that connection a lot of the time".*

Figure 1. Alumni tree categories (Authors, 2023).

For the alumni, the desired curriculum focus would be, as follows:

- A curriculum that combines the specific hard skills or technical knowledge of each engineering field (maths, physics, programming skills) with a strategic focus on soft skills (e.g., emotional intelligence, leadership, behaviour management, conflict resolution, mental health, communication skills, employment law, work methods/habits);
- A curriculum with a strong training offer in the area of computer programs (even basic Office programs, e.g., Excel) and in the area of programming that is constantly updated and in line with international innovations (e.g., teaching of outdated, obsolete and outdated software programs);
- A practice- and research-oriented component of the curriculum that might be operationalized, for instance, by developing research-applied projects or by offering regular mini-internships or extended internships.

3.2. Students

In the content analysis of the interviews conducted with students, six categories (Figure 2) and twenty-five subcategories were identified.

The students highlight personal fears related to training, namely, what was not covered by the curriculum, which materialises in the demands of employers, and not knowing what the future holds, especially in Portugal, which is camouflaged by a possible lack of knowledge of the potentials of biomedical engineering:

- *"The idea we usually get is that you're a biomedical engineer, you learn quickly, you learn other things, so we hire you to do things that have nothing to do with what you've learnt, but you adapt, so come on";*
- *"For me personally, I don't see much of a future in Portugal in the area I'm interested in now, which I probably wanted to do; I don't see a future in Portugal from what I've heard";*

- *"I think this type of competence [soft skill] is much easier, at least I see it for our generation, if it's something of our own initiative, if we're the ones looking for it, if we sign up for activities, if we join the Centre. Not exactly a chair that forces us to develop these"*;
- *"I also found it interesting that I started to like other areas that I hadn't expected to like so much, like the programming part and all; that part that was more daunting at first became a lot more interesting and even helped to combat so much physics, because then you'd get to those subjects and then you'd be like ah! this is different, it's something else. That's the feedback that's been positive so far, but there's still some time to go"*.

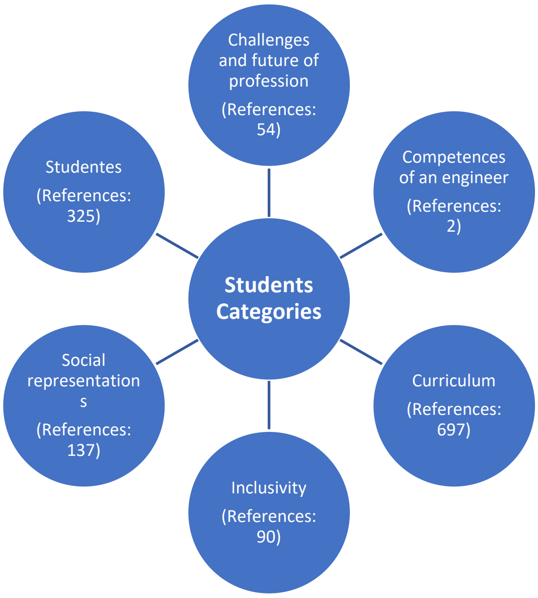

Figure 2. Student tree categories (Authors, 2023).

The students suggest a curriculum that focuses on a more hands-on and applied component that emphasizes the alignment between theory and practice, which might be operationalized through seminars with company representatives, as well as more time allocated in the laboratory and on research, with meetings with researchers and doctoral students. In their opinion, it is clear that they would like to have a curriculum with a more professional profile, which seems to be fundamental to what they expect will be asked of them, i.e., a profile that requires adaptability to demanding and constantly changing situations and problems ("resourceful" professional profiles). It is clear from the discourse of the students that they perceive an engineer as professional who possesses soft or transversal skills, which play an essential role in problem-solving, being able to offer a solution that is both creative and economic-efficient, work in a team, lead projects and manage and lead people. One idea that was widely expressed and that is also worth highlighting concerns the "weight" of the profession and the name of the training institution which, according to students, influence what an engineer can be expected to know how to do. That is a way of attributing an "ingenious" profile to the engineer—that of a professional, adaptable to a various set of demands, problems and widely heterogenous situations and problems. Once again, like alumni and employers, students consider it crucial that HEIs and employers establish partnerships with a focus on in-context practices, such as study visits, internships and mini-internships, for example.

3.3. Teachers

In the analysis of the interviews conducted with teachers, ten categories (Figure 3) and thirty-eight subcategories were identified.

Figure 3. Teacher tree categories (Authors, 2023).

The teachers emphasise current challenges such as the demand for new branches, for example, in energy, as a result of the energy crisis, and in terms of programming skills. Also, they believe that in the future, challenges will centre more on transversal skills, as indicated by the following quotations:

- *"One of the shortcomings I see in some young people who go to work is a lack of knowledge of how to manage certain projects, have some capacity for self-organisation and method to do things and have some perspective, guidance, work in this direction; I think they lack this a bit";*
- *"I think that's one of the Achilles' heels of a student who is going to manage people in an institution, the connection, that's one of the big challenges; how do we prepare this generation to manage people, deal with the personal side, that's challenging";*
- *"And it was noticeable that this year there was an interesting demand [in the energy sector], let's say, isn't it? That's what I mean, so sometimes, there are certain trends that have to do with lateral events, right?";*
- *"Today it's difficult to talk about engineering without programming skills, whether students like it or not";*
- *"To give to engineering and promote engineering, not just from a technical point of view, as engineering is very much like that, we look at the objectives of a course, the description of the objectives scares me, it scares me and I know what it means, it's systems, I don't know what, it's such a technical word, so technical that it's necessary to appeal more to the aspect of the contribution that engineering can make to solving the challenges of the 21st century, isn't it?".*

Considering the teachers' perspective, it is possible to highlight the following desires for a curriculum:

- A curriculum with an explicit intent on developing soft skills, particularly with a focus on the development of adaptability and plasticity skills to various technical, work and real-world scenarios and needs, such as autonomy, tools for teamwork, team spirit, coordination/leadership, knowledge of working with others, stress management and cognitive skills such as critical and creative thinking;

- A more student-focused curriculum that considers, for example, the actual interests of students when offering options for a study plan (e.g., offering several options that are less popular with students, as well as some options where there is no continuity and for which students would need to have additional knowledge that is not included in the study plan or in the general curriculum);
- A curriculum that promotes, throughout the student's entire academic career, solid training in the area of computing and programming.

Therefore, the teachers recommend a curriculum that strives for difference, aligns with soft skills and is based on students' real needs and interests. However, it must allow, encourage and include extracurricular activities (e.g., volunteer work, participation in projects) that can also enhance a student's CV. This idea is also defended by employers.

3.4. Employers

In the analysis of the interviews conducted with employers, nine categories (Figure 4) and thirty subcategories were identified.

Figure 4. Employer tree categories (Authors, 2023).

The employers accentuate the need for companies to find an engineer with a profile that matches their needs, more along the lines of soft skills (namely knowing how to work in a team and how to communicate). Interviewees also emphasise the need for companies to recognise and meet the needs of their employees (promoting motivation and a good atmosphere among colleagues; incorporating soft skills; offering mini-internships every year; boosting projects; and more practical applications):

- *"There needs to be an interconnection, particularly with mechanical and electrical engineering, in order to make any kind of integration. Of course, this depends on the project and the biomedical engineer's area of expertise"*;
- *"There are some gaps that we find here when we hire engineering professionals. I think behavioural training is important. Many people from the engineering field go on to take*

on leadership roles and they leave university with little... leadership, behavioural, people, teamwork, so more behavioural training";

- *"They should promote more study visits and more... greater contact with schools... I don't know... we receive a lot of requests here for work, projects...";*
- *"I'd go more for integration into internships, whether in companies or hospitals";*
- *"If they did something like mini-internships every year, it would be great";*
- *"I think sharing experiences with other departments, doing joint projects, I think that would help at least in this part of soft skills".*

The employers also highlight the idea of a curriculum that focuses on the development of soft skills, particularly those that offer tools for teamwork and leadership but also the development of creativity and innovation skills, critical thinking, problem-solving, proactivity, conflict resolution, communication skills, working methods and strategies, autonomy and entrepreneurship. These challenges relate to the acquisition of skills in programming; communication; simple, effective and quick problem-solving; demands of employers, more in the area of soft skills; and for new branches. An ideal curriculum would ensure a solid training of computing knowledge and skills (even basic Office programs, e.g., Excel); digital, programming, foreign (especially English) and Portuguese (spoken and written) languages; and management throughout the academic curriculum. In line with the alumni, the employers also recognize HEIs as having the capability of being at the forefront of innovation; in this sense, they also stressed the importance of these institutions to be concerned with the needs and problems faced by society, not only in scenario anticipation but also, and mainly, in terms of continuous training provision adjusted in time and content (e.g., different formats of short-term training and workshops).

It is worth noting that all the interviewees emphasise the importance of implementing wide changes to the curriculum and promoting transversal competences. These changes require further measures if the future engineer is to respond effectively to the demands not only of the profession itself but also of society and employers. In this sense, how can the curriculum respond to the challenges identified?

When taking together the various stakeholders' perspectives, the relevance of higher education institutions (HEIs) are highlighted, and these are (and should be) always at the forefront of innovation but must also be attentive and in tune with the needs of society, either by anticipating scenarios or by increasingly offering training (e.g.: different formats of training actions). However, for these goals to be effective, it is critical to establish strong partnerships between HEIs and employers to discuss and articulate practices in the workplace that truly promote real-world competences. This intention constitutes a challenge in itself. It is also worth highlighting that the alumni also suggest renewal of the teaching staff, referring to aging teachers with teaching practices mostly based on a tradition based on routine and outdated content and programs—for example, the lack of teacher training regarding software updating. They also point out that it seems that it is mainly the younger teachers who attend the training courses promoted by the HEIs and who apply new knowledge in teaching without forgetting the importance of the interaction between teaching and research (e.g., changing the standard practice of innovation only being applied to research and not to teaching).

4. Discussion

Focusing on the curriculum, the various participants depicted a wide set of challenges and future demands for engineering training and professional development. Most participants stressed the importance of developing transversal or soft skills in addition to technical skills, assuming an integrative vision to respond to society's demands. In a more specific perspective, the importance of soft skills concerning leadership, working with and in teams and cognitive skills such as creative and critical thinking was stressed but also the acquisition of programming skills, adaptation to new realities and the need for interdisciplinarity. The effective development of the soft skills domain requires innovative, unified curricula and pedagogies based on a range of learning strategies [3,12], where knowledge is shared in classrooms, teachers behave like facilitators, and traditional engineering disciplines become integrated in interdisciplinary courses [14].

As can be seen, all the stakeholder groups highlighted the need to introduce sweeping changes in the curriculum and in the promotion of soft skills (even though there were differences within the group participants). In this sense, in order to promote a more inclusive curriculum and teaching and learning practices, the various stakeholders interviewed suggested involving not only higher education institutions in the organisation of their courses and curricula (for example, prioritising soft skills or transversal competences) and marketing policies (advertising courses with a more inclusive approach in terms of gender) but also teaching staff (for example, renewing teaching staff and training them in various areas, especially in soft skills or transversal competences and in practices that promote active learning). The lack of employability skills associated with soft skills could easily be eliminated by the promotion of collaborative learning spaces, authentic learning experiences based on engaging students in real situations, project-based learning, industrial visits, guest lectures and problem-solving methodologies [2,5,12,14–16].

To Moalosi et al. [15], employers' demands are at the levels of technical knowledge (hard skills) and generic competence attributes such as soft skills, as well as personal attributes and values. These attributes now seem to be one of the main outcomes of higher education and competences that all graduates should possess. On their part, teachers are increasingly valuing the development of graduates' attributes, seeking to renew and articulate the content of their subjects in response to calls for teaching and learning that is more aligned with soft skills. One of the aims of higher education should be to provide opportunities for students to develop transversal skills, i.e., learning to learn, solving problems creatively, learning to communicate transparently, working as part of a team, managing conflicts, adapting to various cultural contexts and persevering in the face of complicated or stressful situations [17]. Many universities are currently trying to redefine their curricula to incorporate the attributes identified by employers into teaching programmes and to provide students with the skills to meet these needs. This requires a new approach to teaching and learning, which promotes the integration of internships, more regular contact with companies, multidisciplinary projects and co-teaching with key-members of companies. Stakeholders, in particular alumni, in a study carried out in India by Rao P et al. [18], identified four key-attributes, skill, performance, adaptability and communication, in order to understand the types of disruptions in engineering education and the attributes any engineering graduate must sustain in the industry. Curiously, in both Portugal and India, alumni recognise that engineering graduates have difficulty adapting to new technologies, due to poor training in programming, for example; and soft skills, like communication competences, are another limitation found for engineering graduates [17,18].

Studies show that different learning methodologies even improve student assessment about methodologies used in classes that present real-world experiences, encourage problem-based learning and use case studies as active learning methodologies [19,20]. However, other measures will still be necessary for the engineer of the future to meet the demands not only of society but also of employers and the profession itself. Future work could explore how these demands from different stakeholders could reformulate engineering curricula, materializing in the teaching and learning process, and what their impact is on teacher training, in particular.

5. Conclusions

This study improves our understanding on the perspectives of different stakeholders in the perception of engineering curricula and the professional practice of an engineer. The need for designing a curriculum that can balance soft (transversal) and hard (technical) skills for professional success is evident. To design a curriculum with a clear focus on soft skills (e.g., emotional intelligence, leadership, behaviour management, conflict resolution, communication skills, working/habits methods) and aligned with hard skills or technical knowledge is a demand but also a challenge. The results of this study are aligned with other studies that have concluded that engineering graduates lack the skills demanded by employers [18], particularly regarding the "21st Century Skills" required by employers. Employers also demand higher levels of other application-based or technical skills from engineering graduates, such as tools for teamwork, coordination/leadership, knowing how to work with others, critical thinking, creativity, problem-solving, proactivity, behaviour management, conflict resolution, knowing how to communicate, working/habits methods, autonomy, showing initiative and entrepreneurship. One possible explanation for the limitations identified is that these attributes are not easily measurable and are difficult to incorporate into curricula. Additionally, the difficulty in developing assessment tools for these professional competences is rendered even more problematic and questionable when assessing and resolving ethical dilemmas, as well as evaluating the development of team competences and project effectiveness. It is essential to incorporate changes in curricula not only in light of pedagogical research but also to provide an adequate response to the needs of society, particularly employers and newly graduated engineers, who complain about the lack of transferable skills in increasingly complex work and professional development environments.

Author Contributions: For this research, C.F. (Carla Ferreira) conceived and designed the analysis; collected the data; contributed data and analysis tools; performed the analysis; wrote the paper; conceptualized the paper; and reviewed the paper. B.G. and R.V. collected the data; contributed to data and analysis tools; reviewed the paper; and was responsible for supervision, project administration and funding acquisition. R.V., A.A.-C., J.D.-d.-O., V.N., S.S. and T.C. reviewed the paper; collected the data; and contributed data and analysis tools. C.F. (Cláudia Figueiredo) conceived and designed the analysis; collected the data; contributed data and analysis tools; conceptualized the paper, reviewed the paper; and was responsible for supervision, project administration and funding acquisition. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by FCT grant EXPL/CED-EDG/1009/2021 (Funding programme of the Portuguese Foundation for Science and Technology); http://doi.org/10.54499/EXPL/CED-EDG/1009/2021.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The authors declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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