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Strategies for Continuously Improving the Professional Development and Practice of Engineering Educators*

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Lifelong learning plays a fundamental role for all engineering professionals, including engineering educators, as the working context is now international and rapidly changing. The training and professional development of engineering educators are hence of vital importance for letting universities serve society. In this study, the main challenges for the promotion of well-trained and change-oriented engineering educators are methodically analyzed, as linked to preparing the future generations of engineers. A systematic analysis of such challenges is performed and helps with the finding of unsolved or critical aspects, which can be grouped into main problems. After studying them, a collection of actuations or potential solutions, together with a set of tools for checking their progress, are put forward. Key strategies directly involve teachers themselves and their teaching methodologies, implicate students and the relationships with educators, take advantage of available resources and are dependent on the surrounding environment. Their effects are discussed, based on authors' experience, and considering the information from the studies carried out by numerous colleagues worldwide.

Keywords: engineering education; engineering educators; lifelong learning; teaching practice; quality and continuous improvement

1. Introduction

The engineering educators of the future, apart from providing students with the fundamental theoretical knowledge on basic disciplines of science and technology, should be able to train engineers capable of addressing the current global societal challenges and of keeping pace with the innovative techniques, procedures and resources that continuously reshaping professional practice. Engineering education, as happens with engineering professional practice, requires a continuous development to be adapted to the radical scientific-technological revolutions and to a globalized and growingly interconnected world. Ideally, educators should continue investigating in their specialties, during their whole professional life, to offer their students the most recent literature and to make them participate in scientific-technological progresses. Therefore, as science and technology advance exponentially, the need for the continuous update of educators importantly grows, especially in engineering. The contents developed for a course today, may not be pertinent in just a couple of years. Besides, students belong to an increasingly digital and globalized society and to get students involved in the class the methodologies must be renovated. New methodologies and best practices are being incorporated successfully to engineering education; however, educators must develop new skills to use them properly [1–4].

To cite a relevant example, in the last two decades in Europe, along the implementation of the European Higher Education Area (EHEA), a very profound educational evolution has been performed. Engineering programs have been restructured and gradually implanted. In this process the progression of the educators in terms of pedagogical performance has been remarkable. It is important to highlight that most professors are now employing and training students in the use of innovative technologies that did not exist when they were students. Besides, the teaching-learning methodologies used in European universities before the implementation of the EHEA were mainly restricted to master classes, in which the communication skills of the educator and the blackboard were the main educational resources. Additional skills and resources are now needed.

Apart from that new technologies and interactions among engineers (the emergence of artificial intelligence and big data, the spread of 3D printing and the makers' movement, innovative open-source and collaborative approaches, the open software and hardware movements, among others) common of the Industry 4.0 and Society 5.0 paradigms, increase the complexity and quicken the pace of change. All this makes the duties of engineering professors even more demanding [5, 6]. Despite all the efforts put into educational innovation and perhaps due to the new complex educative environment and technological changes, at present, many educators feel like being behind their students and not connecting with them or completely fulfilling their expectations.

Consequently, in this study, the main challenges for the promotion of well-trained and change-oriented engineering educators are methodically

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analyzed, as linked to preparing the future generations of engineers. A systematic analysis of such challenges is performed and helps with the finding of unsolved or critical aspects, which can be grouped into main problems. After studying them, a collection of actuations or potential solutions, together with a set of tools for checking their progress, are put forward. Their effects are discussed, based on personal experiences, and considering the information from the studies carried out by numerous colleagues worldwide, including those from a recently co-edited special issue on: "*Guiding Engineering Educators: Keeping Pace with Scientific-Technological Change and Socio-Economic Development*" for the International Journal of Engineering Education [7].

2. Current Challenges for Preparing Engineering Educators

An important objective of this study is to analyze the key challenges found by engineering educators and to explain how their adequate training could help to strategically face them. Both classical and more recent challenges, motivated by methodological changes in engineering education and by continuous technological advances that force professors to keep pace with engineering methods changing faster than ever before (in our approach to technological singularity [8]), are introduced further on.

Problem solving in engineering is more and more complex and it is necessary to compose groups with heterogeneous members to develop innovative, effective, safe and sustainable solutions. In the same way, to offer a specialized training to the future engineers, a collective approach far away from the traditional individual approach is required. This collaboration would progressively support the establishment of knowledge networks, where educators could share instruments and experiences. In these networks, education practice would be analyzed and guidelines for best practices could be developed. Some pioneering international networks, such as the CDIO "*Conceive – Design – Implement – Operate*" initiative may serve as *gold standards* for the future of an engineering education oriented to complex and multi-faceted problem solving [9, 10].

Besides, training programs for engineering educators should incentivize the development of new experts and, in order to achieve this objective, besides focusing on the academic knowledge, these programs should be completed with intensive tutoring or mentoring. Similarly to what happens in a professional environment, the mentors should be educators of the own organization because they could share their experience and ease the insertion of the novel docents. Hence, the academic organizations should promote the creation of interesting formative programs, which may contribute to develop the docent profile and recognize them by awarding the educators. These training programs should be diverse and complete, because the required docent skills go far beyond the academic ones, and the educators must work in different dimensions.

Currently, research is the principal source of knowledge for the educators. A continuous research contributes to offer students the most recent innovations in the study area. If this studies are carried out working closely with companies, the benefits are exponential, as they help to highlight the applicability of what is being studied, which ends up with a promotion of student motivation. Nevertheless, the research techniques used are not always the most efficient from a teaching-learning perspective or better results may be obtained by using different methodologies. For this reason, training in research methods would enhance the results and if this training is combined with specialized workgroups, best practices and new innovative methods can be developed.

In addition, everyday new technologies emerge and, if they are correctly applied, they can help to improve the daily task of educators. However, the time needed to learn them and the difficulties to use them efficiently in class are some of the barriers encountered by educators. New technologies are everywhere, the digital world allows mobility, agility and accessibility, and training should take advantage of them. For instance, students use their smartphones to access the virtual campus, download their documentation and send their assessments. Therefore, the training of the educators should show how to use new technologies and share the results from previous experiences, also to motivate engineering educators in their lifelong learning quest.

In fact, lifelong learning has been recently put forward by the European Union Council and Commission Report on the *"Strategic Framework for Cooperation in Education and Training until 2020"* (2015/C 417/04) [11] as one of the main drivers of change for promoting a knowledge-based economy, for increasing social cohesion and for improving equal opportunities. However, in spite of the lifelong learning and mobility programs available for educators, the professors from technical universities are sometimes reluctant to benefiting from them or, in most cases, cannot take advantage from such opportunities, mainly due to overwhelming work-related (and especially bureaucratic) duties, lack of supporting funding or even

familiar constraints. This makes the preparation of successful engineering educators even more challenging.

At the same time that research skills or the technology abilities must be developed to increase the quality of lectures, it is important to know, understand and try to apply the last trends in educational practice. New methodologies are getting good results in the engineer formation, such as flipped classroom, experiential learning or gamification [12–14]. These methodologies involve students in more active teaching-learning, when compared to the traditional "sage on the stage" approach. Training the educators on innovative pedagogical practices should also offer experiences and guidelines about how to implement them in their areas of expertise. Consequently, educative organizations should create platforms where educators can share innovative practices forming working networks. Initiation programs with experienced engineering educators mentoring their younger peers can prove also very adequate [15–18].

Regarding internationalization, for example, the European Higher Education Area promotes the creation of international academic programs. ERASMUS and other programs interchange students among universities, thus fostering a global training with international groups. However, the level of the second language of the educators is not always high enough and, in spite of existing mobility programs, the professors from technical universities are sometimes reluctant to benefit from them. Training in communication skills using a second language could enhance the quality of the lectures and increase the participation in mobility programs.

Finally, it is important that organizations encourage the participation of the educators in global initiatives of open education. In Open Course Ware platforms educators can find resources of other educators from different countries and complete them. These materials are used frequently in MOOC platforms, which promote getting a high impact due to the number of students, although somehow lacking the benefits of face-to-face training. The open education helps to expand horizons and set global contact networks of professionals from different countries.

In any case, future work is necessary and research in best practices to face the aforementioned educator challenges will contribute to enrich the quality of higher education, especially in engineering. Additional common problems in the professional practice of engineering education, presented in the following section, need to be analyzed, together with the issues linked to preparing educators and to their keeping pace with technological change, so as to systematically propose strategies for solving some of the main challenges that engineering educators currently face.

3. Common Problems in the Training of Engineering Educators and during their Professional Practice and Development

Together with the challenges linked to a changing world that requires innovative methods to tackle engineering education in a satisfactory way, there are important and common problems connected to the training and professional practice of engineering educators that affect students learning outcomes and should be adequately managed.

For selecting the most relevant and widespread ones to analyze and solve, we have systematically reviewed papers in the engineering education arena and read reports on trends in higher education, but also consulted newspapers that periodically highlight the "evils" of the university, which are unfortunately in many cases aligned with the contemporary universal trend of post-truth and sensational journalism. Very especially we have relied on calm discussions among authors and colleagues, which reflect the overall situation in our country, although we understand that they may be also common worldwide based on our international experiences and participation in international networks. According to our study, it is important to list the following common problems in modern engineering education (and in higher education in general):

1. "Professors do not pay enough attention (paradoxically) to teaching-learning tasks, as their impact on their professional development is low".
2. "Professors tend to focus too much on their own research and teaching tasks, which limits collaboration with and learning from colleagues".
3. "Access to academic positions starts with a PhD completely focused on advanced research and normally alien to pedagogical formation and experience".
4. "Experienced professors tend to think that no one knows about their courses better than themselves and are reluctant to external advice".
5. "Overwhelming bureaucratic tasks force professors to focus more on the gathering of (controversial) evidences than on students' learning process and outcomes".
6. "Professors have difficulties to develop innovative experiences in their classes due to varied boundary conditions".

7. "The technological gap between professors and students does not allow taking advantage of the many possibilities offered by ICT in education".
8. "Professors teach in the same way in the international programs, as in the traditional courses, despite special issues linked to students' diversity".

In previous successful studies, aimed at proposing strategies for transformation, based on the key drivers of change in university (i.e. teachers, students, resources and environment), our strategy was always based on finding the causes for the different problems, to connect such causes with the drivers of change and to subsequently group the causes, propose high-impact solutions and select tools and indicators to measure progress [19–21]. The application of such procedure for the aforementioned problems is presented in the following section, together with a final discussion, just before summarizing and concluding the study. In essence Ishikawa cause-effect diagrams, common in quality management systems [22], are used and then the information is grouped and summarized by affinity to proposed actuations with maximal expected impact.

4. Finding the Causes for the Detected Problems in Connection with Main Drivers of Changes

The previous formulation and list of problems allow authors to organize different cause-effect diagrams, in which the problems are linked to different causes associated to the four drivers of change considered. Coincident causes can be grouped or associated by topics and corrective actuations may be proposed, together with the control measurements, which may contribute to the simultaneous resolution of different problems.

To illustrate the procedure by using one example, Fig. 1 shows the cause-effect diagram for the problem: "*Professors do not pay enough attention (paradoxically) to teaching-learning tasks, as their impact on their professional development is low*".

Possible causes for this problem being so common are connected to professors themselves and to how colleagues see university life: in some cases, university professors do not consider teaching as relevant part of their duties as research projects; in others, professors prefer to focus on promotion, mainly by publishing research articles and by devoting themselves to management and bureaucracy, than on preparing good lessons and teaching-learning experiences. Regarding available resources, possible causes for the problem may be connected to the lack of funding for innovative teaching tasks and projects or for lifelong learning activities, which makes some professors act too pragmatically and focus on those tasks more associated to their promotion and well-being. Students may also have some responsibility, especially if they just concentrate on passing exams, instead of on actually learning a profession. This may demotivate professors and progressively limit their dedication to updating and innovating. The environment is also important, as current accreditation systems do not adequately account educational innovation and teaching quality, at least when compared to the weight given to research. It would be interesting to analyze if universities, working in accordance with the current accreditation schemes, are always serving society as they should, although this goes beyond the purpose of present study. Some of these causes can be also found in connection to different problems (i.e. the isolation of professors, their difficulties when trying to prepare innovative experiences, or the perhaps excessive focus on research).

The methodology is applied in a similar way for all mentioned problems. The different cause-effect diagrams are depicted in Figs. 1–8, showing at least 12 main causes for the different problems, on which

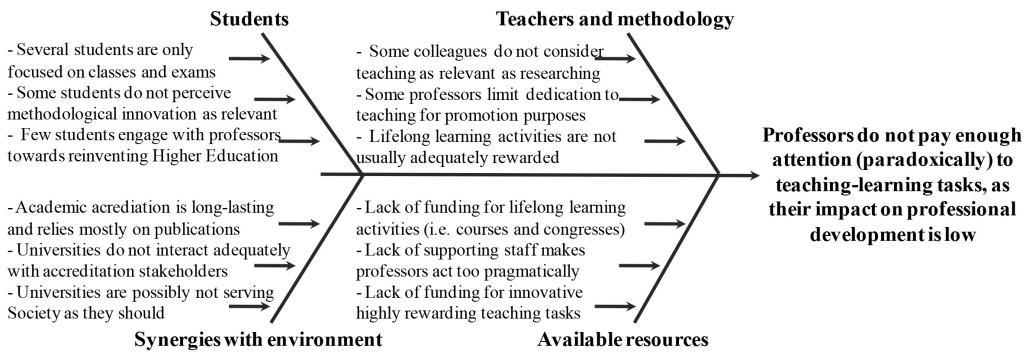

Fig. 1. Cause-effect diagram of the problem: "Professors do not pay enough attention (paradoxically) to teaching-learning tasks, as their impact on professional development is low".

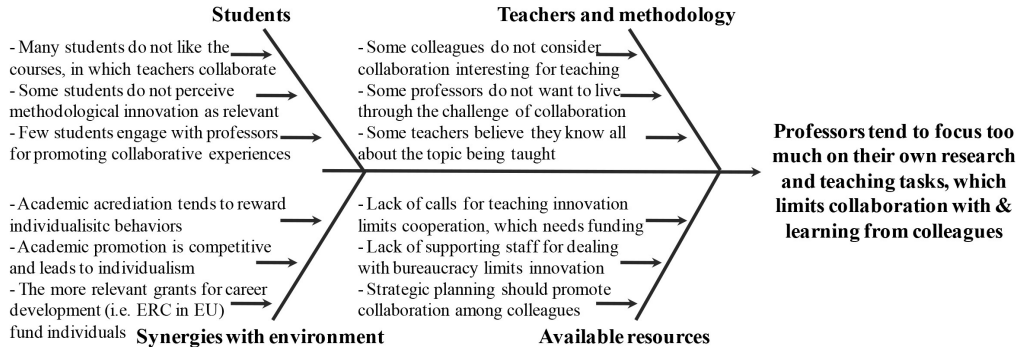

Fig. 2. Cause-effect diagram of the problem: "Professors tend to focus too much on their own research and teaching tasks, which limits collaboration with colleagues and learning from them".

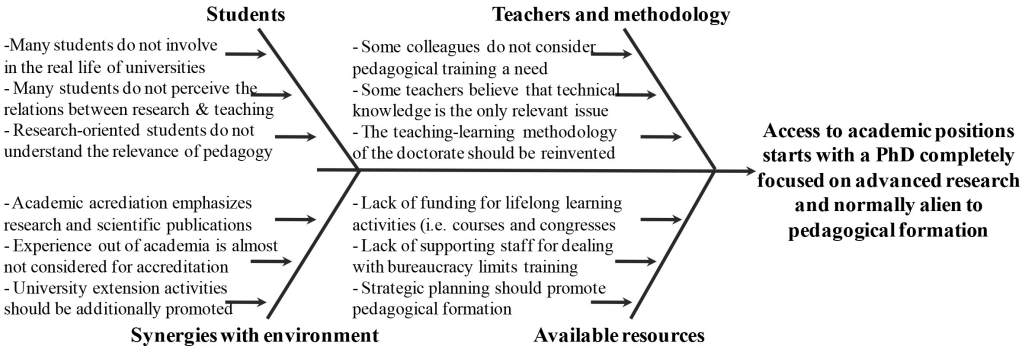

Fig. 3. Cause-effect diagram of the problem: "Access to academic positions starts with a PhD completely focused on advanced research and normally alien to pedagogical formation".

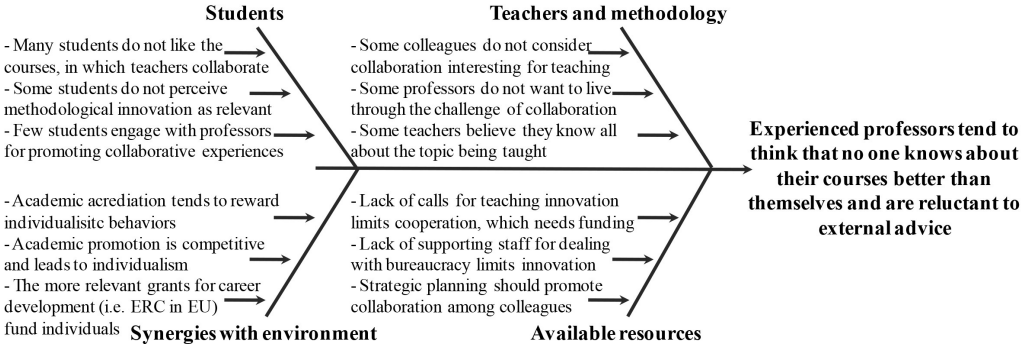

Fig. 4. Cause-effect diagram of the problem: "Experienced professors tend to think that no one knows about their courses better than themselves and are reluctant to external advice".

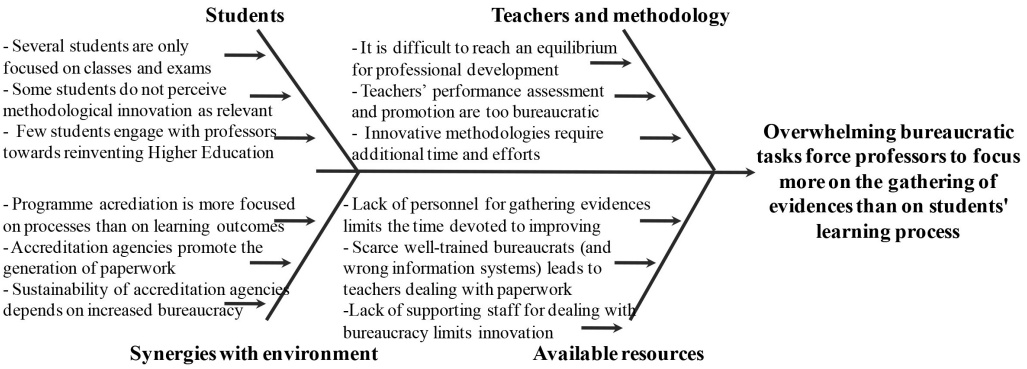

Fig. 5. Cause-effect diagram of the problem: "Overwhelming bureaucratic tasks force professors to focus more on the gathering of evidences than on students' learning process".

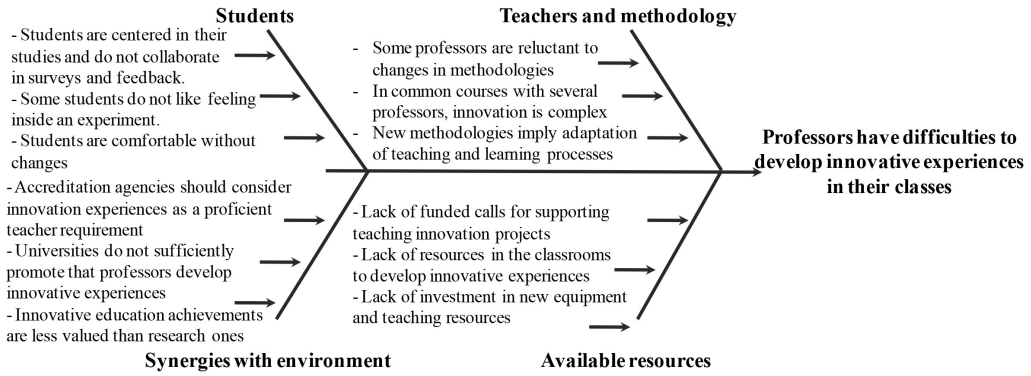

Fig. 6. Cause-effect diagram of the problem: "Professors have difficulties to develop innovative experiences in their classes and courses".

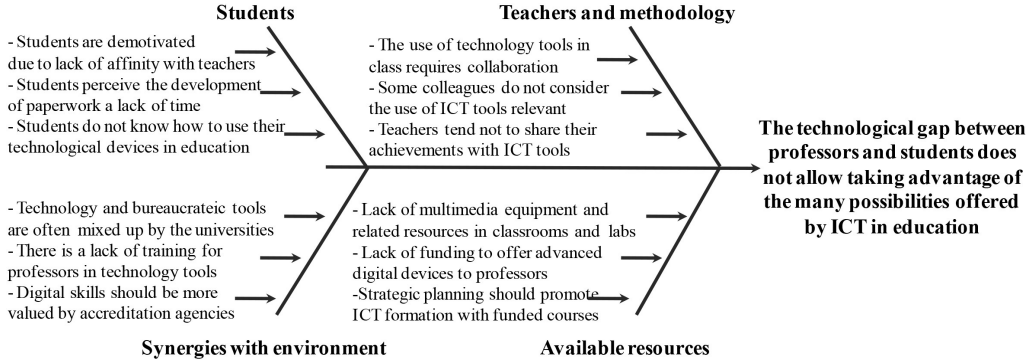

Fig. 7. Cause-effect diagram of the problem: "The technological gap between professors and students does not allow taking advantage of the many possibilities offered by ICT in education".

Fig. 8. Cause-effect diagram of the problem: "Professors teach in the same way in the international programs as in the traditional course despite special issues linked to students' diversity".

the study focuses, in order to detect the most relevant causes (i.e. typically those that affect different problems). Afterwards, the main limitations, proposed solutions and additional tools for checking their progress are summarized in Table 1, and additionally discussed in subsection 4.2, divided depending on the driver of change, on which the solutions focus. It is important to note that some of the problems highlighted are endemic to Spanish higher education institutions and usually more common in Europe, so several proposed solutions may be possibly already part of the state-of-the-art in other countries. In any case authors believe and hope that the presented process and several of the keys for change proposed may be of interest for readers and colleagues worldwide.

5. Proposed Strategic Solutions and Tools for Checking Progress

5.1 Strategies focused on Students

Higher education, especially in the engineering arena, relies on motivation. Engineering students should be made aware engineering professions

Table 1. Table summarizing the main difficulties and problems detected for the promotion of "Engineering Education for All" and some proposed solutions for greater success

Problems linked to	Proposed solution	Tools to check progress
Students:		
Inadequate perception of the relevance of innovative methods and extracurricular activities (excessive focus on lessons and exams)	Include sustainable extra-curricular activities (trips, association activities, challenges...) in the curriculum and assess them adequately	Number of credits linked to extra-curricular activities
	Include the possibility of carrying out stays in research centres, partner universities or enterprises as part of the curriculum with adequate assessment	Number of stays carried out in enterprises or universities
	Modify evaluation procedures and focus on outcomes	Number of exams per term
Low engagement with their universities for defining the future of Engineering Education	Improve the relationships between teachers and students linked to their future professional development	Number of joint activities carried out (i.e. study trips)
	Involve students in research and development projects involving multidisciplinary collaborations	Number of stipends offered
	Promote the teaching-learning activities proposed and organized by student associations	Number of activities entirely devoted to students
Digital natives and paradoxically with low developed digital skills for education	Provide programs with complementary activities focused on soft skills	Number of activities developed
	Promote the coordination of vertical projects throughout courses developing digital skills	Number of projects implanted
Teachers/methodology:		
Lack of time for changing methodologies	Provide help from central facilities for bureaucratic tasks and reduce such tasks focusing on outcomes	Number of hours devoted to the less relevant actuations
	Promote the incorporation of teaching assistants and research fellows into teaching	Number of assistants incorporated
Lack of pedagogical experience / inadequate perception of the need for lifelong learning	Require an adequate pedagogical experience and performance of teaching innovation tasks for tenure track	Accreditation agencies and contracting procedures
	Provide help from central facilities (institutes of educational sciences) for making teachers improve	Number of courses offered and performed
	Provide training to manage students' diversity (i.e. outgoing and incoming students)	Satisfaction surveys of exchange students
Lack of compromise with the learning of students	Reduce the number of hours devoted to purely bureaucratic activities	Number of hours devoted to the less relevant actuations
	Promote innovative teaching-learning activities and student-centered lessons focused on outcomes	Number of innovation projects developed
Synergies/environment:		
Contact with teaching-learning partners and stakeholders is not always easy or direct	Promote joint teaching-innovation projects with partners & industries and increase their relevance for tenure track	Number of teaching-innovation projects
	Include collaborative teaching-learning/service-learning (i.e. support to development) actions to the curricula	Number of novel collaborations established
	Encourage the creation of company chairs that sponsor facilities and focused educational activities	Number of company chairs
Accreditation agencies are far from universities, teachers, and societal needs	Organize round tables about the future of engineering for making evaluators aware of societal needs	Number of events organized
	Organize round tables about the future of engineering for deciding new and sensible requirements for accreditation	New guidelines for accreditation and promotion
Available resources:		
Offices and staff from different faculties and departments do not share good practices for improving teaching	The central (rectoral) offices focus on (if needed force) the implementation of a central service for sharing good practices in teaching and learning processes	Number of students and teachers exchanged
	Promote collaboration and communication between researchers from different departments and faculties	Number of joint projects performed
Lack of stipends and resources for lifelong learning of teachers	Involve enterprises in patronage activities, after their implication in successful joint projects	Funds raised
	Promote patronage activities via public recognition	Funded activities
Lack of support to bottom-up proposals	Rectorate supports teachers when they propose novel pedagogical actuations and helps them to incorporate these activities to the programs for long-term impact	Number of novel formative experiences developed
Lack of adequate staff to handle bureaucracy	Focus on systematic/objective resource management, increase resources devoted to teaching-learning and decide on the basis of merit and professional practice	Improved performance, increase of resources, surveys and questionnaires

transform the world more than any other disciplines. Students should be co-involved in any transformation pursued in higher education and they should understand that innovative teaching-learning methods are not whims from professors, but in most cases correspond to demonstrated approaches to enhance the teaching-learning process and to promote the learning outcomes. Motivation can be promoted by including extra-curricular activities (trips, association activities, challenges . . .) in the curriculum and by giving students the possibility of carrying out stays in research centres, partner universities or enterprises, as part of the curriculum, always with the adequate assessment. Progressively modifying the assessment procedures, towards fairer methods than traditional exams, in which actual performance as future engineering professionals and overall effort are considered, may be also source for additional student motivation. Then, they will recognize professors that innovate and give a special attention to learning experiences; hence professors will be additionally motivated to continuously actualize their courses and to compromise with lifelong learning, consequently creating a virtuous circle.

5.2 Strategies focused on Teachers and Teaching Methodology

The traditional transition from being a PhD student to a university professor should be mentored and harmonized in higher education institutions. A good start point may be to follow the seven principles of innovative doctoral training [23], so that PhD researchers do not only focus on research excellence, but also get trained in different professional environments (including academia, as well as industry) and get their soft skills and international connections promoted. Besides, this transition should be supported by courses focusing on pedagogical skills, on teaching methodologies and on organization and assessment of engineering courses, whose outstanding impact has been previously highlighted in examples that could be considered gold standards [15].

Ideally, every minute that a professor devotes during his/her professional life, should be connected to the promotion of students' learning. Knowledge generation through research clearly helps to improve the learning process, as it constitutes a permanent source of renovation for the different courses and keeps professors updated in their field. Lecturing and educational innovation tasks also are motivated by a desire to better serve students. However, in the last couple of decades, the number of hours devoted by professors to purely bureaucratic tasks and to useless interactions with computer applications has dramatically increased [24]. These computer apps, developed with the hope of serving as quality monitoring tools, act in too many occasions act as black holes, to which information is thrown, but no outputs (or related control or correcting measures) are ever collected (or derived) from them. Quality monitoring and bureaucratic tasks should be supported by well trained professionals and by dedicated resource-efficient teams of administration staff. The relevant indicators, but not more, should be monitored and measures taken on their evolution, which would help to optimize resources and to promote teachers' dedication to teaching and research and to increase the budget devoted to educators (see also strategies focused on resources).

To support lifelong learning of professors, universities should count with central facilities, such as educational innovation departments and research centers on educational sciences, which could manage annual calls for educational innovation projects and develop the training strategy and take charge of the educational offer for university professors wishing to keep up pace with technological advances and their teaching or to improve in pedagogical aspects. This couple of educational innovation department and research center on educational sciences is probably more relevant for universities worldwide than any other department or research center, in which could be invested.

5.3 Strategies focused on Synergies with the Environment

Universities should rethink the merits by which their professors are evaluated (and in some countries accredited) and considered adequate for promotion. Educational innovation projects and educational papers should be considered on par with research projects and scientific-technological papers for promotion purposes. Educating is as challenging as researching and it is the responsibility of universities to consider teaching efforts and teaching quality, at the same level as dedication to research and innovation results, as part of the key requisites for hiring their professors. Universities should also take a more active position in the evaluation and selection of their staff and should work more closely with accreditation agencies, or even assume their roles, especially in countries where the accreditation agencies do not work with objective parameters, for evaluating the adequacy of candidates for promotion. Seeing that teaching vocation and quality and dedication to educational innovation are adequately considered for professional development would be a fundamental advance, towards professors compromised with their training as educators and with lifelong learning activities.

The cooperation between university and business is in continuous study. The future is uncertain and the findings of the studies in digital transformation show a complete reconversion of future jobs [25]. This new paradigm implies the need for a higher approach between university and business. The gap between enterprise profiles and academic profiles could be reduced if the companies join the academic processes. Engineer education is often too technical and entrepreneurial soft skills are neglected. Students should initiate their formation immersed in companies from the beginning. Service-learning and other innovative methodologies could contribute to improving results. The cooperation between university and business should not be limited to economic sponsor or research projects, this relation should be widened to teaching-learning processes, planning, and other activities. Besides, this union should be expanded to the rest of society to allow them to understand the future of engineering challenges.

5.4 Strategies focused on available Resources

In general, professors are motivated to improve their classrooms, and over the years they look for new methodologies, documents, or assessments to get better results with their students. However, their findings and experiences are not always published and rarely shared, even with department colleagues. Implementing additional international discussion forums, for sharing good practices would be a rewarding option. Participation in research projects should be equated to involvement in educational projects for promotion purposes. Professors with innovative methods or effective resources should be encouraged to share and open their findings. For this challenge, universities should ease these tasks to professors, not only by funding the innovation projects, but also by reducing bureaucratic processes.

Sabbatical periods should be reinvented: a whole year sabbatical impacts importantly the daily activity of departments and teaching units, while shorter "missions", in which professors could enjoy one-month visits to colleagues for partner universities, mainly for educational innovation purposes, could be more effective. Such (funded) shorter missions could reach a larger number of educators, hence involving a larger part of the educational community in the transformation processes, and could also be performed in a more regular fashion, for example every one or two years after exams period, without affecting the dynamics of courses.

6. Final Discussion and Perspective

The presented cause-effect analysis has allowed us to study the problems identified according to the dimensions of: "students", "teachers and methodology", "synergies with environment" and "available resources". After developing the different analyses, it has been perceived that some of the core causes that generate these problems could be grouped or were even the same. This situation enables us to offer concrete solutions with a wide impact, for alleviating several problems at the same time, including achievement indicators to analyze their development.

In relation to students, the main challenge has been identified as improving the motivation and involvement of students in the learning process. For this purpose, it is proposed to offer them new activities that bring them closer to the reality of companies and research centers, complementing their training with soft skills, in order to improve their future job placement and professional development, and proposing a broader evaluation.

Regarding professors, the need of complementing the profile of university professors with training in additional areas has been identified. These should be complementary to their lines of research, with a special focus on pedagogy and innovative methodologies. In addition, universities need to reduce the bureaucratic tasks to allow professors to focus on teaching and research. A more generalized creation of centers specialized in encouraging educational innovation and lifelong training would be beneficial, in the authors' opinion.

Considering the synergies with the environment, two main lines stand out. On the one hand, balancing the recognition of teaching and research merits. Both must be considered comparable aspects for the evaluation of the professors in terms of their academic progress, granting of funds for projects, and any other evaluations. On the other hand, the need to bring companies closer to universities, not only with sponsored projects, but also joining educational processes to design activities and initiatives that respond to current and real needs in engineering education. Besides, universities should promote training periods and visits of professors to foreign centers, to develop both research and educational projects, guaranteeing both professional stability and supporting the departments during the absence of professors under training.

The future of engineering education will probably become increasingly difficult in the years to come. The digital transformation of companies will be accompanied by a transformation in society. Artificial intelligence or robotics will replace many current jobs, but they will also create new jobs that do not exist today. New generations of engineers will have to face great challenges in many cases

supported by constantly changing technologies. Soft skills will probably gain great importance: adaptation to change, creativity, computational thinking or entrepreneurship will be the essential complements to technical knowledge. Engineer educators find here the challenge of adapting at the same speed as their environment changes, for which lifelong learning and strategies linked to different drivers of change can provide the adequate answers.

7. Conclusions

The main objective of the study was to methodically analyze the main strategies for the promotion of well-trained engineering educators and for their professional development, as linked to preparing the engineers of the future. The different analyses performed have resulted in a broad collection of strategies aimed at preparing engineering educators for a continuously changing world. Although many reflections derive from personal professional experiences in Spain, authors believe that many observations may be relevant to educators and university managers beyond our country, as they are supported by referenced studies from universities worldwide. Lifelong learning and educational innovation should be encouraged and funded, as well as recognized and necessarily considered for tenure track positions and for professional development. Student-centered approaches to engineering education, in a way following the spirit of the Bologna Declaration, are more necessary than ever before, due to the rapid pace of technological development. In the modern world, immersed in constant scientific and technological revolutions, increasing faculty-student interactions and mutual feedback, through shared contributions to the high level learning objectives and by means of co-creation experiences, is bound to improve students' progress and professors' lifelong learning. Finally, the best universities are not just exceptional research centers but, in essence, places where the teaching-learning processes are continuously reinvented, which constitutes a source of joy both for students and professors, and where the most interesting debates on engineering education are performed, as essential tool for renovation and permanent improvement.

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