

Searching for needed changes of curricula and educational techniques in engineers' formation

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Abstract. This paper is presented the search approach and the resulting conclusions, in the case of a faculty with a technical profile, considering the analysis of the existing curricula, the employers' requirements regarding the knowledge of the graduates and the way of university-enterprise collaboration, as well as the opinions of the students enrolled in these study programs. We believe that such analyses are necessary and useful and should be a support for the decisions to adopt higher technical education to the requirements of the labour market, more so as the accelerated transformations towards the digitized society are visible, but also through the pressures put on the pedagogy and teaching techniques, due to the excessive use of online teaching methods.

1. Introduction

There are many more studies and programmatic documents, at the European and national level, on the need to adapt the study programs in higher technical education, to the current requirements of the economic environment, especially for companies that have a specific industrial field of activity.

To support these adaptation requirements, several types of projects have been created and are underway, which have as general objectives the training of human resources involved in higher technical education, teaching staff and students alike, but also the way of their relationship with the employing companies of graduates.

The specific objectives considered to be supported by this type of project are the training/development of entrepreneurial skills of students, future engineers, and the introduction/modification of technical disciplines, with emphasis on innovative content and the use of innovative teaching techniques.

2. Context of the study

There is an intense and continuous concern at the EU level on education, with dedicated initiatives and structures for this area, for example, The European Education Area, considered to be "education is the foundation for personal fulfilment, employability and active, responsible citizenship" [1].

It is also "essential to the vitality of European societies and economies" and "access to quality and inclusive education, training and lifelong learning is a right for all citizens, as enshrined within the European Pillar of Social Rights" [1].

Report Employment and Social Developments in Europe [2] "confirms the ongoing positive labour market trends as well as an improving social situation review confirms positive trends but highlights the increasing need for skills and inclusion".

Organizations and markets are globally interconnected via the internet, while digital technologies, robotics, artificial intelligence are revolutionizing production and consumption processes. New technologies are creating new markets and jobs, while traditional ones are on the verge of extinction, with the structure of EU economies in a fast-changing process. Therefore, the need to adapt the forms of vocational education to this evolution, in content and teaching techniques, is acutely felt.

On the other hand, the EU 2020 strategy, through the work programme of DG Education and Culture, underlines the need to integrate creativity, innovation and entrepreneurship into school curricula and proposes a series of actions aimed at supporting Europe's entrepreneurial and innovative capacities. In the EU's Strategic Framework for Education and Training, one of the four strategic objectives is "stimulate creativity and innovation, including entrepreneurship, at all levels of education and training" [3].

In higher education, an indicator accepted in comparative studies is the percentage of the population who have attended some form of higher education, the tertiary segment. From this point of view, tertiary educational attainment is low, only 25% of the population aged between 25 and 34 holds a tertiary education degree. Although the proportion has improved over time, it is significantly below the EU average of 40.5% and the EU-level target of 45% by 2030. In the age segment 20-29 years, for every 1000 people, 46.2 higher education graduates (ISCED 5-8) in Romania, compared to 61.9 on average across the EU [4].

If we refer to technical higher education, there are relatively low numbers of tertiary educated professionals, and their skills are insufficiently aligned with labour market needs. Even if in the educational offer the percentage of graduates in science, technology, engineering, and mathematics is one of the highest in the EU (30%), but due to the low number of graduates, the availability of specialists is low. Emigration further reduces the number of tertiary-educated professionals, with an estimated 40% of Romania's graduates in the 24-64 age group having emigrated [4, 5].

Beyond the statistical data on tertiary education, an issue of concern in the field concerns the adequacy of the educational offer to the needs of the economy, expressed by the index of non-correlation of qualifications. The higher this index, the more the education system, schools and universities do not prepare qualified people for the needs of the market, of companies. According to National Bank of Romania (BNR) data, the largest mismatch is in the university field, at 2.4%, almost half of the total value, Figure 1.



Figure 1. Mismatch of qualifications in the labour market [4]

As a consequence of this situation, the amount potentially lost by Romania on account of this deficiency is 6.4% of GDP (10 billion euros in 2018, 13 billion in 2019, annual growth 29%) [6].

To support the adaptation requirements of people with higher education and their skills to the needs of the labour market, several types of European projects have been proposed, with general objectives of:

- the need to improve the links of cooperation between higher education institutions and economic agents active on the labour market and in the local/regional business environment;

- an insufficient/deficient correlation of educational needs with the demands of the labour market and strongly correlated with the asset. employers in the economic and competitive sectors;
- the need for curricular alignment in the universities of technology and engineering profile to the advanced evolution of technology;
- the need to adopt entrepreneurship in universities as part of practical academic experience among students.

The following are presented the results of a study, carried out within the framework of such a project [7], which attempts to identify the requirements /needs of the labour market in competitive economic sectors, respectively of employers, regarding the qualifications and knowledge required by graduates of faculties with technical specificity.

3. Deployment of the study

Research had the main purpose of identifying solutions for adapting the educational offer of the Faculty of Managerial and Technological Engineering in Oradea to the requirements of the labour market in Oradea and the surrounding area.

Given the context set out above, the research was oriented on three distinctly treated directions through independent studies, thus:

- 1) analysis of the professional training offered of the students of the faculty, the curricula of 4 study programs;
- 2) identification of training requirements requested by employers, for graduates of technical faculties;
- 3) finding existing problems at the level of students, through activities with a relevant target group.

The results obtained were interpreted as a whole, to have a broader picture of the training needs that the faculty has to offer. These aspects will be correlated with possible entrepreneurial and intrapreneurial requirements existing in companies and the use of new, innovative technologies in content and teaching.

3.1. Analysis of the professional training offered of the students of the faculty

The curricula used for all study programs in the fields of industrial engineering, engineering and management, road vehicles and mechatronics were analyzed. The weights of the imposed disciplines compared to the optional ones, respectively of the fundamental, field and speciality disciplines versus complementary and optional disciplines, Figure 2.

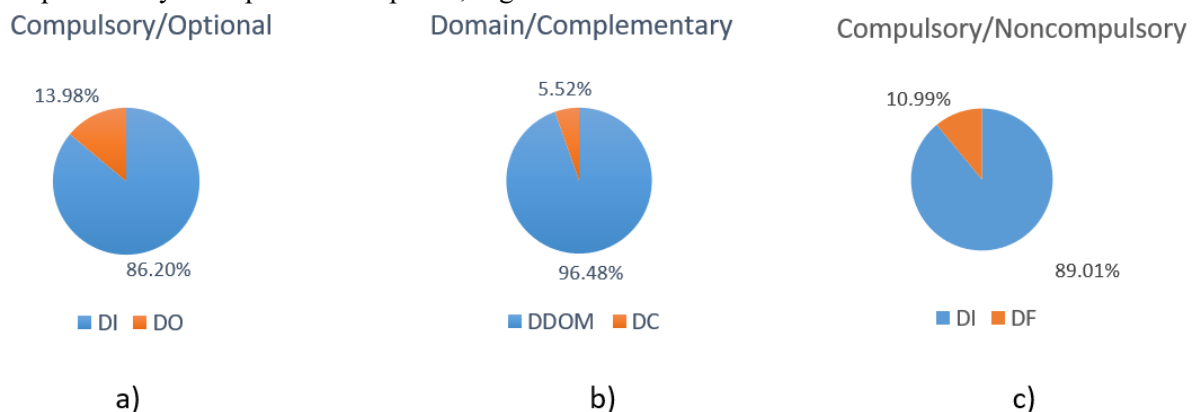


Figure 2. The weights of the subjects in the curriculum

For all the analyzed curricula, it was found that the optional subjects are in a small percentage compared to the compulsory ones, Figure 2. a, while the percentage of the complementary ones is almost insignificant, Figure 2. b, and the percentage of the non-compulsory subjects is also small, Figure 2.c.

Also, a distinct discipline of entrepreneurship specific to the fields has not been identified, and the supply of optional subjects is reduced, which can be considered a weakness of an educational plan adapted to the current requirements.

3.2. Identification of training requirements requested by employers

This second part of the study is qualitative research that was carried out through a questionnaire and open interviews with representatives of the management of employers. The goal was to obtain details related to the need for professional training of students, future engineers to cover as wide and efficiently as possible the work tasks in the company.

From the answers of the companies contacted, for three questions that we consider important, the answers are presented in Figure 3, Figure 4 and Figure 5.

1. What are the fields of study for graduates that you want to hire?

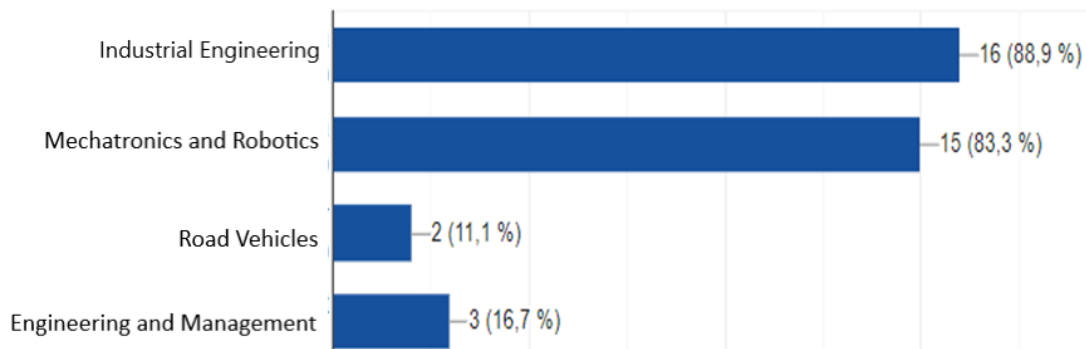


Figure 3. Fields of study of interest

2. What are the technical skills required for the students/graduates you want to hire?

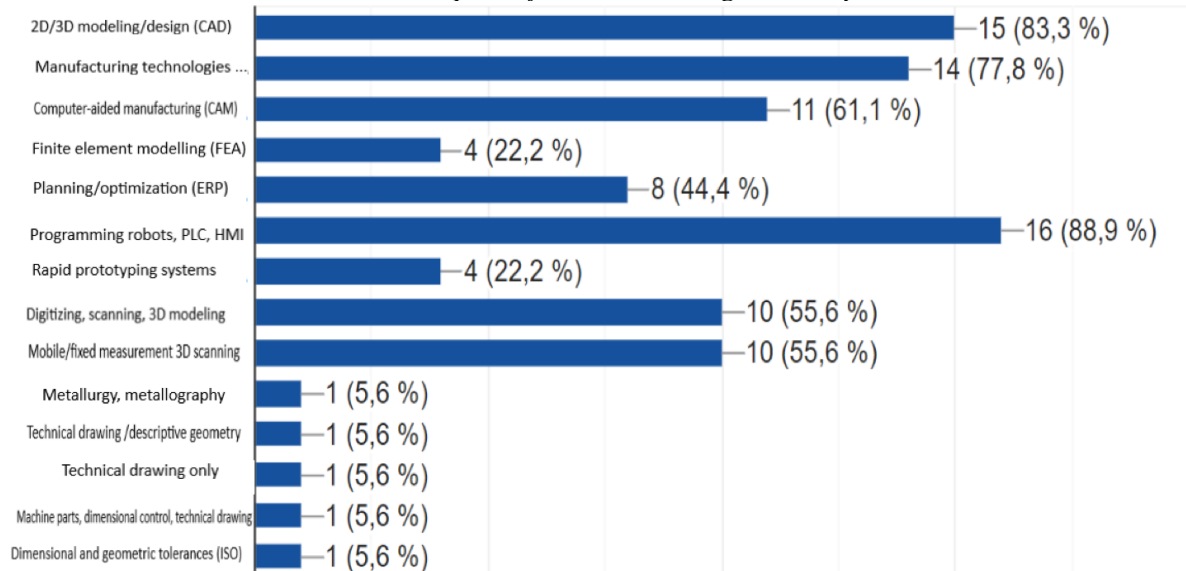


Figure 4. Technical skills desired by employers

3. *What are how you can contribute to the training of the students/graduates you want to hire?*

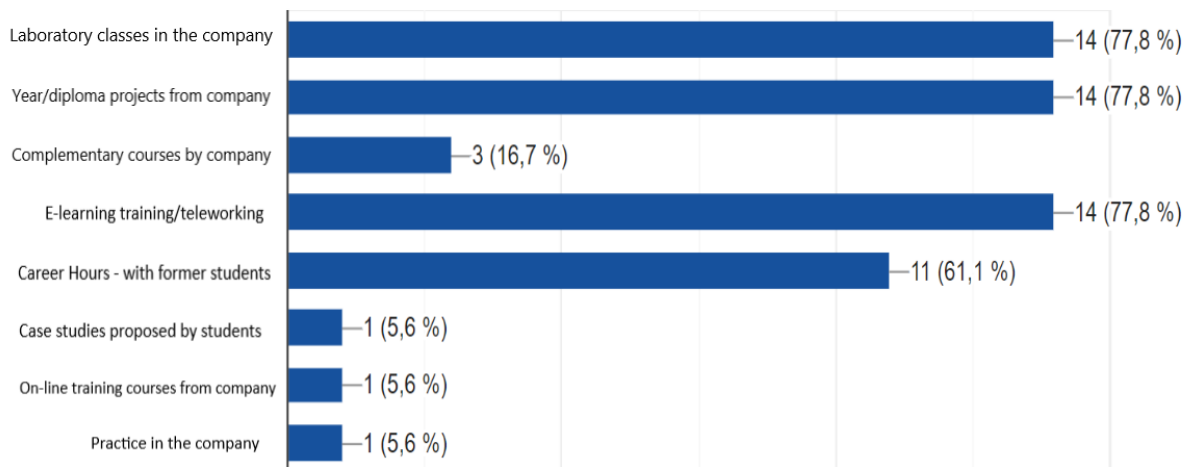


Figure 5. Involvement of companies in the training of students

3.3. *Existing problems at the level of students*

Through a questionnaire, it was tried to find out the students' opinions about the subjects that create difficulties in promotion, subjects that concentrate a large volume of information in a short time and semesters of schooling that has too much work. The question we consider important and the students' answers are presented in Figure 6.

4. *What are the semesters that require too much work? (A large number of projects in a single semester, etc.)?*

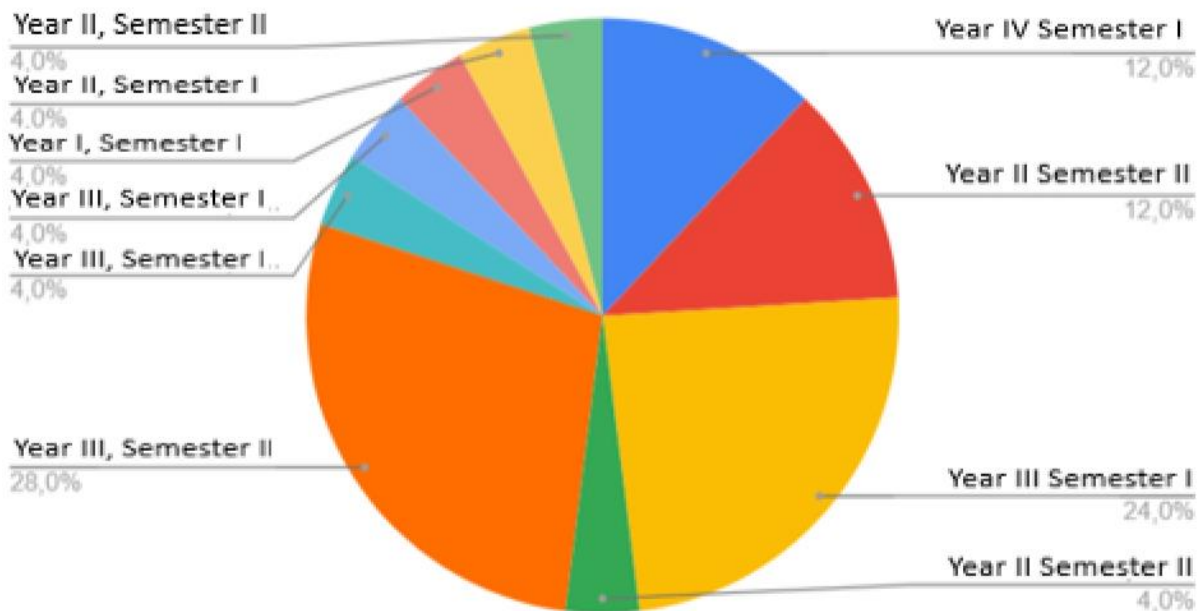


Figure 6. The learning effort during the semesters

4. Conclusions

The adaptation to market requirements of the educational offers in higher education is a priority expressed by the strategic documents of the European Union and is supported by a series of funded projects, with objectives related to the human resource involved.

In this paper are presented the results of a study, carried out within the framework of such a project, which concerns aspects of adapting the existing study programs at a technical faculty, in terms of the content of the curricula, the requirements of the employers in the field and the students.

It was found that the complementary and optional subjects are less present in the curricula and there are no distinct disciplines of entrepreneurship.

The most desired fields required by employers are industrial engineering, mechatronics and robotics, engineering and management. They suggested as important an innovative technical discipline, which would support the new, innovative technologies that they assimilate into companies.

From the point of view of students, a difficult problem is the uneven loading of activities and the assimilation of knowledge during semesters.

These results can be the support for the modification/adaptation of the educational offers, in the sense of adapting the needs of the labour market

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