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Transversal Competences of University Students of Engineering

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Abstract

One of the key changes of the European Higher Education Area is the implementation of a competence-based educational system. Students are now more than ever the axis around which the university system orbits. The competences that students should acquire during their studies include transversal competences, which are those competences related to leadership skills, problem solving, and teamwork, highly valued by labor market. This is particularly important in engineering, as these skills can influence the selection of one candidate over another. So, the evaluation and teaching of these kinds of competences are now some of the main challenges facing university professors as the corresponding learning objectives need to be set and assessed, both for study programs as well as for each individual subject, and this process is new for teachers. Focusing precisely on this aspect, our work, based on an empirical study conducted with a sample of 102 engineering students from the University Center of Merida, uses a tool to measure the progress of such students in different transversal competences. This tool not only allows us to evaluate the level of competence development, but also allows us to detect students' areas of weakness in cross-curricular training that can then be addressed.

Key words: *the Bologna process; competence based education; engineering education; higher education; labor market.*

Introduction

The European Higher Education Area (EHEA) or the Bologna process is a new learning organizational framework which aims to blend the different European university systems, so that qualifications can be compared through common features such as workload and to facilitate student exchange between different universities

within the European Union (Fernández, Carballo, & Galán, 2010). To achieve these proposals, universities around Europe had to adapt their qualifications (undergraduate, graduate and postgraduate study programs) to EHEA standards and assess workload of each subject through ECTS (European Credit Transfer and Accumulation Systems).

In Spain, Higher Education institutions chose a system of four-year study programs, with 60 ECTS credits for each academic year, a total of 240 credits. The new study programs were introduced in the academic year 2009/2010, and for this reason they are still in the implementation process. One of the main novelties concerning EHEA is the change from the traditional, teacher-oriented methods towards learner-centered programs based on the acquisitions of competences (*Royal Decree 1393/2007*, Spain, 2007) as a means to ensure the professional performance of students when they finish their studies (Romero, 2010). That implies a big change in university teaching methodologies and requires that the curriculum explicitly indicate those specific and transversal competences that students should acquire during their studies. This leads professors to a new challenge: training students in transversal competences and assessing their acquisition. Usually these kinds of competences are developed in different subjects throughout the study program so it is difficult to measure whether the student is developing each competence correctly or not. Therefore, it is essential to establish mechanisms to measure students' progress in competence acquisition and identify areas not addressed before.

The importance of this new methodological approach is reflected in the extensive literature on the subject (Albanese, Mejicano, Mullan, Kokotailo, & Gruppen, 2008; Halász & Michel, 2011; Lozano, Boni, Peris, & Hueso, 2012; Male, Bush, & Chapman, 2010). However, most of these studies are only theoretical. Our study tries to provide a more practical point of view, providing data in order to develop a more in-depth understanding of this area and help teachers overcome difficulties arising from a shift in methodological perspective.

In this context, the overall purpose of our research is to ascertain the level of development of transversal competences of engineering students at the University Center of Mérida: Bachelor in Engineering for Industrial Design and Product Development, Bachelor in Engineering in Geomatics, Bachelor in Computer Engineering and IT and Bachelor in Telematic Engineering. To determine whether students have acquired transversal competences, and to what extent, we will review the training methods used to develop these kinds of competences on the basis of any identified deficiencies. Beginning with this principal objective there are also two sub-objectives on which the work is based:

- To analyze the level of development of the dimensions that shape the transversal competences of engineering students and to verify whether there is any difference in the level of development of such competences related to gender, study program and year of study.
- To study the relationships between the different dimensions analyzed, in order to determine how much they contribute to the development of transversal competences.

To achieve the above purposes, our work will develop as follows. Firstly, in section two, we will describe the types of competences students need to acquire during their studies, emphasizing transversal competences. Section three explains the importance of transversal competences for engineering students. Sections four and five describe the methodology used in the quantitative study, and present the results. Finally, in the last section, we will present our conclusions and possible directions for research.

Transversal Competences in Higher Education

The Bologna Declaration on the European Space for Higher Education (1999) reflects one of the major challenges faced by the new EHEA: the need to demonstrate the ability to adapt to the new and changing demands posed by modern society and scientific advances. The attitudes and skills that society demands of future professionals are aspects that any educational model should consider. Businesses today no longer require experienced experts, but competent professionals (Ríos, Cazorla, Díaz-Puente, & Yagüe, 2010). The EHEA allows for the implementation of a model based on competences (Palma, Ríos, & Miñán, 2011) to improve employability and to respond more effectively to the needs of the labor market (Romero, 2010).

In the current context, characterized by the rapid exchange of information, students must possess generic skills, dispositions and attributes that are transferable to many occupational areas and situations (Bridgstock, 2009). For this reason, the European Union is paying close attention to the competences (Mulder, Gulikers, Biemans, & Wesselink, 2009), considering transversal competences as key elements to ensure a more flexible workforce capable of adapting more quickly to the constant changes that occur in an increasingly interconnected world (Rico, Coopens, Ferreira, Sánchez, & Agudo, 2013). Competences are no longer understood only as a set of knowledge, skills or abilities that are applied to solve problems related to a specific professional profile, but also include psychological and social dimensions (Romero, 2010). A competence is more than knowledge and skills. It is the ability to meet complex demands, supporting and mobilizing psychosocial resources (including skills and attitudes) in a particular context (Rychen & Salganik, 2003). According to the Delors Report (Delors & Mufti, 1996), competence is the integration of knowledge, know-how and know-be, in addition to the mere learning of an occupation. It is necessary for students to acquire competences that enable them to deal with multiple situations, some of which are unpredictable.

Competences can be classified into two types: technical or specific competences and generic or transversal competences. The first type includes those that are directly related to an activity or job (Solanes, Núñez, & Rodríguez, 2008), while transversal competences refer to personal attributes of a cognitive, social, attitudinal or evaluative nature that enrich professional behavior. Although they are not strictly necessary for the exercise of the profession, they become a distinguishing element that adds qualitative value to the employee or future employee (Corominas, 2001).

Employers increasingly recognize the important competences such as the ability to adapt to change, to be assertive or to work in a team. Since specific competences are generally becoming obsolete due to technological advances, the labor market increasingly attaches more importance to transversal competences because they are durable, more relevant and useful for promoting lifelong learning (Corominas, 2001). In addition, these competences are key elements for innovation and competitiveness, while also contributing to the motivation and satisfaction of employees and therefore to productivity (Rico et al., 2013).

According to the DeSeCo Project (Rychen & Salganik, 2001), competences can be divided into three categories (see Figure 1).

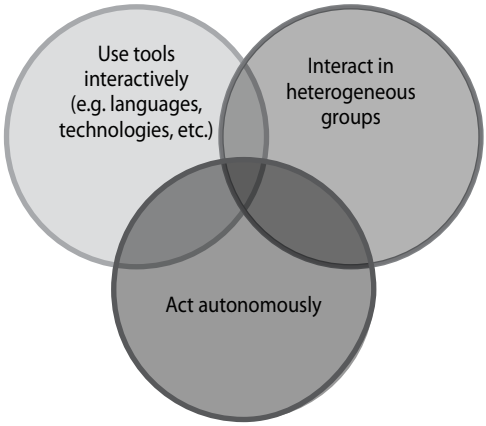

Figure 1. Competences category
(Source: Adapted from *Definition and Selection of Key Competencies - Executive Summary*, 2005)

In the same vein, the Tuning Project (González & Wagenaar, 2003) states that generic or transversal competences that identify elements that may be common to any degree, may be divided into three types: instrumental, interpersonal and systemic.

- ❒ Instrumental competences are those with an instrumental function and they include:
  - Cognitive skills, that is, the ability to understand and use thoughts and ideas.
  - Methodological skills needed to interact in professional environment: time management and learning strategies, decisions making or problem solving.
  - Technological skills, which are those related to the use of technical facilities, computers and information management skills.
  - Linguistic skills, both oral and written communication, or the knowledge of a second language.
- ❒ Interpersonal competences, that tend to facilitate the process of cooperation and social interaction. These competences may be:
  - Individual skills, that is, those related to the ability to express feelings or perceptions of an issue, the ability to criticize and to receive criticism constructively.

– Social and interpersonal skills related to the ability to work in a team, and express ethical or social commitments in a socially appropriate way.

❒ Systemic or integrative competences, which are the skills and abilities related to systems as a whole. They allow us to appreciate the relationships and linkages of the parts to a whole, and include the skills needed to plan changes to improve systems as well as design new ones, and require as the basis the prior acquisition of instrumental and interpersonal skills.

Transversal Competences of Engineering Students

In the field of engineering it is necessary to possess transversal competences because the labor market (Martínez, 2011) values competences related to social skills, leadership, language, management or ICT skills more than the specific knowledge of each engineering program, since these are considered to have been acquired by students through the qualification. However, adequate attention is not paid to these competences because they usually involve several courses. International studies with large sample sizes have identified and measured competence deficiencies in engineering graduates based on the perceptions of different stakeholders (Male et al., 2010).

In a research conducted in the United States and Europe involving 1,372 engineers, the importance of different competences for graduate performance was analyzed. General skills, widely applicable (problem-solving skills, analytical and methodological skills, teamwork skills and communication) were considered more important than specific know-how of engineering. This study found major deficiencies in competences related to communication skills, leadership and social skills (Bodmer, Leu, Mira, & Rütter, 2002; Male et al., 2010).

Furthermore, in a study conducted in Australia with a sample of 300 graduates in engineering, deficiencies were identified in six competences (practical engineering, business engineering skills, communication skills, self-control and proper attitude, problem solving, teamwork) (Male et al., 2010). Most of these are transversal competences.

The current accreditation systems explicitly require that the competences of engineering graduates should go far beyond knowledge taught in lectures and assessed through exams. The ability to apply knowledge is as important as the acquisition of knowledge. It is vitally important that good engineering training teaches students to experiment and to develop their abilities under the supervision of senior engineers (Bodmer et al., 2002).

The EHEA has begun to resolve this problem by identifying transversal competences that graduates in engineering should possess, but some methodological and evaluative changes are necessary in order to train students and assess these aspects properly. The key aspect in this process is to improve the alignment of competences, methodology and evaluation (Hernández-Leo et al., 2012) in order to successfully implement these processes. In our case, we focus on the evaluation process with the intention of obtaining a reliable tool to assess students' progress in developing these types of competences.

Methodology

Our research is based on an empirical study analyzing engineering students perceptions in the University Center of Mérida, at the University of Extremadura, located in the Southwest region of Spain. The data used were collected specifically for this study, therefore primary information was used.

Data Collection Instrument

The data were collected through a questionnaire previously employed by Solanes, Nuñez and Rodríguez (2008). The questionnaire, which includes 45 items on a Likert scale ranging from 1 to 5 points, with 1 being the lowest and 5 the highest, allowed us to understand the perceptions of engineering students on the level of transversal competences acquired.

The questionnaire employed had been validated in previous work (Solanes et al., 2008). In the above mentioned study, reliability and internal consistency of the instrument was equal to 0.92, distributed in six factors that explained 53.15% of the variance. In our research, internal consistency, measured by Cronbach's alpha, increased to 0.968, distributed in nine factors explaining 74.109% of the total variance.

Sample

The study was conducted in 2011 through the implementation of a web based questionnaire in the Moodle learning platform. We chose this interview method because it was not only the cheapest and fastest way, but also in this particular case it suited our target groups exactly - engineering students used to employing Moodle.

One hundred and two questionnaires were answered by the first and second year engineering students at the University Center of Mérida, University of Extremadura, enrolled in the following study programs: Bachelor in Engineering for Industrial Design and Product Development, Bachelor in Engineering in Geomatics, Bachelor in Computer Engineering and IT and Bachelor in Engineering in Telematic. All questionnaires were valid (n = 102).

The variables recorded in the header of the questionnaire allowed us to characterize the sample in terms of year of studying, gender and degree. Thus, based on the first variable, of the 102 students who participated in this study, 54 students (52.94%) were first-year, and 48 (47.06%) were second-year students. From the point of view of gender, it should be noted that the sample is widely masculinized since, in general, students of technical degrees are still mainly male, and of the 102 persons surveyed, 72 were men (70.59%) and 30 were women. From the point of view of degrees, the group of respondents which was the most numerous consisted of students of Bachelor in Engineering for Industrial Design and Product Development, followed by students of Bachelor in Engineering in Telematic, Bachelor in Computer Engineering in IT, and Bachelor in Engineering in Geomatics, respectively (see Figure 2).

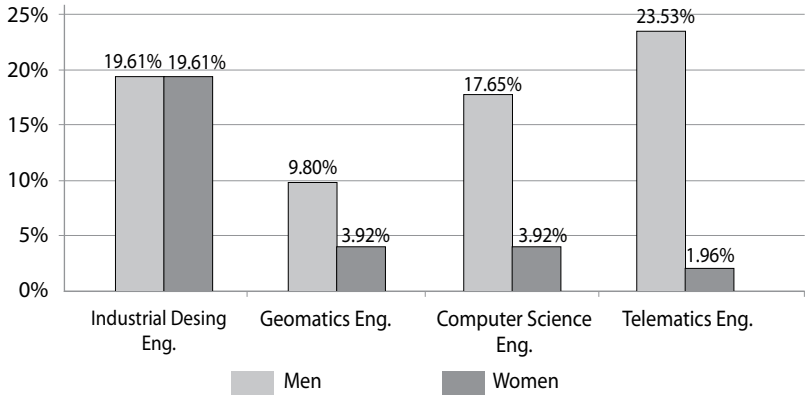

Figure 2. Sample distribution by gender and degree

Statistical Analysis

The research team processed the data obtained via questionnaire using SPSS, v. 19. Firstly, we carried out a descriptive analysis of the variables, with statistics of central tendency measures and dispersion, and then we tested the significance of differences in scores of the observed variables, through an analysis of variance (ANOVA) for gender, study program and year of study. Secondly, we used principal component analysis. This statistical technique was useful because it allowed us to reduce a big number of variables to a smaller number of basic categories or factors, which contained most of the information and were considered sufficient to explain the model. We tried to synthesize full information with the minimum loss criterion of explanatory power. Next, we studied the significance from the differences in scores observed for the principal components or factors, using the Student t test.

Analysis of Results

Initial Analysis

To achieve the first goal of our research, to analyze the dimensions that shape the transversal competences, we started with a descriptive analysis of each variable, focusing on the mean and standard deviation (see Table 1).

Table 1

Mean and standard deviation of the 45 items of the questionnaire

Item	Means	Standard Dev.
1. Knowledge related to the study program	3.19	1.019
2. Capacity for concentration	3.12	1.023
3. Capacity for innovation in practical work or assignments	3.34	0.962
4. Ability to value academic results obtained in exams	3.21	1.052
5. Capacity for adapting to new situations	3.69	0.925
6. Capacity for thinking ahead and planning	3.07	1.119
7. Time management skills	3.06	1.113
8. Ability to organize team work	3.42	1.017
9. Ability to take advantage of one's own resources	3.36	0.965

Item	Means	Standard Dev.
10. Ability to use university resources optimally	2.96	1.021
11. Ability to negotiate favorable outcomes	3.31	1.047
12. Problem solving skills used during class time	3.42	0.972
13. Ability to synthesize ideas	3.36	0.980
14. Competitive ability	3.21	1.122
15. Ability to remain calm in adverse or conflicting situations	3.24	1.001
16. Ability to act clearly and firmly in stressful situations	3.40	0.986
17. Ability to work as a member of a team	3.84	0.931
18. Ability to co-ordinate others	3.51	1.078
19. Willingness to participate	3.57	1.076
20. Capacity to relate to classmates	4.04	0.824
21. Ability to communicate	3.90	0.956
22. Interpersonal skills (empathy and listening skills)	3.82	0.968
23. Easily relate to teachers	3.72	0.813
24. Entrepreneurial ability	3.46	1.105
25. Ability to promote ideas and suggestions	3.40	0.954
26. Ability to inspire confidence	3.60	1.001
27. Ability to persuade without provoking hostility	3.01	1.094
28. Ability to easily accept new responsibilities	3.42	1.103
29. Ability to relate well with classmates	3.99	0.929
30. The possibility of managing people and resources	3.22	1.152
31. Ability to maintain the good reputation of the university in the community	3.25	1.020
32. Ability to recognize personal strengths and weaknesses	3.49	1.006
33. Ability to remain calm in stressful situations and meet deadlines	3.40	0.986
34. Self-confidence: ability to apply the knowledge learned during the study program	3.45	1.184
35. Motivated to study	3.70	1.115
36. Ability to maintain normal performance levels in stressful situations and with a deadline	3.21	1.038
37. Ability to maintain calm during public presentations	3.06	1.179
38. Satisfaction from achieving the goals	3.94	1.043
39. Ability to accept new responsibilities easily	3.51	0.959
40. Latest exam results	3.34	1.067
41. Ability to find new and innovative solutions	3.33	1.079
42. Ability to adapt to new situations easily	3.79	0.862
43. Ability to establish resource management systems	3.37	0.902
44. Ability to overcome any difficulty unsupported	3.43	0.925
45. Ability to work in environments that fall outside the scope of the study program	3.94	0.903

According to the results shown in Table 1, the mean of the variables ranges from 2.96 points in item 10 (ability to use university resources optimally) to 4.04 points in item 20 (capacity for relationships with classmates). On this basis, students assess

transversal competences positively, valuing all, except the skill to use University resources optimally, above the midpoint of the scale (3).

After the descriptive study, an analysis of variance (ANOVA) was conducted for the variables gender, study program and year of study. To do that, we took the Fisher value (F) as an index of discriminating power and (p) the effect of significance being $\alpha = 0.05$. To apply ANOVA, homogeneity of variances is required, which was verified by Levene's test.

Gender

According to the results shown by the ANOVA analysis conducted for the 45 items of the questionnaire, significant differences between male and female respondents in item 6 (capacity for planning), and in item 39 (ability to accept new responsibilities easily) were found, as can be seen in Table 2. Based on the results of Levene's test, with p=0.291 and p=0.378 for items 6 and 39 respectively, the hypothesis of equal variances required for ANOVA is corroborated (see Table 2).

Table 2

Mean, standard deviation and ANOVA (gender) for items 6 and 39

	Gender	N	Mean	Standard deviation	F	Sig.
Item6	Men	72	2.88	1.113	6.658	0.011*
	Women	30	3.47	0.900		
	Total	102	3.05	1.084		
Item39	Men	72	3.25	0.931	3.989	0.049*
	Women	30	3.67	1.028		
	Total	102	3.37	0.974		

Thus, results indicate that women have better self-perception of items 6 and 39 than men. That is, women feel they have better capacity for planning. In the same vein, women value their ability to accept new responsibilities more highly than men.

Study Program

Table 3 shows significant differences in items 8 (ability to organize team work), 15 (ability to maintain the performance in stressful situations) and 30 (the ability to manage people and resources). The results obtained by Levene's test corroborate the homoscedasticity required for ANOVA.

In Table 3, by looking at the mean scores for item 8 (ability to organize team work), we can observe that there is a difference between the mean score of group 3 (students of Bachelor in Industrial Design and Product Development) and the average score of other groups, so while these give scores equal to or above 3.57 points, the mean score of group 3 is 3.03. That is, the average capacity to organize work in teams is significantly higher for students of Computer Engineering, Telematic Engineering and Geomatic Engineering than for students of Engineering for Industrial Design and Product Development.

Table 3
Mean, standard deviation and ANOVA (degree) for items 8, 15 and 39

	Bachelor	N	Mean	Standard deviation	F	Sig.
Item8	CS Eng	21	3.57	0.746	4.016	0.010*
	Tel. Eng.	26	3.73	1.041		
	ID Eng.	40	3.03	0.947		
	Ge. Eng.	14	3.71	0.914		
	Total	101	3.42	0.972		
Item15	CS Eng	22	3.18	0.795	2.998	0.034*
	Tel. Eng.	26	3.62	1.023		
	ID Eng.	40	2.90	0.900		
	Ge. Eng.	13	3.00	1.291		
	Total	101	3.16	0.997		
Item30	CS Eng	20	3.40	1.273	3.137	0.029*
	Tel. Eng.	25	3.36	1.221		
	ID Eng.	37	2.59	1.013		
	Ge. Eng.	14	2.86	1.292		
	Total	96	3.00	1.205		

Regarding item 15 (ability to maintain the performance in stressful situations), the average of 3.62 points for group 2 (Engineering in Telematics) is higher than the average for the other groups (which is equal to or less than 3.18 points). In contrast, the perception that students of Engineering in Industrial Design and Product Development have of their ability to overcome stress in adverse situations (2.9) is slightly below the average score of the scale.

With respect to item 30 (the ability to manage people and resources), it can be seen that groups 3 and 4 (Engineering in Industrial Design and Product Development and Engineering in Geomatics, respectively) assessed the development of this capacity below the scale midpoint (see Table 3). This indicates that students of Computer Engineering in IT and Engineering in Telematics have a greater ability to manage people and resources than those of Engineering in Industrial Design and Geomatics.

Year of Study

At the time when the questionnaire was administered, only the first two years of the new study programs had been completed. Therefore, we looked for differences between the first-year students and the second-year students. According to the results shown by the analysis of the variance, significant differences were found only in item 8 (ability to organize team work), as can be seen in Table 4 by the value p=0.023 offered by the ANOVA (*Levene's* test: p=0.814).

In the same vein, the mean for this item is 0.44 points higher in the group of second-year students than the value for the first-year students (3.21 versus 3.65). This difference indicates that the second-year students are more able to organize teamwork than the first-year students.

Table 4

Mean, standard deviation and ANOVA (course) for item 8

	Course	N	Mean	Standard deviation	F	Sig.
Item 8	1	53	3.21	0.988	5.340	0.023*
	2	48	3.65	0.911		
	Total	101	3.42	0.972		

Analysis of Transversal Competences According to the Dimensions Analyzed

To study the relationships between the variables or dimensions analyzed, taking into account the results of the questionnaire, we conducted a principal components analysis that has allowed us to transform the original set of variables into a smaller set of new variables correlated with each other.

Although the skewness and kurtosis values of the sample do not indicate perfect normal distribution, despite the size of the sample, this was treated as a normal distribution because both the Kaiser-Meyer-Olkin test (KMO) (0.785) and Barlett's test of sphericity (p=0.000) showed that data were appropriate for this type of analysis, and the Cronbach's alpha (0.968) indicated good internal consistency. We used the Kaiser criterion, based on the eigenvalue, to choose the resulting factors, determining the extraction 9 factors appropriate (see Figure 3).

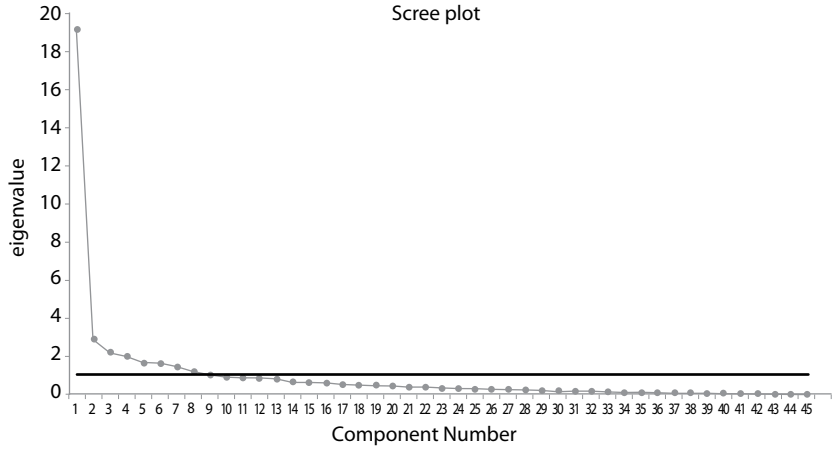

Figure 3. Scree Plot

These nine factors, that explain 74.109% of the total variance (after Varimax rotation), and that may be identified with different transversal competences, are: (1) management skills, (2) skills for entrepreneurship and problem solving, (3) social skills, (4) communication and leadership skills, (5) responsibility and concern for the goals, (6) motivation, self-confidence and stress management, (7) creativity, analytical skills and efficiency, (8) willingness to work in a team, and (9) capacity for self-criticism. The main components, the percentage of variance explained and the reliability of their scales, measured by Cronbach's alpha, are shown in Table 5.

Table 5

Main components

	% of variance explained	Internal Consistency	Items
C1. Management skills	13.548	0.913	2,4,6,7,8,9,14,15,16,18,33
C2. Skills for entrepreneurship and problem solving	12.218	0.916	12,24,25,32,41,42,43,44,45
C3. Social skills	11.065	0.874	5,11,17,20,21,22,29
C4. Communication and leadership skills	9.009	0.823	23,26,27,30,37
C5. Responsibility and concern for the goals	7.550	0.810	28,38,39
C6. Motivation, self-confidence and stress management	7.298	0.785	1,31,34,35,36
C7. Creativity, analytical skills and efficiency	5.267	0.663	3,10,13
C8. Willingness to work in a team	4.617		19
C9. Capacity for self-criticism	3.538		40

To test whether these differences were statistically significant, the mean of each main component was compared to the average of all items, which is equal to 3.3808 (Table 4). So, we may conclude that there is a statistically significant difference ($p<0.05$) between the global average and the mean of the main component 3 (social skills), which indicates that the competence relating to social skills is significantly above the global average. By contrast, although with lower significance ($p<0.05$), the main components 1 (management skills), 4 (communication and leaderships skills and motivation) and 7 (creativity, analytical skills and efficiency) are below the average, which allows us to identify training needs.

Table 6

Mean, standard deviation, and t-test of the main components

	N	Mean	Standard Deviation	t	Sig. (bilateral)
C1	102	3.2329	0.74942	-1.993	0.049*
C2	102	3.4545	0.72713	1.024	0.308
C3	102	3.7339	0.75498	4.723	0.000**
C4	102	3.1832	0.83760	-2.383	0.019*
C5	102	3.4869	0.92237	1.162	0.248
C6	102	3.3087	0.81370	-0.895	0.373
C7	102	3.2239	0.78367	-2.023	0.046*
C8	100	3.5200	1.04910	1.327	0.188
C9	97	3.1649	1.13358	-1.875	0.064

Discussion of Results

Women studying engineering programs at the University Center of Mérida consider that they have better planning skills and a greater ability to accept new responsibilities than their male classmates, which may derive from previous experience. This indicates that these skills need to be developed more in men. However, since it is not possible

to separate the training of men and women, activities for students in general, such as tasks throughout the semester in which students have to organize themselves and take responsibility for the completion of the task can be planned.

Furthermore, the fact that students of Engineering in Industrial Design and Product Development are less able to organize team work than students of other programs may be due to the practical character of this program, since a large proportion of its content is individualistic and of artistic nature. This allowed us to detect a lack of team-working ability that could be supplemented or enhanced by more group work tasks and through the use of different cooperative learning techniques.

On the other hand, students of Computer Engineering have a significantly greater ability to maintain performance in adverse situations than students of the other programs analyzed in this work. This difference may be explained by the fact that students of Computer Engineering are used to practical work (software development, for example) that leads to mistakes and poses challenges to be overcome while facing important time and/or resources constraints. However, students of Industrial Design have a significantly lower perception of their skills in this respect compared to students of other programs, which is below the average score of the scale. This may be because, as mentioned previously, Industrial Design is the program with a more creative and artistic content. In order to develop this competence properly, it would be advisable to include some challenges related to this competence in practical work, such as tasks with limited resources, whether material or time.

The students of the Bachelor in Computer Engineering program and of the Bachelor in Engineering in Telematics program have a greater ability to manage people and resources than the students of the Bachelor in Engineering in Industrial Design and Product Development and students of the Bachelor in Engineering in Geomatics programs. This difference may be due to the fact that they are used to working in groups in most of their subjects, which is not so common in the other two programs.

The fact that second-year students have a greater ability to organize team work is quite logical, because in the first-year students may not have worked on this skill properly, as the subjects are more theoretical and there are a greater number of students than in the second year, when generally there are fewer students in the classroom and the subjects are more practical, allowing the teachers to work on this skill efficiently.

With regards to the second objective of this work, the principal component analysis, extracting nine components that cover all aspects or dimensions key of transversal competences in engineering was conducted. This analysis allowed us to observe that although no component is below the midpoint of the scale (3), there are very significant differences with respect to the general average obtained, especially in the component "social skills", which is clearly above the average and indicates that these skills have been sufficiently developed, but that more attention should be paid to some specific qualifications, as mentioned above.

However, components such as management skills, communication and leadership skills, motivation, self-confidence and stress management are below average, indicating

that there may be a need for training in these areas. As these competences are the most relevant for professional life (Martínez, 2011), they must be developed in order to prepare graduates to join the labor market.

Conclusions and Future Research Guidelines

The methodological novelties related to the Bologna process pose several challenges, and one of the most important ones is competence training and assessment, both specific and generic. This work has focused on transversal or generic competences because their development and assessment is a difficult task, as they are acquired in different years of study and in different subjects.

Very interestingly, this study shows that it is possible to assess the level of development of transversal competences through a questionnaire and to detect possible deficiencies in students' competence training. So, it is possible to generate information that is reliable, valid and easy to obtain (including on-line), and that allows the development of transversal competences in the new engineering study programs to be assessed. Moreover, the nine main components obtained allow us to associate them with the competences of each degree in order to study correlations between them.

In spite of the fact that this is an important contribution to the literature of the field, our study is not exempt from limitations. One limitation of this paper is the lack of a post-hoc analysis in order to analyze the similarities or differences between first year students and the second-year students. Another one is the fact that the sample is widely masculinized, which makes comparisons difficult by the gender criterion. In the future, it would be advisable to conduct a longitudinal study that would enable the analysis of whether students are improving their perception of the abilities and transferable skills they possess and their transversal competences, in order to verify if such competences are being developed properly within the different study programs.

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Transverzalne kompetencije studenata strojarstva

Sažetak

Jedna od glavnih promjena europskog prostora visokog obrazovanja jest uspostava obrazovnog sustava uutemeljenog na kompetencijama. Studenti su u današnje vrijeme više nego ikada u središtu oko kojega se vrti sveučilišni obrazovni sustav. Kompetencije koje bi studenti trebali steći tijekom svojeg studiranja uključuju transverzalne kompetencije, tj. one koje su povezane s vještinama rukovođenja, rješavanja problema i sa sposobnošću rada u timu, a koje su visoko cijenjene na tržištu rada. Te su osobine iznimno važne u strojarstvu, jer one mogu dati prednost kandidatu koji ih posjeduje. Dakle, evaluacija i poučavanje tim vrstama vještina sada predstavljaju glavne izazove s kojima se sveučilišni profesori suočavaju, jer se odgovarajući obrazovni ishodi moraju postaviti i ocijeniti, i za sveučilišne studijske programe i za svaki pojedinačni kolegij, a taj je proces nastavnicima potpuno nov. Usredotočujući se upravo na taj aspekt, naš rad, koji se temelji na empirijskom istraživanju provedenom na uzorku od 102 studenta strojarstva sa Sveučilišnog centra u Meridi, koristi se alatom kojim možemo utvrditi napredak tih studenata u području različitih transverzalnih kompetencija. Taj alat ne samo da nam omogućava procjenu stupnja razvoja kompetencija nego nam također omogućava prepoznavanje slabih područja studenata u međukurikularnom obrazovanju, na kojima se kasnije može dodatno raditi.

Ključne riječi: *Bolonjski proces; obrazovanje utemeljeno na kompetencijama; obrazovanje u području strojarstva; tržište rada; visoko obrazovanje.*

Uvod

Europski prostor visokog obrazovanja ili Bolonjski proces novi je organizacijski okvir koji ima za cilj spojiti različite europske sveučilišne sustave, tako da se stečene kvalifikacije mogu usporediti s pomoću zajedničkih obilježja kao što su opterećenje studenata, i kako bi se olakšala razmjena studenata različitih sveučilišta u sastavu Europske unije (Fernández, Carballo i Galán, 2010). Da bi se to postiglo, sveučilišta diljem Europe morala su prilagoditi svoje obrazovne kvalifikacije (diplomske, dodiplomske i poslijediplomske studije) standardima europskog prostora visokog obrazovanja te vrednovati svaki kolegij dodjelom određenog broja bodova prema Europskom sustavu prijenosa bodova (*European Credit Transfer and Accumulation Systems*).

U Španjolskoj su se institucije visokog obrazovanja odlučile za četverogodišnje studijske programe. Tijekom svake akademske godine može se steći 60 bodova, tj. ukupno 240 bodova tijekom studija. Novi studijski programi uvedeni su u akademskoj godini 2009./2010. te su još uvijek u procesu provedbe. Jedna od najvećih novosti u europskom prostoru visokog obrazovanja jest zaokret od tradicionalnih metoda okrenutih nastavniku prema programima koji u središte stavljaju studente i u kojima se naglasak stavlja na stjecanje kompetencija (*Kraljevski dekret* 1393/2007, Španjolska, 2007) kao na način na koji bi se osigurao profesionalan rad studenata kada završe fakultetsko obrazovanje (Romero, 2010). To podrazumijeva veliku promjenu metodike nastave na sveučilištu i zahtijeva da se u kurikulu eksplicitno navedu te posebne i transverzalne kompetencije koje bi studenti trebali steći za vrijeme studiranja. Obrazovanje studenata u području transverzalnih kompetencija i ocjenjivanje tih kompetencija predstavlja novi izazov za sveučilišne profesore. Obično se takve kompetencije razvijaju putem raznih kolegija u studijskom programu, pa je teško ocijeniti razvija li pojedini student te kompetencije dobro ili ne. Stoga je neophodno uspostaviti mehanizme za procjenu napretka studenata u usvajanju kompetencija i prepoznavanju područja koja bi trebalo unaprijediti.

Važnost tog novog metodičkog pristupa odražava se u brojnoj literaturi napisanoj o toj temi (Albanese, Mejicano, Mullan, Kokotailo i Gruppen, 2008; Halász i Michel, 2011; Lozano, Boni, Peris i Hueso, 2012; Male, Bush i Chapman, 2010). Međutim, većina tih studijskih programa teorijske je prirode. Naše istraživanje pokušava pružiti praktičniji pristup prikazujući podatke koji bi trebali pomoći u razvoju boljeg, detaljnijeg razumijevanja tog područja i pružiti pomoć nastavnicima da premoste teškoće koje se javljaju kao rezultat promjene metodičkog pristupa.

U tom je kontekstu opći cilj našeg istraživanja bio utvrditi stupanj razvijenosti transverzalnih kompetencija studenata strojarstva na Sveučilišnom centru u Meridi u sljedećim studijskim programima: prvostupnik strojarstva, smjer Industrijski dizajn i razvoj proizvoda; prvostupnik strojarstva, smjer Geomatika; prvostupnik računalnog inženjerstva i informacijskih tehnologija, zatim prvostupnik strojarstva, smjer Telematika. Da bi se utvrdilo jesu li studenti usvojili transverzalne kompetencije, kao i u kojoj mjeri, preispitat ćemo neke nastavne metode koje se koriste za razvoj takve vrste kompetencija na temelju prepoznatih nedostataka. Osim tog glavnog cilja, postoje još dva cilja ovog rada:

- Analizirati stupanj razvijenosti dimenzija koje čine transverzalne kompetencije studenata strojarstva i provjeriti postoji li razlika u stupnju razvijenosti tih kompetencija s obzirom na spol, studijski program i godinu studiranja.
- Proučiti veze između različitih analiziranih dimenzija, da bi se utvrdilo koliko su one bitne za razvoj transverzalnih kompetencija.

Da bismo postigli sve navedene ciljeve, naš je rad organiziran na sljedeći način. U drugom poglavlju opisat ćemo vrste kompetencija koje studenti moraju usvojiti tijekom studiranja, stavljajući naglasak na transverzalne kompetencije. U trećem se

poglavlju objašnjava važnost transverzalnih kompetencija za studente strojarstva. U četvrtom i petom poglavlju objašnjavaju se metode koje su korištene u kvantitativnom istraživanju i dan je pregled rezultata. Na kraju, u zadnjem poglavlju, prikazat ćemo svoje zaključke i moguće smjernice za buduća istraživanja.

Transverzalne kompetencije u visokom obrazovanju

Bolonjska deklaracija o europskom prostoru visokog obrazovanja (1999) odražava jedan od najvećih izazova s kojim se novi europski prostor visokog obrazovanja suočava: potrebu za pokazivanjem sposobnosti prilagodbe novim i promjenjivim zahtjevima koje postavlja moderno društvo i napredak znanosti. Stavovi i vještine koje društvo zahtijeva od budući stručnjaka jesu aspekti koje bi svaki obrazovni model trebao razmotriti. U poslovnom svijetu danas se ne traže stručnjaci s radnim iskustvom, nego kompetentni profesionalci (Ríos, Cazorla, Díaz-Puente i Yagüe, 2010). Europski prostor visokog obrazovanja omogućava provedbu modela utemeljenog na kompetencijama (Palma, Ríos i Miñán, 2011) da bi se povećala zapošljivost i da bi se moglo učinkovitije odgovoriti na potrebe tržišta rada (Romero, 2010).

U sadašnjem kontekstu, koji karakterizira iznimno brza razmjena informacija, studenti moraju posjedovati generičke vještine, sklonosti i atribute koji su primjenjivi na različita područja i situacije (Bridgstock, 2009). Zbog tog Europska unija kompetencijama posvećuje veliku pažnju (Mulder, Gulikers, Biemans i Wesselink, 2009), smatrajući transverzalne kompetencije ključnim elementima u stvaranju fleksibilne radne snage koja se sposobna brzo prilagoditi stalnim promjenama koje se događaju u sve međusobno povezanijem svijetu (Rico, Coopens, Ferreira, Sánchez i Agudo, 2013). Kompetencije se više ne smatraju samo skupom znanja, vještina ili sposobnosti koje se primjenjuju u rješavanje problema povezanih s određenim poslovnim profilom, nego također obuhvaćaju psihološku i društvenu dimenziju (Romero, 2010). Kompetencija je više od znanja i vještina. Ona je sposobnost da se udovolji kompleksnim zahtjevima, koja podržava i koristi psihosocijalne resurse (uključujući i vještine i stavove) u određenom kontekstu (Rychen i Salganik, 2003). Prema Delorsovu izvješću (Delors i Mufti, 1996), kompetencija je integracija znanja, praktičnog znanja i funkcioniranja, a ne samo puko učenje nekog zanimanja. Neophodno je da studenti steknu kompetencije koje im omogućavaju snalaženje u različitim situacijama, od kojih su neke nepredvidive.

Kompetencije se mogu svrstati u dvije skupine: tehničke ili specifične kompetencije i generičke ili transverzalne kompetencije. Prva skupina obuhvaća one kompetencije koje su izravno povezane s aktivnošću ili poslom (Solanes, Núñez i Rodríguez, 2008), a transverzalne se odnose na osobne atribute kognitivne, društvene, individualne ili evaluativne prirode koje obogaćuju profesionalno ponašanje. Iako one nisu izričito potrebne za obavljanje posla, one postaju element koji pojedinca odvaja od drugih, te predstavljaju dodatnu kvalitetu zaposlenika ili budućeg zaposlenika (Corominas, 2001).

Poslodavci sve više prepoznaju važne kompetencije poput mogućnosti prilagodbe promjenama, upornosti i rada u timu. Budući da specifične kompetencije općenito postaju zastarjele zbog tehnološkog napretka, tržište rada sve više i više važnosti pridaje transverzalnim kompetencijama zbog toga što su one trajne, relevantnije i korisne za promicanje cjeloživotnog učenja (Corominas, 2001). K tomu, takve su kompetencije ključni elementi inovacija i konkurentnosti, istodobno pridonose motivaciji i zadovoljstvu zaposlenika, a samim time i produktivnosti (Rico i sur., 2013).

Prema DeSeCo projektu (Rychen i Salganik, 2011), kompetencije se mogu podijeliti u tri kategorije (vidi Sliku 1).

Slika 1.

Jednako se tako u Tuning projektu (González i Wagenaar, 2003) navodi da se generičke ili transverzalne kompetencije koje prepoznaju elemente koji mogu biti zajednički raznim smjerovima mogu podijeliti u tri vrste: instrumentalne, interpersonalne i sistemske.

- ❒ Instrumentalne kompetencije su one s instrumentalnom funkcijom, a obuhvaćaju:
  - – Kognitivne vještine, tj. sposobnost razumijevanja i korištenja misli i ideja;
  - – Metodičke vještine potrebne za interakciju u profesionalnom okruženju: upravljanje vremenom i strategije učenja, donošenje odluka ili rješavanje problema;
  - – Tehnološke vještine, a to su one povezane s korištenjem tehničkih resursa, računala i vještine upravljanja informacijama;
  - – Jezične vještine, koje obuhvaćaju i usmenu i pismenu komunikaciju, ili znanje drugog jezika.
- ❒ Interpersonalne kompetencije, koje obično olakšavaju proces suradnje i društvenu interakciju. Te kompetencije mogu biti:
  - – Individualne vještine, tj. one vještine povezane sa sposobnošću izražavanja osjećaja ili shvaćanja problema, kao i sposobnošću kritiziranja i prihvaćanja konstruktivne kritike;
  - – Društvene i interpersonalne vještine, koje se odnose na sposobnost rada u timu i koje izražavaju etičku ili društvenu predanost na društveno prihvatljiv način.
- ❒ Sustavne ili integrativne kompetencije, tj. vještine i sposobnosti povezane sa sustavima kao cjelinom. One nam omogućavaju da cijenimo odnose i veze između dijelova i cjeline, te uključuju vještine potrebne za planiranje promjena koje će unaprijediti postojeće sustave i dizajnirati nove, a koje kao svoju osnovu podrazumijevaju prethodno usvajanje instrumentalnih i interpersonalnih vještina.

Transverzalne kompetencije studenata strojarstva

U području strojarstva neophodno je posjedovati transverzalne kompetencije jer tržište rada (Martínez, 2011) smatra kompetencije povezane s društvenim vještinama,

rukovođenjem, jezicima, menadžmentom ili informacijsko-komunikacijske vještine korisnijima nego specifično znanje svakog smjera strojarstva, jer se za njega smatra da su ga studenti stekli tijekom svojeg fakultetskog obrazovanja. Međutim, svejedno se ne posvećuje dovoljna pažnja tim kompetencijama jer one obično obuhvaćaju nekoliko kolegija. Međunarodni studijski programi s velikim uzorkom studenata prepoznali su i izmjerili nedostatak kompetencija kod apsolvenata strojarstva na temelju zapažanja različitih zainteresiranih strana u tom procesu (Male i sur., 2010).

U istraživanju provedenom u Sjedinjenim Američkim Državama i Europi u kojem su sudjelovala 1372 inženjera strojarstva, analizirala se važnost različitih kompetencija za njihov rad. Opće vještine, koje se mogu primijeniti na velik broj područja (vještine rješavanja problema, analitičke i metodološke vještine, vještine rada u timu i komunikacijske vještine) smatraju se važnijima od specifičnog praktičnog znanja o strojarstvu. U ovom su istraživanju prepoznati glavni nedostatci kompetencija povezanih s komunikacijskim vještinama, vještinama rukovođenja i društvenim vještinama (Bodmer, Leu, Mira i Rütter, 2002; Male i sur., 2010).

Nadalje, u istraživanju provedenom u Australiji na uzorku od 300 apsolvenata strojarstva, utvrđeni su nedostaci u šest kompetencija (praktični dio rada u strojarstvu, vještine proizvodnog strojarstva, komunikacijske vještine, samokontrola i ispravan stav, rješavanje problema, timski rad) (Male i sur., 2010). Većina tih vještina pripadaju skupini transverzalnih kompetencija.

Trenutni sustavi akreditacije podrazumijevaju da kompetencije diplomiranih inženjera strojarstva uvelike nadilaze znanje koje im je preneseno na predavanjima i testirano ispitima. Sposobnost primjene znanja je jednako važna kao i usvajanje znanja. Od iznimne je važnosti da dobro obrazovanje u području strojarstva uči studente kako eksperimentirati i razviti svoje sposobnosti pod nadzorom starijih inženjera (Bodmer i sur., 2002).

Europski prostor visokog obrazovanja počeo je rješavati taj problem tako što je određeno nekoliko transverzalnih kompetencija koje bi inženjeri strojarstva trebali posjedovati, no potrebne su neke metodičke promjene, kao i promjene u ocjenjivanju znanja, da bi se studente moglo obrazovati na odgovarajući način i ispravno procijeniti te aspekte. Glavni je cilj u tom procesu poboljšati usklađenost kompetencija, metodike i ocjenjivanja (Hernández-Leo i sur., 2012), da bi se taj proces mogao uspješno provesti. U našem smo se slučaju usredotočili na proces ocjenjivanja s ciljem pronalaska pouzdanog alata za ocjenjivanje napretka studenata u razvoju navedene vrste kompetencija.

Metode

Naše se istraživanje temelji na empirijskoj studiji i analizira zapažanja studenata strojarstva sa Sveučilišnog centra u Meridi, Sveučilišta u Extremaduri, smještenog u jugozapadnom dijelu Španjolske. Korišteni su podaci, odnosno informacije iz prve ruke, bili prikupljeni upravo za ovo istraživanje.

Instrument prikupljanja podataka

Podaci su bili prikupljeni s pomoću upitnika kojim su se prije koristili Solanes, Nuñez i Rodríguez (2008). Upitnik se sastojao od 45 tvrdnji Likertove skale s kojima su studenti morali izraziti svoje slaganje ili neslaganje odabiranjem brojeva u rasponu od 1 do 5; 1 izražava neslaganje, a 5 potpuno slaganje s tvrdnjom. Upitnik nam je pomogao u shvaćanju zapažanja studenata strojarstva o stupnju usvojenosti transverzalnih kompetencija.

Upitnik kojim smo se koristili bio je provjeren u prijašnjim istraživanjima (Solanes i sur., 2008). U spomenutom je istraživanju, pouzdanost i unutarnja konzistencija instrumenta bila 0,92, distribuirana u 6 faktora koji su objasnili 53,15% varijance. U našem je istraživanju unutarnja konzistencija, izmjerena Cronbachovom alfom, povećana na 0,968, te distribuirana u 9 faktora koji su objasnili 74,109% ukupne varijance.

Uzorak

Istraživanje je provedeno 2011. godine, a primijenjen je upitnik na internetu na Moodle platformi za učenje. Odabrali smo takvu metodu intervjua zato što je ona bila ne samo najjeftiniji i najbrži način prikupljanja podataka nego je u ovom slučaju upravo ona najbolje odgovarala našoj ciljnoj grupi – studentima strojarstva koji su navikli upotrebljavati Moodle.

Na upitnik su odgovorila 102 studenata prve i druge godine strojarstva sa Sveučilišnog centra u Meridi, Sveučilišta u Extremaduri, upisanih u sljedeće studijske programe: prvostupnik strojarstva, smjer Industrijski dizajn i razvoj proizvoda; prvostupnik strojarstva, smjer Geomatika; prvostupnik računalnog inženjerstva i informacijskih tehnologija, kao i prvostupnik strojarstva, smjer Telematika. Svi upitnici bili su valjani (n = 102).

Varijable zabilježene u zaglavlju upitnika pomogle su nam klasificirati uzorak s obzirom na godinu studija, spol i studijski program (smjer). Dakle, na temelju prve varijable od 102 studenta koji su sudjelovali u istraživanju, 54 studenta (52,94%) bilo je na prvoj godini studija, a njih 48 (47,06%) bilo je na drugoj godini studija. S obzirom na spol trebalo bi napomenuti da je uzorak uvelike muškog spola, jer su, općenito gledajući, studenti tehničkih studija još uvijek pretežno muškarci, pa je od 102 studenta koji su sudjelovali u istraživanju njih 72 (70,59%) bilo muškog spola, a 30 ženskog. S obzirom na studijski program, najbrojniju skupinu ispitanika sačinjavali su studenti smjera Industrijski dizajn i razvoj proizvoda, zatim studenti smjera Telematika, zatim studenti smjera Računalno inženjerstvo i informacijske tehnologije, zatim smjera Geomatika (vidi Sliku 1).

Slika 1.

Statistička analiza

Istraživački tim obradio je podatke dobivene upitnikom koristeći se SPSS, v. 19. Najprije smo proveli deskriptivnu analizu varijabli, uz statistiku mjera centralne tendencije i disperzije, a zatim smo testirali važnost razlika u rezultatima promatranih

varijabli primjenom analize varijance (ANOVA) za spol, studijski program i godinu studiranja. Kao drugo, koristili smo se analizom glavnih komponenti. Ta je statistička metoda bila korisna jer nam je omogućila smanjivanje broja varijabli na manji broj osnovnih kategorija ili faktora, koji su sadržavali najviše informacija i za koje smo smatrali da su dostatni za objašnjenje modela. Pokušali smo sintetizirati sve informacije s kriterijem minimalnog gubitka pri objašnjavanju. Nakon toga smo proučili važnost razlika u rezultatima koje smo uočili kod glavnih komponenti ili faktora, koristeći se t-testom za studente.

Analiza rezultata

Inicijalna analiza

Da bismo ostvarili prvi cilj našeg istraživanja, analizu dimenzije koje oblikuju transverzalne

kompetencije, započeli smo s deskriptivnom analizom svake varijable, usredotočujući se na srednju vrijednost i standardnu devijaciju (vidi Tablicu 1).

Tablica 1**.**

Prema rezultatima prikazanim u Tablici 1 srednja vrijednost varijabli kreće se u rasponu od 2,96 za tvrdnju broj 10 (Sposobnost optimalnog korištenja sveučilišnih resursa) do 4,04 za tvrdnju broj 20 (Sposobnost uspostavljanja odnosa s kolegama). Na temelju toga studenti su pozitivno ocijenili transverzalne kompetencije, ocijenivši ih sve, osim vještine optimalnog korištenja sveučilišnih resursa, iznadprosječnom ocjenom (3).

Nakon deskriptivne analize provedena je analiza varijance (ANOVA) za varijable spol, studijski program i godina studija. Da bismo to učinili, odabrali smo Fisherovu vrijednost (F) kao diferencijalni indeks i (p) statističku značajnost vrijednosti $\alpha = 0.05$. Da bismo primijenili ANOVA analizu varijance, bila je potrebna homogenost varijance, što je potvrđeno Levenovim testom.

Spol

Prema rezultatima koje je pokazala ANOVA analiza provedena na 45 tvrdnji navedenih u upitniku, uočene su značajne razlike između ispitanika muškog i ženskog spola kod odgovora na tvrdnju 6 (sposobnost planiranja) i tvrdnju 39 (sposobnost lako prihvatiti nove obveze), kako se može vidjeti u Tablici 2. Na temelju rezultata Levenova testa, u kojem je p=0,291 i p=0,378 za tvrdnje 6 i 39 posebno, potvrđena je hipoteza jednake varijance koju zahtijeva ANOVA analiza (vidi Tablicu 2).

Tablica 2.

Dakle, rezultati pokazuju da žene imaju bolje samoopažanje kod tvrdnji br. 6 i 39. Odnosno, žene osjećaju da imaju bolju sposobnost planiranja. Na isti način žene više vrednuju svoju sposobnost prihvaćanja novih odgovornosti nego što to čine muškarci.

Studijski program (smjer)

Tablica 3 pokazuje značajne razlike u tvrdnjama br. 8 (sposobnost organiziranja timskog rada), 15 (sposobnost zadržati smirenost u drugačijim i konfliktnim situacijama) i 30 (sposobnost upravljanja ljudima i resursima). Rezultati dobiveni Levenovim testom potvrđuju homoskedastičnost koju zahtijeva ANOVA.

Tablica 3.

Kada se pogledaju srednje vrijednosti za tvrdnju br. 8 (sposobnost organiziranja timskog rada) u tablici 3, može se primijetiti da postoji razlika između srednje vrijednost rezultata kod skupine 3 (prvostupnik strojarstva, smjer Industrijski dizajn i razvoj proizvoda) i srednje vrijednosti rezultata drugih skupina. Dok su njihovi rezultati 3,57 bodova ili više, srednja vrijednost rezultata skupine je 3,03. Dakle, prosječna sposobnost organiziranja timskog rada znatno je veća kod studenata računalnog inženjerstva, telematike i geomatike nego kod studenata industrijskog dizajna i razvoja proizvoda.

Što se tiče tvrdnje br. 15 (sposobnost zadržati smirenost u drugačijim i konfliktnim situacijama), prosjek 3,62 za skupinu br. 2 (Telematika) veći je od prosjeka ostalih skupina (koji je jednak ili manji od 3,18 bodova). Za razliku od toga stav koji studenti industrijskog dizajna i razvoja proizvoda imaju o svojoj sposobnosti da zadrže smirenost u drugačijim situacijama (2,9) nešto je niži od prosječnog rezultata na skali.

S obzirom na tvrdnju br. 30 (sposobnost upravljanja ljudima i resursima) može se vidjeti da su studenti iz skupina 3 i 4 (industrijski dizajn i razvoj proizvoda i geomatika) procijenili razvoj te sposobnosti kao niži od srednje vrijednosti na skali (vidi Tablicu 3). To upućuje na činjenicu da studenti računalnog inženjerstva i telematike imaju veću sposobnost upravljanja ljudima i resursima od studenata industrijskog dizajna i razvoja proizvoda i geomatike.

Godina studija

U vrijeme provedbe ankete završile su samo prve dvije godine novih studijskih programa. Stoga smo tražili razlike između studenata prve i druge godine. Prema rezultatima koje je pokazala analiza varijance, značajne razlike uočene su samo u tvrdnji br. 8 (sposobnost organiziranja timskog rada), kao što se može vidjeti u Tablici 4, gdje je ANOVA dala vrijednost p=0,023 (Levenov test: p=0,814).

Isto je tako srednja vrijednost te tvrdnje za 0,44 boda veća kod skupine studenata druge godine nego kod studenata prve godine (3,21 prema 3,65). Ta razlika pokazuje da studenti druge godine mogu organizirati timski rad bolje nego studenti prve godine.

Tablica 4.

Analiza transverzalnih kompetencija prema dimenzijama

Da bismo ispitali vezu između analiziranih varijabli ili dimenzija, uzimajući u obzir rezultate ankete, proveli smo analizu glavnih komponenti koja nam je omogućila pretvaranje izvorne skupine varijabli u manju skupinu novih varijabli, koje su u međusobnoj korelaciji.

Iako vrijednosti asimetrije i kurtoze uzorka ne ukazuju na savršenu, normalnu distribuciju usprkos veličini uzorka, ona je tretirana kao normalna distribucija jer su i Kaiser-Meyer-Olkinov test (KMO) (0,785) i Barlettov test sferičnosti (p=0,000) pokazali da su podaci pogodni za takav tip analize, a Cronbach alfa (0,968) je pokazala dobru unutarnju konzistenciju. Na temelju svojstvene vrijednosti koristili smo se Kaiserovim kriterijem da bismo odabrali dobivene faktore, te odabrali 9 dobivenih faktora (vidi Dijagram 2).

Slika 2.

Tih devet faktora, koji objašnjavaju 74,109% ukupne varijance (nakon Varimax rotacije) i koji se mogu uočiti kod različitih transverzalnih kompetencija, jesu: (1) vještine menadžmenta, (2) poduzetničke vještine i vještine rješavanja problema, (3) društvene vještine, (4) komunikacijske vještine i vještine upravljanja, (5) odgovornost i briga za ciljeve, (6) motivacija, samopouzdanje i kontrola stresa, (7) kreativnost, analitičke vještine i učinkovitost, (8) spremnost na timski rad i (9) samokritičnost. Glavne komponente, postotak objašnjene varijance i pouzdanost njihovih skala mjerenih Cronbach alfom prikazani su u Tablici 5.

Tablica 5.

Da bi se ispitalo jesu li te razlike statistički značajne, srednja vrijednost svake glavne komponente uspoređena je s prosjekom svih tvrdnji, koji je iznosio 3,3808 (Tablica 4). Stoga možemo utvrditi da postoji statistički značajna razlika ($p<0,05$) između ukupnog prosjeka i srednje vrijednosti komponente 3 (društvene vještine), koja upućuje na činjenicu da je kompetencija koja se odnosi na društvene vještine znatno iznad ukupnog prosjeka. Za razliku od toga, iako s nižom značajnošću ($p<0,05$), glavne komponente (1) vještine menadžmenta, (4) komunikacijske vještine i (7) kreativnost, analitičke vještine i učinkovitost su ispod prosjeka, što nam omogućava prepoznavanje stvarnih potreba u procesu obrazovanja.

Tablica 6.

Rasprava o rezultatima

Žene koje studiraju različite smjerove strojarstva na Sveučilišnom centru u Meridi smatraju da imaju bolje vještine planiranja i veću sposobnost prihvaćanja novih odgovornosti od svojih muških kolega, što može biti i rezultat prethodnog iskustva. To upućuje na to da se te vještine trebaju više razviti kod muškaraca. Međutim, kako nije moguće odvojiti obrazovanje muškaraca od obrazovanja žena, mogu se planirati opće aktivnosti za sve studente, kao što su zadaci tijekom semestra za čije se ispunjavanje studenti moraju organizirati i preuzeti odgovornost.

Nadalje, činjenica da su studenti smjera industrijski dizajn i razvoj proizvoda manje sposobni organizirati timski rad nego što su to kadri studenti drugih smjerova, može biti i rezultat praktičnog karaktera tog smjera, jer je velik dio njegova sadržaja individualističke i umjetničke prirode. To nam je omogućilo prepoznati nedostatak

sposobnosti organiziranja timskog rada koja bi se mogla poboljšati tako što će se studentima davati više zadataka koje moraju odraditi u skupinama korištenjem različitih tehnika suradničkog učenja.

S druge pak strane, studenti smjera računalno inženjerstvo imaju znatno veću sposobnost održati dobar način rada u nepredviđenim situacijama od studenata drugih smjerova analiziranih u ovom radu. Ta se razlika može objasniti činjenicom da su studenti računalnog inženjerstva naviknuti na praktični rad (razvoj računalnih programa, na primjer) koji vodi do pogrešaka i predstavlja izazov koji studenti moraju prevladati dok su suočeni s važnim vremenskim ograničenjima i ograničenim resursima. Međutim, studenti industrijskog dizajna imaju znatno nižu predodžbu o svojim vještinama vezanim uz to područje u usporedbi sa studentima drugih smjerova, a ona je niža od prosjeka skale. Razlog tome, kako je već spomenuto, može biti taj što je industrijski dizajn studijski program s više kreativnog i umjetničkog sadržaja. Da bi se ta kompetencija razvila na odgovarajući način, bilo bi korisno u praktični rad uvesti neke izazove vezane uz tu kompetenciju, kao što su zadaci s ograničenim resursima, bili oni materijalne ili vremenske prirode.

Studenti smjerova računalno inženjerstvo i telematika imaju veću sposobnost upravljanja ljudima i resursima od studenata industrijskog dizajna i razvoja proizvoda i geomatike. Ta razlika može biti rezultat toga što su oni naviknuti raditi u skupinama u većini predmeta, što nije slučaj kod druga dva studijska programa.

Činjenica da studenti druge godine imaju veću sposobnost organiziranja timskog rada potpuno je logična, jer na prvoj godini studenti nisu detaljno radili na toj vještini, budući da su nastavni predmeti više teorijske prirode, a broj studenata na prvoj godine veći je od broja studenata na drugoj godini, kada ih je općenito manje u skupinama i kada su predmeti više praktične prirode, što omogućava nastavnicima uspješniji rad na toj vještini.

S obzirom na drugi cilj ovog rada, analizu glavnih komponenti, izvršen je odabir devet komponenti koje pokrivaju sve aspekte ili dimenzije ključne za transverzalne kompetencije u strojarstvu. Ta nam je analiza pomogla uočiti da iako nijedna komponenta nije ispod srednje vrijednosti skale (3), postoje značajne razlike s obzirom na dobiveni opći prosjek, pogotovo u komponenti „društvene vještine", koja je izrazito iznad prosjeka i pokazuje da su te vještine dovoljno razvijene, a da više pažnje treba posvetiti nekim specifičnim kvalifikacijama, kako je već spomenuto.

Međutim, komponente kao što su vještine menadžmenta, komunikacijske vještine i vještine rukovođenja, motivacija, samopouzdanje i kontrola stresa su ispod prosjeka, što upućuje na činjenicu da možda postoji potreba za radom na tim područjima. Kako su te kompetencije najvažnije za profesionalan rad (Martínez, 2011), moraju se razviti da bi pripremile studente za ulazak na tržište rada.

Zaključak i smjernice za buduća istraživanja

Metodičke novine povezane s Bolonjskim procesom predstavljaju neke izazove, a jedan od najvažnijih jest nastava i ocjenjivanje kompetencija, i specifičnih, i generičkih.

Ovaj rad usmjeren je na transverzalne ili generičke kompetencije jer je njihov razvoj i ocjenjivanje težak zadatak, budući da se one usvajaju i razvijaju u različitim godinama studija i različitim predmetima.

Jako je zanimljivo primijetiti da ovo istraživanje pokazuje da je moguće ocijeniti stupanj razvoja transverzalnih kompetencija putem ankete i uočiti moguće nedostatke u obrazovanju studenata u području kompetencija. Dakle, moguće je doći do podataka koji su pouzdani, valjani i koje je lako dobiti (i putem interneta), te koji omogućavaju ocjenjivanje razvoja transverzalnih kompetencija u novim smjerovima strojarstva. Štoviše, devet glavnih komponenti koje smo dobili pomažu nam u povezivanju s kompetencijama svakog smjera da bismo mogli proučiti njihove međusobne korelacije.

Usprkos činjenici da je ovo važan doprinos literaturi iz ovog područja, naše istraživanje ipak ima neka ograničenja. Jedno od njih je nepostojanje post-hoc analize da bi se proučile sličnosti ili razlike između studenata prve godine i studenata druge godine. Drugo je ograničenje činjenica da je uzorak uvelike muškog spola, što otežava usporedbu na temelju spola. U budućnosti bi bilo korisno provesti longitudinalno istraživanje koje bi nam pomoglo ispitati jesu li studenti popravili svoju predodžbu o sposobnostima, vještinama i transverzalnim kompetencijama koje posjeduju, da bismo provjerili razvijaju li se te kompetencije na odgovarajući način tijekom nastave u različitim studijskim programima.