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Engineering undergraduates' perceptions of soft skills: relations with self-efficacy and learning styles

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Abstract

Engineering education literature shares a consensual vision of the importance of soft skills for every workplace. However, undergraduates may not be aware of soft skills importance for their future employment and professional development. This research examines how undergraduates rate their current proficiency in a range of soft skills, and how do they perceive its importance for future employment. It also explores relations between proficiency in soft skills and self-efficacy, a variable strongly associated with competent performance, and learning styles, in order to identify practical implications for the design of more effective skills development programs.

Keywords: engineering education; soft skills; learning styles; self-efficacy

1. Introduction

One of the crucial areas of research in engineering education is, according to "The Research Agenda for the New Discipline of Engineering Education" (2006) the knowledge and skills that future engineers must learn in the classroom and develop during professional practice. Today's engineering graduates have an abundance of technical knowledge, but most lack the interpersonal and social skills required by modern job settings, such as effective communication and teamwork. In recent years, industries, professional organizations (e.g. ABET - Accreditation Board for Engineering and Technology), and international

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organizations (e.g. European Commission), have all noted the weakness in soft skills proficiency among recent engineer graduates. In line with this, there is a consensus in engineering education literature that highlights the urgency to help undergraduates acquire a broad range of soft skills that facilitate employment transition and professional career development. But what about undergraduate students? Are they aware of soft skills importance for engineering profession?

Several studies have already tried to understand undergraduates perceptions of soft skills importance for work context (Nabi & Bagley, 1999; Passow, 2012). With the present study we wanted to know in which soft skills are engineering undergraduates less efficient, and find out their preferred learning styles and self-efficacy.

Soft skills are transferable behaviors that can be used within a wide range of functions, activities and contexts. They are essential to the labor market, specifically in the highly competitive scenarios, and in engineering professional contexts is increasingly important to master them together with the hard and technical skills (King, 2012).

Self-efficacy, according to Albert Bandura (1999), is a mechanism of personal agency consisting of individual's beliefs regarding performance capabilities in a particular domain. In this sense, self-efficacy can be defined as being a prospective competence-based variable that predicts action (Bandura, 1997). More specifically, perceived self-efficacy represents an optimistic sense of personal competence accounting for motivation and performance in multiple life domains (Scholz, Gutiérrez-Doña, Sud, & Schwarzer, 2002). In fact, previous studies have consistently found a significant and positive correlation between perceived self-efficacy and successful performance (Beeftink, Van Eerde, Rutte, & Bertrand, 2012; Hughes, Galbraith, & White, 2011; Schunk & Gunn, 1986).

More than ever, higher education engineering courses are asked to prepare efficient, autonomous and competent future engineers (Holvikivi, 2007), in order to respond to labor market demands for high qualified professionals. There is a general acceptance that the manner in which individuals prefer to approach a task or learning situation – learning style preference – has an impact on academic achievement and professional performance. The Index of Learning Styles (ILS; Felder & Soloman) has been widely used in engineering education research (Litzinger, Lee, Wise, & Felder, 2007), and studies reported that the majority of engineering students are predominantly visual, sensing, inductive, and active learners (Carrizosa & Sheppard, 2000; Felder & Silverman, 1988; Kuri, Silva, & Pereira, 2006).

2. Method

2.1. Sample

A sample of 337 undergraduate engineering students of four Portuguese public universities participated in the study, including 292 males and 45 females. The ages of participants ranged from 18 to 38 years (Mean=22.19, SD=3.045). Forty seven percent of the participants frequented the Bologna's 1st cycle studies (N=154), and 53 percent the 2nd cycle studies (N=173). Nine percent of the participants (N=30) were working-students.

2.2. Instruments

A list of 29 soft skills was designed based on literature and on findings of several studies (e.g. Dijkgraaf et al., 2009; Spkins, Silburn, & Birchall, 2006). Using a 5 point Likert scale (1 minimum importance, 5 maximum importance), participants were asked to self-evaluate their proficiency in the skills at the present moment (Proficiency - P), and to rate the importance of the same skills in future employment (Importance - I).

Self-efficacy was assessed using the translated Portuguese version of General Perceived Self-Efficacy scale (GSE) by Schwarzer and Jerusalem (1995; Nunes, Schwarzer, & Jerusalem, 1999). Participants are instructed to estimate their ability with respect to several situations (for example, "*If I am in trouble, I can usually think of a solution*"). The scale consists of ten statements and participants have to respond to each one according to a 4-point Likert scale, in a range from 1 (*not at all true*) to 4 (*exactly true*). High reliability, stability, and construct validity of the GSE scale was found in several studies (Leganger, Kraft, & Røysamb, 2000; Schwarzer & Born, 1997; Schwarzer, Mueller, & Greenglass, 1999).

Felder and Solomon developed the Index of Learning Styles (ILS) specifically for engineering education. The ILS classifies students learning preferences in four dichotomic dimensions (Felder, 1996; Felder & Spurlin, 2005):

- Sensing/Intuitive. Sensing learners are oriented toward facts and procedures, concrete and practical information. Intuitive learners are more oriented toward theories and meanings, conceptual and innovative ideas.
- Visual/Verbal. Visual learners prefer visual representations of material whilst verbal learners prefer written and spoken words.
- Active/Reflective. Active students learn by doing and working with others. Reflective learners learn through thinking and prefer to do it alone.
- Sequential/Global. Sequential students learn in small incremental steps, orderly and linearly. Global learners have an holistic view of things and learn in large steps.

The ILS has 4 scales, corresponding to the four pairs of learning styles, with 11 items each. In all items, respondents have to chose one of two possible answers (e.g. "*I understand something better after if:(a) try it out; (b) think it through*").

2.3. Procedure

An assessment protocol was composed by soft skills rating, GSE and ILS. The protocol was distributed in classroom to undergraduates of electrical and electronic engineering, with subfields in computers, electronics and telecommunications.

3. Results

Four research questions were addressed in the study: (1) how do undergraduates rate their proficiency in a range of soft skills, at the present moment; (2) how do they rate the importance of soft skills for future employment; (3) in which soft skills do undergraduates indicate gaps; and (4) how does graduates' perceptions relate to self-efficacy and preferred learning styles. Results were also analyzed considering study cycle.

Histograms of the ratings for skills showed that the rating were not normally distributed. The participants predominantly used the upper end of the scale. As skills have been measured on a ordinal

scale and do not meet the distributional assumptions of parametric statistics, nonparametric tests were used to analyze data (Cohen, 2001; Howell, 1997).

3.1. Proficiency, importance and skills' gaps

Table 1 shows undergraduates' mean rates for skills current proficiency and importance for future work, and also presents the skills' gaps. Mean ratings for all skills were above the middle of a five-point scale. Regarding skills' proficiency, higher ratings were found for "responsibility"(M=4.16; SD=.836), "continuous learning" (M=4.12; SD=.694), and "listening" (M=4.11; SD=.773). Lower rating were found for "time management" (M=3.37; SD=.965), and "creativity and innovation" (M=3.50; SD=.858).

Table 1. Skills' mean rates for current proficiency and importance for future work

Skill	Proficiency (P)		Importance (I)		Skill gap	
	Mean (SD)	Med (IR)	Mean (SD)	Med (IR)	I-P	Wilcoxon
1. Teamwork	3.85 (.753)	4.00 (0)	4.42 (.664)	5.00 (1)	.57	-10.429*
2. Oral communication	3.61 (.877)	4.00 (1)	4.20 (.787)	4.00 (1)	.60	-8.89*
3. Written communication	3.70 (.782)	4.00 (1)	4.04 (.740)	4.00 (1)	.34	-6.276*
4. Foreign languages	3.68 (.853)	4.00 (1)	4.26 (.726)	4.00 (1)	.59	-9.233*
5. Networking	3.70 (.819)	4.00 (1)	4.16 (.750)	4.00 (1)	.45	-8.472*
6. Listening	4.11 (.773)	4.00 (1)	4.29 (.735)	4.00 (1)	.18	-3.630*
7. Conflict resolution	3.75 (.801)	4.00 (1)	4.15 (.807)	4.00 (1)	.40	-6.757*
8. Argumentation	3.69 (.777)	4.00 (1)	4.10 (.732)	4.00 (1)	.42	-6.913*
9. Information sharing	3.94 (.825)	4.00 (2)	4.02 (.768)	4.00 (1)	.08	-1.280
10. Intercultural relation	3.91 (.861)	4.00 (2)	3.83 (.867)	4.00 (1)	-.07	-1.300
11. Time management	3.37 (.965)	4.00 (1)	4.43 (.721)	5.00 (1)	1.06	-12.313*
12. Work organization	3.59 (.888)	4.00 (1)	4.33 (.858)	5.00 (1)	.74	-9.606*
13. Autonomy	3.80 (.809)	4.00 (1)	4.30 (.718)	4.00 (1)	.50	-8.354*
14. Responsibility	4.16 (.836)	4.00 (1)	4.45 (.811)	5.00 (1)	.28	-4.703*
15. Goal orientation	3.84 (.784)	4.00 (1)	4.13 (.731)	4.00 (1)	.30	-5.736*
16. Pressure tolerance	3.67 (.937)	4.00 (1)	4.17 (.773)	4.00 (1)	.50	-7.204*
17. Meeting deadlines	3.99 (.885)	4.00 (2)	4.59 (.658)	5.00 (1)	.60	-9.785*
18. Problem solving	3.86 (.697)	4.00 (1)	4.27 (.756)	4.00 (1)	.41	-7.897*
19. Systemic vision	3.60 (.787)	4.00 (1)	3.96 (.726)	4.00 (0)	.36	-7.340*
20. Cost estimative	3.63 (.940)	4.00 (1)	4.05 (.837)	4.00 (2)	.42	-6.909*
21. Creativity and innovation	3.50 (.858)	4.00 (1)	4.24 (.732)	4.00 (1)	.74	-11.228*
22. Persuasion	3.63 (.833)	4.00 (1)	3.89 (.786)	4.00 (1)	.26	-4.792*
23. Adapting to change	3.77 (.801)	4.00 (1)	4.20 (.767)	4.00 (1)	.43	-7.617*
24. Proactivity and initiative	3.73 (.834)	4.00 (1)	4.14 (.750)	4.00 (1)	.41	-6.884*
25. Attention to detail	3.85 (.856)	4.00 (1)	4.10 (.737)	4.00 (1)	.25	-4.761*
26. Continuous learning	4.12 (.694)	4.00 (1)	4.29 (.747)	4.00 (1)	.17	-3.370*
27. Flexibility	3.98 (.722)	4.00 (0)	4.18 (.671)	4.00 (1)	.20	-4.379*
28. Decision-making	3.83 (.843)	4.00 (1)	4.06 (.783)	4.00 (1)	.22	-3.616*
29. Leadership	3.64 (.863)	4.00 (1)	4.05 (.800)	4.00 (1)	.42	-7.154*

Notes: SD=standard deviation; IR=interquartile range

Regarding skills' importance, undergraduates indicated higher importance to "meeting deadlines" (M=4.59; SD=.658), "responsibility" (M=4.45; SD=.811), "time management" (M=4.43; SD=.721),

"teamwork" (M=4.42; SD=.664) and "work organization" (M=4.33; SD=.858). The median of 5.00 was found for all of these skills. Undergraduates indicated lower importance to "intercultural relation", "persuasion" and "systemic vision". In general, the mean importance ratings ranged from 3.83 (intercultural relation) to 4.59 (meeting deadlines), and these results show that undergraduates consider soft skills as having high importance for professional practice.

As noted in previous studies (e.g. Nabi & Bagley, 1999), undergraduates rated the importance of soft skills more highly than their proficiency in the same skills. Wilcoxon signed-rank test was used to medians analysis. Significant differences were found between ratings of all skills, except for "intercultural relation" and "information sharing". That is, undergraduates ratings revealed gaps in 27 of the 29 analyzed skills. The most evident gap was found for "time management" ($Z=-12.313$, $p\cong0$), however 8 skills obtained mean differences superior to 0.50, to know: "work organization", "creativity and innovation", "oral communication", "meeting deadlines", "foreign languages", "teamwork", "autonomy", and "pressure tolerance".

Mann-Whitney test was used to analyze possible differences between 1st cycle and 2nd cycle undergraduates. Significant differences were found regarding proficiency on "flexibility" ($M_{1st\_cycle}=3.88$, $M_{2nd\_cycle}=4.06$, $U=-2.512$, $p=.012$), "foreign languages" ($M_{1st\_cycle}=3.55$, $M_{2nd\_cycle}=3.77$, $Z=-2.224$, $p=.026$), and "proactivity and initiative" ($M_{1st\_cycle}=3.64$, $M_{2nd\_cycle}=3.83$, $Z=-2.033$, $p=.042$). According to these results, 2nd cycle undergraduates rated higher than 1st cycle undergraduates in the previous skills. Concerning skills' importance, significant differences were found again between study cycles, with higher ratings of 1st cycle undergraduates in "intercultural relation" ($M_{1st\_cycle}=3.92$, $M_{2nd\_cycle}=3.73$, $Z=-2.008$, $p=.045$) and "creativity and innovation" ($M_{1st\_cycle}=4.33$, $M_{2nd\_cycle}=4.15$, $Z=-1.967$, $p=.049$).

3.2. Self-efficacy and learning styles

Undergraduates showed preferences for active, sensing, markedly visual, and sequential learning styles, as has been referred by literature (e.g. Kolmos & Holgaard, 2008). They also reveal high self-efficacy levels. Table 2 shows the results for the total sample and study cycle groups.

Table 2. Self-efficacy and learning styles

Variable	Total sample (n=337)		1st cycle (n=154)		2nd cycle (n=173)	
	Mean (SD)	Median (IR)	Mean (SD)	Median (IR)	Mean (SD)	Median (IR)
GSE	30.85 (4.03)	31.00 (6.00)	30.99 (3.77)	31.00 (5.00)	30.72 (4.33)	30.00 (5.00)
Active	6.71 (2.19)	7.00 (3.00)	6.44 (2.39)	7.00 (3.00)	6.94 (1.98)	7.00 (2.00)
Reflective	4.27 (2.20)	4.00 (3.00)	4.54 (2.41)	4.00 (3.00)	4.05 (1.98)	4.00 (2.00)
Sensorial	6.87 (2.06)	7.00 (2.00)	7.03 (2.04)	7.00 (3.00)	6.77 (2.07)	7.00 (3.00)
Intuitive	4.05 (2.06)	4.00 (2.00)	3.91 (2.04)	3.00 (3.00)	4.16 (2.07)	4.00 (2.00)
Visual	8.39 (2.03)	9.00 (3.00)	8.33 (2.00)	9.00 (3.00)	8.55 (1.98)	9.00 (3.00)
Verbal	2.54 (2.03)	2.00 (3.00)	2.61 (2.02)	2.00 (3.00)	2.41 (1.99)	2.00 (3.00)
Sequential	6.25 (2.01)	6.00 (3.00)	6.53 (2.06)	7.00 (3.00)	6.05 (2.11)	6.00 (3.00)
Global	4.70 (2.09)	5.00 (3.00)	4.41 (2.06)	4.00 (3.00)	4.91 (2.10)	5.00 (3.00)

Notes: SD=standard deviation; IR=interquartile range

Significant differences were found between groups in learning styles preferences for sequential-global dimension. On one hand, 1st cycle undergraduates showed higher preference for the sequential style in comparison with 2nd cycle undergraduates ($M_{sequencial[1st]}$=6.53, $M_{sequencial[2nd]}$=6.05, Z=-2.123, p=.034). On the other hand, 2nd cycle undergraduates showed higher preference for global style ($M_{global[1st]}$=4.41; $M_{global[2nd]}$=4.91; Z=-2.244, p=.025).

A correlation analysis was performed to determine the relation between soft skills and self-efficacy, and between soft skills and learning styles. Table 3 shows Spearman correlation coefficients between variables.

Table 3. Correlations between soft skills and self-efficacy and learning styles

Skill	GSE	Act	Ref	Sens	Int	Vis	Verb	Seq	Glob
1. Teamwork	,194**	,254**	-,256**	-,015	,007	,138*	-,138*	,062	-,071
2. Oral communication	,244**	,049	-,047	-,159**	,153**	,015	,000	,049	-,046
3. Written communication	,204**	-,005	-,001	-,041	,030	,010	-,016	,038	-,053
4. Foreign languages	,246**	-,054	,059	-,114*	,136*	-,100	,130*	-,091	,098
5. Networking	,260**	,072	-,076	-,057	,055	-,010	,002	,007	-,010
6. Listening	-,019	,010	-,012	,094	-,099	-,110*	,099	,024	-,029
7. Conflict resolution	,236**	,030	-,031	-,097	,088	,030	-,044	,054	-,060
8. Argumentation	,356**	,024	-,027	-,176**	,160**	,030	-,030	-,044	,037
9. Information sharing	,161**	,165**	-,166**	-,046	,052	,077	-,089	,054	-,049
10. Intercultural relation	,172**	,031	-,032	-,105	,106	-,014	,006	-,033	,033
11. Time management	,219**	,013	-,015	-,013	,002	,003	,007	,097	-,092
12. Work organization	,133*	-,029	,026	,046	-,052	-,025	,020	,151**	-,151**
13. Autonomy	,351**	,021	-,024	-,135*	,143**	,004	-,005	,047	-,052
14. Responsibility	,155**	,045	-,051	-,058	,036	,034	-,050	,093	-,096
15. Goal orientation	,344**	-,002	-,003	-,134*	,123*	-,002	,000	,094	-,100
16. Pressure tolerance	,276**	,082	-,083	-,141**	,137*	-,039	,021	-,085	,082
17. Meeting deadlines	,130*	,064	-,071	-,044	,048	,065	-,070	,092	-,097
18. Problem solving	,375**	,014	-,017	-,165**	,165**	,018	-,017	,014	-,023
19. Systemic vision	,291**	,072	-,078	-,036	,035	,022	-,023	,013	-,023
20. Cost estimative	,194**	,069	-,070	-,051	,064	,008	-,013	,052	-,058
21. Creativity and innovation	,345**	,035	-,034	-,289**	,293**	,075	-,067	,065	-,065
22. Persuasion	,257**	,063	-,055	-,073	,071	,006	,011	,161**	-,154**
23. Adaptation to change	,272**	,141**	-,139*	-,121*	,133*	,077	-,078	,080	-,074
24. Proactivity and e initiative	,334**	,019	-,012	-,097	,103	-,025	,046	,010	,000
25. Attention to detail	,221**	-,128*	,125*	-,001	,008	-,026	,033	,100	-,095
26. Continuous learning	,390**	-,013	,009	-,081	,090	-,041	,050	,116*	-,110*
27. Flexibility	,211**	,084	-,082	-,024	,024	,022	-,012	,049	-,039
28. Decision-making	,325**	,032	-,032	-,102	,096	-,040	,045	,022	-,016
29. Leadership	,395**	,102	-,098	-,166**	,154**	,066	-,068	-,041	,042

Notes: GSE=General Self-Efficacy; Act=Active; Ref=Reflective; Sens=Sensing; Int=Intuitive; Vis=Visual; Verb=Verbal; Seq=Sequential; Glob=Global

*Correlation is significant at the 0.05 level

**Correlation is significant at the 0.01 level

Undergraduates with higher self-efficacy tended to rate themselves higher in soft skills' ability, except for "listening" (r_s =-.019, p=.727).

We found significant positive correlations between active style and "teamwork" (r_s=.254, p=.000), "information sharing" (r_s=.165, p=.002) and "change adaptation" (r_s=.141, p=.009), and a significant negative correlation with "attention to detail" (r_s=-.128, p=.019). These results show that active undergraduates, that prefer learning by doing, tended to rate higher than more reflective undergraduates in their ability to work in teams, share information and adapt to change.

Sensing style showed negative significant correlations with "oral communication"(r_s=-159, p=.003), "foreign languages" (r_s=-.114, p=.037), "argumentation" (r_s=-1.76, p=.001), "autonomy" (r_s=-.135, p=.013), "goal orientation" (r_s=-.134, p=.014), "tolerance to pressure" (r_s=-141, p=.009), "problem solving" (r_s=-.165, p=.002), "creativity and innovation" (r_s=-.289, p=.000), "adapting to change" (r_s=-.121, p=.026) and "leadership" (r_s=-.166, p=.002). On the other hand, we found positive significant correlations between intuitive style and the same previous skills.

Results showed a positive significant correlation between visual style and "teamwork" (r_s=.138, p=.011), and negative significant correlation with "listening" (r_s=-.110, p=.044). Verbal style showed only a negative significant correlation with "teamwork" (r_s=-.138, p=.011).

At last, positive significant correlations were found between sequential style and "work organization" (r_s=.151, p=.006), "persuasion" (r_s=.161, p=.003), "continuous learning" (r_s=.116, p=.033). One negative significant correlation was found between global style and the same previous skills.

4. Discussion

Individuals need to become actively involved in the management of their own careers as early as possible rather than relying solely on external sources. Through assessment methodologies, undergraduates can promote awareness of the importance of soft skills for their future employment, and look for personal strategies to overcome possible skills deficiency. In line with is, curriculum development must focus on utilizing appropriate pedagogic techniques which enhance learning and develop soft skills, in order to prepare undergraduates for employment.

Although not exhaustive, the soft skills list used in the present study is applicable to multiple engineering work settings. Findings suggest that undergraduates identified deficiencies in the quality of skills they considered important for future work. Correlations between perceived ability in soft skills and learning styles preferences could have implications for curriculum design, despite the correlation coefficients founded in this study were relatively low. Specific training could be designed and delivered to respond to major skills' gaps, using learning styles based methodologies. For example, enhancing teamwork skills using active and visual learning strategies, and work organization skills using sequential learning strategies. Furthermore, by soft skills development, self-efficacy is promoted, and it is fundamental to competent performance.

Results should be interpreted paying attention that the sample consisted of only 337 undergraduates from four Portuguese universities, and that self-report methodology also limits the generalization of the current findings. The results must be viewed as indicative only. Further research, with employers and graduates, is required to refine the tested list of soft skills and to evaluate the most effective learning strategies for their development.

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