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Personal and Emotional Skill Profiles in the Professional Development of the Computer Engineer*

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The importance of generic skills in career success is a fact that nobody questions. The professional world requires universities to provide specific training so that future professionals can improve their job performance. Although proposals and recommendations have been made to include such skills in the curriculum, universities find such an idea hard to implement. One major barrier is the lack of an evaluation model in the acquisition of such skills, which are far more complex than those based on obtaining knowledge. This paper proposes a generic emotional intelligence and personality-based model with which to assess generic skills. This kind of model is evaluable and makes it possible to measure student competence. For this study, the model was applied to analyse the profile of computer engineers. The view of experts and professionals was taken into account for the study, and levels of competence were measured in a sample of Computer Engineering students through a series of tests. The results showed differences between student profiles and the opinion of the experts, as well as between the views of professionals and experts. However, a significant similarity was found between the views of professionals and the students' actual skill level.

Keywords: professional profile; computer engineers' skills; professional skills; generic skills; emotional intelligence

1. INTRODUCTION

THERE IS GROWING EMPHASIS in the workplace on non-academic skills due to the influence they have on work performance. The search for maximum performance from employees has led to research into the skills that the most successful employees possess that enhance company performance [1]. New skills that companies require of professionals relate not only to their handling of technology, but also to social and emotional skills, strategic, organisational and planning capabilities, and so on [2]. In their analysis of these skills, various authors [3–6] have concluded that, rather than general intelligence alone, emotional-social intelligence and personality factors also form part of the complex skill set required of individuals to develop their professional work successfully. The relationship between emotional skills and performance has been supported by numerous studies [7–11].

Several institutions have taken the importance of these aspects into account, as is proved by the development in 2001 of the *Career Space Project* [12], with the backing of the European Commission. The project was created by the Career Space consortium, which is formed by eleven major information and communication technology (ICT) companies—BT, Cisco Systems, IBM Europe, Intel, Microsoft Europe, Nokia, Nortel Networks, Philips Semiconductors, Siemens AG, Telefónica S.A. and Thales, as well as the European Information, Communications and Consumer Electronics Industry Technology Association (EICTA). The *Career Space Project* provides a set of guidelines and recommendations as a basis for developing curriculum programmes, analysing 100 ICT syllabuses from nine European countries. This project establishes the need for people with professional behavioural skills and recommends that ICT curricula contain a scientific base of ~ 30%, a technology base of ~30%, an application base and systemic thinking of ~25%, and a personal and business skills element of up to ~ 15%. The Career Space Project states that 'ICT graduates need a solid foundation in technical skills from both the engineering and IT cultures, with a particular emphasis on a broad systems perspective. They need training in team work, with real experience of team projects where several activities are undertaken in parallel. ICT graduates also need good personal skills such as problem-solving abilities, awareness of the need for lifelong learning, a readiness to fully understand the needs of the customer and their colleagues on a project, and awareness of cultural differences when acting in a global environment'.

1.1 Generic skills in the field of education

When developing their ICT syllabuses, universities should first define the profile or profile group

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for which they want to train their students. These profiles should be decided after consultation with industry and other stakeholders [12]. The Career Space consortium also believes that it would be best for stakeholders (local companies, representatives from professional certification organisations, public administration bodies, students themselves and universities) to participate in this feedback mechanism in order to define the type of courses that universities need to provide.

One aim of universities is to help provide access to employment. Their central role in the European Higher Education Area is to educate students by helping them to acquire skills, abilities and values, by adopting a new methodology aimed at learning skills [13]. The *Delors Report* for UNESCO [14] highlights the role of emotions and emphasises the need to educate with regard to the emotional side of being human as well as the cognitive side. The Bologna declaration [13], which contains considerations for creating a common European area of higher education by 2010, underlines the importance of education in terms of students acquiring skills, abilities, responsibility and social values, by adopting a new methodology aimed at learning skills. The *Tuning Educational Structures in Europe* project [15], funded by the European Commission as part of the Socrates programme, develops professional profiles, learning outcomes and desirable skills in terms of both generic abilities and skills for each area of study. These are individual skills that relate to the ability to express one's feelings, criticism and self-criticism skills, and social skills relating to interpersonal skills, the ability to work in a team and displaying social or ethical commitment.

According to the OECD [16], selecting key skills depends on what societies value at a particular time and in a certain context. At present, some of the most important proposals are developed by international or national agencies such as the ILO/CINTERFOR [17], the OECD [16] and the ANECA [2], or by EU initiatives such as the Tuning Project [15]. Furthermore, identifying and validating professional skills is based mainly on methodologies involving the consensus of a panel of experts and extensive checking within the sector before any skills are validated [17].

As mentioned previously, existing proposals on the key skills that professionals should possess stem from knowledge derived from experts and business professionals. Traditional lecture style courses could be redesigned in a manner that develops students' expectation of what it means to be a professional and the skills associated with that, while at the same time advancing their knowledge [18]. However, syllabus elements designed to meet the business world's expectations in terms of skills should be implemented from within the education sector [19]. Indeed, one major problem faced by learning centres to include skills education in their syllabuses is how to assess these skills. While academic skills are easy to evaluate, scholars must now also consider how to evaluate issues not directly related to the acquisition of knowledge, such as interpersonal skills, responsibility and stress management. Although there are methods to improve these aspects in individuals, they will be difficult to incorporate into the curriculum if we have no way of controlling students' level of acquisition.

1.2 Emotional intelligence and work performance

Some studies emphasise that a person's ability to adapt to the environment could be determined by emotional intelligence (EI) [4, 20]. Adapting well could result in success at work, as shown in studies by Møller and Powell [21], Rozeil, Pettijohn and Parker [22], and Sjöberg [23] in the workplace; by Culver and Yokomoto [24], Lam [25] and Parker [26] in the field of education; and by Ciarrochi, Deane and Anderson [27], Parker, Taylor and Bagby [28] and Salovey [29] in the mental health services. Poor adaptation, meanwhile, could have negative consequences at work, such as the well-known syndrome of *burnout*, where good stress management or other variables can prevent or reduce emotional states of depression or stress at work [30].

Models that are widely accepted by the scientific community to explain and assess EI do exist, and are used to describe emotionally intelligent people. Thus, authors whose models are based on abilities [5, 10] include EI as a set of cognitive skills to use and manage emotions adaptively. Other authors prefer to consider EI as a feature that includes certain key personality traits for developing emotionally intelligent behaviours [3, 31, 32].

Various instruments have been developed to assess the concept of EI, focusing on both ability and self-reporting: the *Trait Meta-Mood Scale-48* (TMMS-48), developed by the Mayer and Salovey research group [33]; the *Spanish Modified Trait Meta-Mood Scale-24* (TMMS-24), a version of the TMMS-48 translated and reduced by the Malaga research group [34]; the *Schutte Self-Report Inventory* (SSRI) by Schutte, Malouff, Hall, Haggerty, Cooper, Golden, and Dornheim [35]—all self-reported measures with acceptable internal consistency, reliability and validity; and the *Multifactor Emotional Intelligence Scale* (MEIS) [36] and the *Mayer-Salovey-Caruso Emotional Intelligence Test* (MSCEIT) [37], based on a practical approach.

Various instruments have been developed to assess EI, using mixed models based on self-reported measures. These include the *Bar-On Emotional Quotient Inventory* (EQ-i) [38]; the *Trait Emotional Intelligence Questionnaire* (TEIQue), created by Petrides and Furnham, and which is similar to EQ-i [39]; and the *Emotional Competence Inventory* (ECI) by Goleman [40], created to predict effectiveness and personal outcomes at work and in the business world.

1.3 The generic skills of computer engineering

The current curriculum for computer engineering is based on the curriculum developed jointly by

the IEEE (Institute of Electrical and Electronic Engineers) and the ACM (Association of Computer Machinery) [41, 42], which deals only with skills relating to the specific discipline. As a result of the Bologna declaration and UNESCO recommendations, proposals have arisen taking into account the generic skills of computer professionals. Such is the case of the Career Space project [12], which focuses on the profile of ICT professionals (and does not therefore analyse computer engineers), providing a series of recommendations of the 'competencies' that their curriculum vitae should include. In this report, generic abilities are grouped under the title of 'personal skills' and do not detail the specific areas that these skills should be broken down into, or how they are assessed. In a similar vein, another series of studies in Spain at a national level, known as PAFET, also provides a profile of technical knowledge and personality traits or personal skills for ICT professionals, but does present proposals for inclusion in the curriculum.

The research project known as 'The Flexible Professional in the Knowledge Society: New Demands on Higher Education in Europe' (better known as REFLEX) [43] is an initiative that forms part of the 6th European Union Framework Programme. Its reports provide comparative data for thirteen European countries, classified by students, graduates and employers, among others, and refer to a subset of generic skills, but the results are grouped by disciplines rather than by specific degrees.

Clearly the work of various professional fields requires different levels of generic or emotional skills. For this reason, the studies conducted to date define generic skills for a wide range of degrees. As seen above, the REFLEX project, like Tuning, does not deal specifically with a degree course in computer engineering, as in REFLEX it falls inside 'engineering', and in Tuning it does not appear as an object of study. Similarly, these projects consider generic skills that include some EI and personality sub-skills. However, no study has analysed personality and EI by including all skills. Furthermore, there is no way to assess the generic skills proposed, which makes it difficult for university teachers to put into practice.

The objective of this research is to establish the professional skills of computer engineers based on EI and personality models that are widely accepted and have been validated by the scientific community. These profiles were established through the consensus of a panel of experts and consultation with a sample of practitioners. Experts and professionals then linked the skills with those measured in a sample of students from this degree course.

2. METHOD

2.1 Participants

Three kinds of participants were selected for this research:

1) A panel of experts consisting of six academics with considerable experience as professional engineers before joining the university.
2) A group of 102 professional engineers, consisting of 76 from different professional associations of computer engineers, and 26 chosen from two large companies in the Region of Valencia with computer engineering departments: one public and one privately owned.
3) A sample of 138 students in the last two years of the computer engineering degree course at the Polytechnic School of the University of Alicante. A total of 128 participants were male, and 10 were female. The mean age of both groups was 24 years, ranging from 20 to 40.

2.2 Instruments

Instruments used with experts and professionals:

To assess the skills of experts and professionals, the questionnaire showed in Table 1 was used to evaluate eight skills relating to emotional intelligence (emotional attention, clarity, repair, intrapersonal skills, interpersonal skills, stress management, adaptability and general mood) and the big five personality factors (neuroticism, extraversion, openness, agreeableness and, conscientiousness). The skills selected were drawn from the TMMS-24 and EQ-i:S emotional intelligence tests and the NEO-FFI personality test, so that the views of professionals and experts could be compared with the students' measurements.

A workshop was organized to obtain scores on emotional and personality skills for the group of experts. The purpose of the workshop was explained and each skill relating to emotional intelligence and personality traits was described, together with the sub-skills of each one and their exact opposites. Through discussion and by consensus, the experts rated each skill that computer engineers should have from 1 (not at all) to 10 (very important).

An anonymous questionnaire was developed to obtain data from the computer professionals. It assessed the same variables that the experts analysed and which were measured in the students. The questionnaire consisted of a series of both personal questions (gender, age, years of experience, position and professional profile) and questions about the company (name, sector and ownership). A series of 13 questions was then asked, with the aim of evaluating each emotional (first eight) and personal (last five) skill. The professionals were asked to rate the degree of skill that they felt computer professionals should have for each item, from 1 to 10 (1 = not at all and 10 = very important).

The instruments administered to students were as follows:

- The *Traid* Meta-Mood Scale-24 (TMMS-24) [34]. This is an adapted and reduced version of TMMS-48 (developed by Salovey y Mayer) [33].

Table 1. Questionnaire

Skill	Question
Attention	How much attention should computer professionals pay to their mood, personal problems, worries, etc.?
Clarity	To what extent can how people perceive and consider their emotions have an influence on their work?
Repair	What belief or opinion should they have on their ability to interrupt and control negative thoughts and increase positive ones?
Intrapersonal Skills	To what degree should they be in touch with their emotions, be able to express how they feel and communicate their needs to others?
Interpersonal Skills	What ability should they have to establish co-operative, constructive and satisfactory relationships with other people? (be good listeners; able to understand and appreciate other people's feelings)
Adaptability	To what level do they need to successfully handle change and have the skills to solve daily problems by facing them in a positive way?
Stress Management	To what extent do they need to control their impulse and work well under pressure by controlling their stress?
General Mood	To what degree do they need to have a happy and optimistic outlook, be energetic and have the ability to self-motivate?
Neuroticism / Emotional stability	To what degree do they require emotional stability, the ability to keep calm and control their emotions in stressful situations?
Extraversion	To what level do they need to be energetic and active, outgoing and assertive? (the opposing extreme would be calm, reserved and insular)
Openness to Experience	What level of originality, imagination, interest in new ideas and unconventional values do they need to do their job successfully?
Agreeableness	What degree of altruism, generosity, trust and solidarity do they need to do their job? (the opposing extreme would be scepticism and critical thought)
Conscientiousness	To what degree do they need to be methodical, orderly and scrupulous in their professional work?

This self-reported measurement assesses three key elements of emotional intelligence: attention to feelings, emotional clarity and emotional repair. All subjects were asked to review the extent to which they agree with every item on a Likert-style scale of 5 points (1 = strongly disagree, 5 = strongly agree). After reduction, the scale increased its reliability in all factors: Attention (0.90), Clarity (0.90) and Repair (0.86) [34].

- The Emotional Quotient Inventory: Short (EQ-i:S) by Reuven Bar-On [37]. It is a smaller version of the *Emotional Quotient Inventory* that consists of 51 items rated on a 5-point Likert-type scale. This test evaluates the big five factors of EI: intrapersonal skills, interpersonal skills, stress management, adaptability and general mood. The EQ-i:S shows adequate evidence of validity and its internal consistency of sub-scales ranges between 0.65 and 0.86.
- The Reduced NEO Five-Factor Personality Inventory (NEO-FFI) by Costa and McCrae [44]. This is an instrument to assess the big five factors of personality and provide an abbreviated way to measure the five main dimensions: neuroticism, extraversion, openness, agreeableness and conscientiousness. It consists of 60 items and answer options ranging from A (strongly disagree) to E (strongly agree). Implementation and validation of the questionnaire shows good reliability with values ranging between 0.86 and 0.95 for internal consistency, and test-retest stability values ranging between 0.70 and 0.92 (in the Spanish sample), and factorial validity.

2.3 Procedure

For the panel of experts, the professionals were convened to participate in a collaborative working group that was held during business hours. Experts were asked to evaluate, by means of group consensus, the extent of each skill that an effective computer professional should possess, giving a score ranging from 1 (not at all) to 10 (very important).

To collect information from professional computer engineers, two different surveys were performed. Various professional associations of computer engineers around Spain were given access to an online form, and personal contact was also made with the heads of computer engineering of two companies in the region of Valencia, requesting their participation in this research by means of a questionnaire to be put to the workers in their department. The questionnaire asked employees to specify their position in the company as per the profiles analysed in the expert panel mentioned above, and to score from 1 (not at all) to 10 (very important) the degree of each skill that professionals should possess to perform their job successfully.

Data from students were collected during the first quarter of the course by applying the tests in their lecture rooms and during teaching hours. Approximately an hour and a half was needed to gather the data.

2.4 Design and data analysis

Different data analysis techniques were used for this research, as part of a general ex post facto comparative design.

First the profiles for each group were established (experts, professionals and students), taking the different variables into account. The experts' profile was established by the degree of importance given to each variable studied, through the consensus of its participants. The professionals' profile was established by using the mean scores given in the surveys for the different variables. For the students' profile, they were evaluated by applying different tests, and the scores from all the variables were converted into a scale of 1 to 10 points, which made a direct comparison possible with the scores from the questionnaires administered to professionals and experts. Finally, the mean was established for each variable evaluated.

The Euclidean distance was used to measure the distance between the different groups:

$$D = \sqrt{\sum_{i=1}^{n} (A_i - B_i)^2}$$

Cattell's r_p coefficient was applied to view the similarity between the subjects' profiles [45]. Some studies [46] consider Cattell's r_p as the best index to establish the similarity between profiles in all cases and all error conditions, and is the only one associated with a statistical significance test [47].

$$r_p = \frac{2k - \sum d_j^2}{2k + \sum d_j^2}$$

3. RESULTS

Below are the results for the skills tested by the panel of engineering experts, professionals and students.

3.1 Experts

Assessment of the panel of experts shows that the most important skills relate to conscientiousness, interpersonal skills and stress management, which are rated with the maximum score. These are followed in importance by clarity, repair and adaptability (rated 9). The least required skills for professional performance include neuroticism (with a score of 2), attention to one's own emotions, agreeableness and general mood (although these last two have a mean score of 5 and 6, respectively). With the exception of neuroticism, the variables always scored between 5 and 10.

3.2 Professionals

The highest mean scores obtained for the variables of emotional intelligence relate to stress management, adaptability and interpersonal skills, all of which scored more than 8.5, and with the lowest standard deviations (between 1 and 1.4). The lowest-valued variable was intrapersonal skills, with a mean score of 6.92 and a standard deviation of 1.8.

The highest mean score in the personality variables was for conscientiousness, with a score of 8.65 and a standard deviation of 1.4. The variable of neuroticism received the lowest mean score, 2.88, and the lowest standard deviation ($s = 1.1$). The variables of extraversion and agreeableness were also low, with mean scores of 6.56 and 6.39, respectively. Their standard deviations were 1.7 for extraversion and 1.9 for agreeableness.

3.3 Students

For the group of students, the emotional intelligence variables all scored highly (more than 5), with low standard deviations (less than 1.5). The highest mean score for the intelligence variables was for interpersonal skills ($\bar{x} = 8.13$), with a low standard deviation ($s = 0.8$). The students also scored highly in general mood ($\bar{x} = 7.90$ and s=1.0), stress management ($\bar{x} = 7.88$ and $s = 1.3$), adaptability ($\bar{x} = 7.46$ and s=1.0), intrapersonal skills ($\bar{x} = 7.36$ and $s = 1.2$), and repair and emotional clarity, with mean scores of 7.03 and 6.89, respectively, and slightly higher standard

Table 2. Descriptive statistics

Group	Students		Professionals		Experts*
Variables	Mean	Standard Dev.	Mean	Standard Dev.	Mean
Attention	5.75	1.48	7.05	1.96	5
Clarity	6.89	1.40	7.21	1.84	9
Repair	7.03	1.44	7.40	1.50	9
Intrapersonal Skills	7.36	1.20	6.92	1.82	8
Interpersonal Skills	8.13	0.82	8.58	1.45	10
Adaptability	7.46	1.07	8.59	1.21	9
Stress Management	7.88	1.32	8.66	1.07	10
General Mood	7.90	1.03	8.00	1.29	6
Neuroticism	4.88	1.21	2.87	1.09	2
Extraversion	7.25	1.04	6.55	1.72	7.57
Openness to Experience	6.71	1.09	8.06	1.45	7
Agreeableness	6.73	1.03	6.39	1.94	5
Conscientiousness	7.36	1.13	8.64	1.47	10

* The ratings of the experts are by consensus, and therefore have no deviations.

Comparison of the three groups: experts, professionals and students

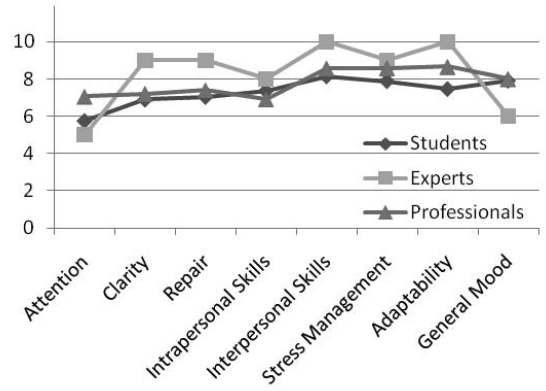

Fig. 1. Emotional intelligence skills.

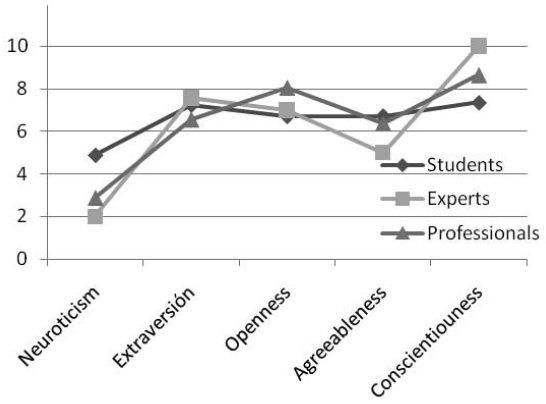

Fig. 2. Profiles for personality skills.

deviations (s = 1.4). The focus variable scored the lowest of all, with a mean of 5.75, and the highest standard deviation (s = 1.4).

As with the variables of intelligence, the mean scores for the personality variables were above 5, with the exception of neuroticism, which scored slightly lower ($\bar{x} = 4.88$), with low standard deviations, between 1.0 and 1.2.

The previous illustrations show the profiles of the three groups as a result of the mean scores given by subjects for the variables of emotional intelligence (Figure 1) and personality traits (Figure 2).

At first glance, the three profiles have a certain similarity. The profiles obtained from experts and professionals follow the same trend; however, there is a band of approximately two points in the profile's widest area, coinciding with some aspects of emotional intelligence. The students' profile is in most cases slightly below that of professionals, and considerably lower than that of the experts.

Table 3 shows the gap between experts, professionals and students with regard to aspects of emotional intelligence and personality traits. The shortest distances were between students and professionals (3.51), specifically in the variables of emotional intelligence, where the lowest distance was achieved (2.07). The longest distance

Table 3. Distances between groups for the variables

Euclidean Distance	Emotional Intelligence	Personality	Global Distance
Students/experts	4.90	4.29	6.51
Students/professionals	2.07	2.84	3.51
Experts/professionals	4.37	2.58	5.07

Table 4. Similarity between group profiles

Cattell' r_p	Emotional Intelligence	Personality	Global Profile
Students/experts	–0.02	–0.10	0.02
Students/professionals	0.72*	0.29	0.60*
Experts/professionals	0.14	0.37	0.28

* $p < 0.01$.

was found between students and experts, in both emotional intelligence and personality traits (4.90 and 4.29, respectively), with an overall distance of 6.51.

Cattell's r_p coefficient and its corresponding level of significance [47] were calculated to analyse whether there was a statistically significant similarity between profiles of different groups. These results are shown in Table 4. Although the Euclidean distances shown in Table 3 seem small and visually similar in Figures 2 and 3, the r_p value shows that there is only significant similarity between professionals and students. Moreover, this similarity was due mainly to emotional skills, as r_p was significant ($p < 0.01$). The profile proximity between the other compared groups is not significant. A very low or even negative similarity index appeared between the profiles of students and experts.

4. DISCUSSION

One issue to be considered in this study is the extrapolation of its findings to a European level. In analysing the skill level required of the rest of the European countries so far involved in the REFLEX project [43] (Italy, France, Austria, Germany, Netherlands, United Kingdom, Finland, Norway, Czech Republic, Switzerland, Belgium and Estonia), 14 of the 19 skills score a higher mean than the score for Spaniards, though the differences are not very relevant. In comparison with Spaniards, graduates from other European countries have jobs with greater demand for skills in terms of identifying new opportunities, thinking analytically, using IT tools, yielding under pressure and discipline. The greatest difference is in the skill of being able to speak and write in foreign languages, although it is given the lowest mean score of all the required skills.

Universities try to train their students in the skills required by businesses. According to the experts, students need to develop more general

skills, such as emotional and personal skills. Recent studies argue that highly effective managers and team leaders begin to develop their skills at an early age, before obtaining any work experience [10], but there are few published studies on skills development [8]. There are several programmes for emotional skills development to be carried out from university to the world of work. Some of the proposals for integrating and developing these skills in the curricula of higher education can be found in [48–51]. On the other hand, a change in methodology can allow students to develop emotional and personal skills that they will need in the future upon entering the world or work; for example, academics could introduce working in teams, which would help students to establish relationships with other group members, and the responsibility that they have for the final result.

The importance of identifying, assessing and developing emotional skills in higher education is shown in [52], with the consideration that the skills involved in emotional intelligence, once related to performance in one's personal, professional and everyday life, are themselves models of skills [4, 53]. However, models of emotional intelligence include generic socio-emotional skills [37].

5. CONCLUSIONS

The results show that all the skills analysed in this research are relevant to a greater or lesser extent to the professional development of computer engineers. This stems from the fact that the panel of experts scored all the variables above the mean, i.e. in no case did any variable score less than 5. For the sake of clarity, it should be noted that, for the neuroticism variable, the focus of the question was inverted (originally emotional stability), obtaining a score of 9 for emotional stability, and thus 2 for neuroticism.

Regarding the professionals' opinion, the mean score given by the group shows that these skills were also relevant for professional development. Every variable was always above 5, except for neuroticism (as was the case for the experts' group). However, the professionals' view coincided with the skills of the students, and differed greatly from what the experts said. The tests showed that students' opinions were similar to those of the professionals. This similarity could be due to the professionals thinking that they have the necessary skills for professional development. Some authors claim that graduates consider themselves suitably prepared, though they perceive a shortfall in skills, particularly social and participatory skills.

As shown in the previous section, according to the experts, students in the last year of computer engineering are not sufficiently well developed in emotional and personal terms to carry out their work successfully. The results show that students are not sufficiently prepared to enter the job market in terms of emotional and personal skills; i.e. they do not have enough skills to work in teams, deal with people, adapt to change or control their emotions, among other factors. These results are consistent with the results of the REFLEX project for professional skills, which emphasised that employers require more skills than those acquired by graduates, whereas graduates say that they hardly use the skills that they have, stressing the difference between the skills level required for professional performance and the skills level acquired in education, as well as the low use that graduates make in their work of skills that they have acquired.

Future research could be designed to analyse each emotional and personality trait sub-skill, and determine where the greatest discrepancies lie between the profiles of the different stakeholders involved in the process of university education.

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