IT Professionals' Competences: High School Students' Views

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Executive Summary

During last few years, the competential paradigm has become a standard for modern Human Resources Management. The importance and the impact of this concept have led higher education institutions to adopt this concept in the definition of educational resources. In this scenario, knowing which competencies and characteristics define professionals in any position is fundamental, not only for organizations and academic institutions, but also for the professionals of the future. In today's environment, with its shortages of professionals in the IT sector, attracting students in order to shape tomorrow's labor force has become a major issue of concern in educational institutions. Within the set of elements employed by such institutions to attract future students, one significant issue is how to convey the professional reality that is faced by prospective students. IT professionals are often subject to negative social stigmas. And this negative view creates negative stereotypes, which are on one hand, generally adopted, and on the other, they don't accurately portray the employees' the working life.

This research presents a study that investigates the perception of the characteristics of IT professionals from the perspective of future professionals: students in their final year of high school. The results indicate that the students generally hold a stereotyped vision regarding the characteristics that are typical of professionals in industry. With the objective of improving the specific knowledge of the professional reality of IT workers, the current paper proposes a number of measures in order to attract students to the profession and inform them of the true professional characteristics of IT professionals. One suggestion is to encourage collaboration between organizations and academic institutions in attracting new people to IT roles and for professional associations to assume a much more active role in communicating IT working styles appropriately.

Keywords: IT education, IT Professionals, Professional stereotypes, Competences, Professionalism.

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Introduction

The importance of IT in current organizational environments cannot be underestimated. According to figures from the European Information Technology Observatory (http://www.eito.com), the IT sector already comprised 5.74% of the GDP of the European Union and represented 3.4% of all employment in 2007. However, these macroeconomic statistics, although undoubtedly encouraging, do not imply a particularly positive scenario for companies owing to the shortage of qualified professionals. Examining a study performed by the Gartner consultancy (Morello, Kyte, & Gomolsky, 2007), the lack of talent is threatening business growth. One of the questions seriously undermining the development of a talented labor force in organizations is the decrease in enrolment of students in IT related degrees. According to the analysis by Gartner, many young people see IT as an unattractive career option: it is both hard work and "uncool." Additionally, this negative image is confirmed by the paradox that the strategic contribution of IT is recognized within enterprises, but the status of the IT department is low (Avison, Cuthbertson, & Powell, 1999). As a consequence, IT professionals are perceived as "strangers on the train" by the rest of the organization (Day, 2007). This set of factors constitutes the basis for the formation of negative stereotypes, both from a social as well as a professional perspective. These stereotypes, which are adopted by a large part of society, also affect school communities and, therefore, prospective students. They, therefore, irrevocably contribute to discouraging new students from studying the profession. This effect has been confirmed by scientific studies. For example, stereotypes include nerdy/geeky (Gurer & Camp, 2002), anti-social (C. D. Martin, 1998), solitary (Craig, Paradis, & Turner, 2002), unethical (C. D. Martin, 1998), poorly dressed (Jemielniak, 2007), to name but a few. Other authors have studied the impact of cinema (Colomo-Palacios, Gómez-Berbís, & García-Crespo, 2007) or television (García-Crespo, Colomo-Palacios, Gómez-Berbís, & Tovar-Caro, 2008) in the characterization of IT professionals. These studies indicate the proliferation of negative characteristics (personality traits, physical…) of IT professionals, although they also note that, in the case of cinema, the number of IT professionals placed in leading roles is systematically increasing. This circumstance aids in "normalizing" the characteristics conveyed in the role played by IT professionals. The degree of impact of this normalization on the enrolment of students in IT degrees will be seen with time.

Currently, the most dramatic example of the lack of interest in IT work can be seen in Switzerland, where student enrolments in the previous five years have fallen by 60%. In this country, the year 2008 has been declared as the year of IT, in order to promote the discipline among young students and stimulate potential new IT students. The principal initiatives that have been performed for the promotion of IT include the organization of events, conferences, meetings with professionals, and awards. The web page of such initiatives may be accessed at http://www.informatica08.ch.

Characteristics that have not, until now, been the subject of attention or academic analysis may increasingly be contributing to the crisis. These characteristics require new professionals to go beyond pure technical knowledge. A workforce is required that has the capacity to adapt (Morello et al., 2007). The need for defining and communicating these characteristics should not be overlooked. The remainder of this article has been structured as follows. Initially, the basic concept of competencies as a novel approach for the description and evaluation of professionals is established and outlined. Secondly, the principal initiatives for the definition of competencies of IT professionals are discussed. Subsequently, a description of the methodology followed to carry out the current study is given, leading to the presentation of the results obtained and a discussion of the observations. Lastly, the principal conclusions of the study are presented and some suggestions for resolving the problems encountered are outlined and identified as areas for future research.

Competence: A New Approach

The competence approach to human resources management has a long history. The early Romans already practiced a type of competence profiling in attempting to detail the attributes of a "good Roman soldier" (Draganidis & Mentzas, 2006, p.52). More recently, the concept of competence was used by early 20th century scientific management (Taylor, 1911) and later revised and redefined by McClelland, former Hay Group director, in the early seventies. According to McClelland (1973), competence concerns the relation between humans and work tasks; rather than knowledge and skills themselves, competence involves the knowledge and skills required to perform a specific job or task in an efficient way. More specifically, competences, from the Latin verb "competere," can be defined as an individual's core skills (motives, traits, self-concept, knowledge, and abilities) that are causally related to a specific, effective criterion and/or a superior performance at work (Spencer, & Spencer, 1993).

The concept of competence is associated with the analysis of professional activities and the inventory of what is necessary in order to accomplish the missions involved in these activities (Levy-Levoyer, 1996). Several authors (e.g. Levy-Levoyer, 1996; G. Martin & Staines, 1994) set up taxonomies in which particular or technical competences are established as those that are necessary to carry out a very specific task of a particular job position and include knowledge, abilities, and skills. On the other hand, universal or generic competences are those that, though not linked to a specific activity or function, do make possible the competent performance of the tasks related to the work position, inasmuch as they refer to characteristics or abilities of the individual's general behavior. These competences permit individuals to adapt to changes in a more efficient and rapid way (Levy-Levoyer, 1996). Such characteristics may be crucial for project success (Sukhoo, Barnard, Eloff, Van der Poll, & Motah, 2005) and comprise the subject of research analysis in the IT field. This study investigates the perceptions of such characteristics, with the objective of better designing future efforts to attract a larger number of students to IT related degrees.

Competence in IT

The IT field has not escaped the influence of the competence approach. The literature is saturated with studies concerning the competencies of the professionals of this sector. Studies can be found about the competencies necessary for software project managers (Sukhoo et al., 2005), analysts (Misic & Graf, 2004), chief information officers (Bassellier, Reich, & Benbasat, 2001), entry-level IT professionals (McMurtrey, Downey, Zeltmann, & Friedman, 2008) and professionals in general (Kovacs, Caputo, Turchek, & Davis, 2006), to cite some of the most significant examples. Within Europe diverse initiatives have been developed in order to establish the competence levels of graduates from various professional degrees. With the objective of adapting to the European Higher Education Space, efforts have been carried out to define the general competencies of all graduates. These competences were identified by the Tuning project (González & Wagenaar, 2003), an initiative sponsored by the European Union for the coordination of the educational structures in Europe. Analyzing the competences established by the Tuning project, a subsequent effort—"The white book on computer science degrees in Spain" (Casanovas, Colom, Morlán, Pont, & Ribera, 2004)—grades both technical and generic competences on a Likert 1-4 scale in order to determine the competence level needed for a computer science degree. This initiative is overseen by the governmental accreditation agency of Spain (ANECA).This competence level was established based on a huge study, which included 1143 interviews with professionals and computer science researchers all over Spain. In this study, generic competences were found to be particularly crucial for new professionals (Levy-Levoyer, 1996). These competences were, therefore, chosen as the focus of the current paper. Table 1 displays a list of generic competence for computer science, weighted according to Casanovas et al. (2004).

Table 1: Generic competence output level for computer science bachelors

Competence	Weight
Capacity for analysis and synthesis	4
Organization and planning	4
Oral and written communication in mother tongue	3
Problem solving	3
Decision-making	3
Critical thinking	3
Team work	4
Interpersonal skills	3
Ability to work on an interdisciplinary team	3
Information management	3
Ability to work in an international context	2
Ethical commitment	3
Environmental sensibility	2
Adaptation/flexibility	3
Creativity	3
Leadership	3
Understanding of other cultures and customs	2
Ability to work in an autonomous way	3
Initiative and enterprise	3
Quality concern	4

The current work is not intended to compare findings among competences. Instead, it is designed to compare the perceptions of high school students with these prior curricula efforts. Results will show the kind of perceptions students have, the influence of stereotypes, and the difference between student perceptions and reported corporate needs. Research questions and issues central to the current work are outlined below:

1. Most valued competence.
2. Least valued competence.
3. Gaps displayed between the curricular recommendations and the responses of the subjects.
4. Are there significant differences between responses according to gender?
5. Are there any parallelisms between professional stereotypes that have been described in the literature and the responses of the subjects?

Methodology

Questionnaire

A questionnaire was designed to be delivered to students in a personal fashion. (A copy of the questionnaire is provided in Appendix.) The administration of the questionnaire took place in groups and with the help of a lecturer, who was previously trained for the tasks to be conducted. The questionnaire was composed of two distinct blocks. The first section consisted of the identification of the subject relative to the demographic features of gender, age, and high school of origin. Secondly, the student was asked to grade the importance of the 20 competences listed. With the aim of constructing the questionnaire objectively and to be able to perform comparisons between the previously cited recommendation of competencies and the results of the questionnaire, the questionnaire was designed as a Likert scale ranging from 1 to 4. Values are 1 (not important), 2 (not so important), 3(quite important) and 4 (very important). This scale was adopted in order to perform comparisons between curricula recommendations and students' views using the same scale. As well as providing the required correspondence with the scale adopted in the curricular initiative, the even scale was employed to avoid what has been termed "central tendency error". This error, which is defined as the reluctance on the part of respondents to give extreme responses (Yu, Albaum, & Swenson, 2003) can be reduced by obliging the subject to select from a range of values which do not contain a central value.

Respondents

A total of 94 respondents completed the questionnaire. Due to incomplete data, 4 surveys were excluded. The sample was composed of 44 men (49%) and 46 women (51%). As previously indicated, the simple was composed of students in their final year of high school in Spain, from different institutions in Madrid, Andalucía, and Castilla-La Mancha. The high schools were selected on the basis of long-standing professional relationships with the researchers who carried out the study. The average age of the respondents was 18.27 years, the standard age of students in the last year of high school. Taking into account that all of the surveys were performed in public high schools in non-disadvantaged suburban areas, it can be induced from these demographics that the social class of the respondents was low-middle to middle. The survey was administered as a voluntary activity at the end of each school day. Prior to this task, the instructions for filling in the survey form and the objectives of the survey were explained to the students. The students were given a limited time frame of 20 minutes to fill out the survey. The teacher who collaborated in the survey, and who had been previously trained in the task, was present in the classroom at all times and responded to any questions (referring the students to the definitions of the competencies in the documentation provided to the teacher).

Content validity

The questionnaire was adapted from another questionnaire used for the determination of competencies for graduates of computer science degrees used by Casanovas et al. (2004). Of particular concern was content validity – the extent to which the set of measures provides adequate coverage for the construct domain or essence of the domain being measured (Churchill, 1979). Some authors (Emory, 1985) pointed out that the determination of content validity is not numerical, but subjective and judgmental. Taking this into account, the researchers requested feedback from three academics who were expert in higher education issues. All of them were asked to comment on the clarity of the questions and measurement items. As a result of this process, some items where rewritten to adjust questionnaire content based upon the experts' opinions.

Statistical Analyses

Table 2 displays the competencies ranked in order of the average values which they were assigned on the scale. Besides the name of the competence, information is included about Casanovas et al. (2004), weight (PRO), average (AVG), standard deviation (SDV), suggested value (VAL), gap between suggested value and curricula recommendation (GAP) and, finally, as stated before, rank based on averages. The value of the VAL column has been calculated by adjusting the ranking to the values, applying a similar adjustment to that employed by Casanovas et al. (2004).The purpose of this adjustment is to ensure that the PRO and VAL scales are comparable, which guarantees that the gap which exists can be analysed accurately and coherently. Alongside the results, an analysis and interpretation of the data has been made, in order to answer the research questions.

Table 2: Competence Results: Professional's level, Average, Standard Deviation, Value, Gap and Rank

Competence	PRO	AVG	SDV.	VAL	GAP	Rank
Ability to work in an autonomous way	3	3.27	0.86	4	1	1
Capacity for analysis and synthesis	4	3.07	0.82	4	0	2
Problem solving	3	3.03	0.88	4	1	3
Creativity	3	3.02	0.91	4	1	4
Initiative and enterprise	3	2.99	0.57	3	0	5
Decision-making	3	2.90	0.75	3	0	6
Adaptation/Flexibility	3	2.84	1.06	3	0	7
Organization and planning	4	2.78	0.91	3	-1	8
Oral & written communication in mother tongue	3	2.60	0.83	3	0	9
Team work	4	2.60	0.97	3	-1	10
Interpersonal skills	3	2.58	0.97	3	0	11
Ability to work in an international context	3	2.53	0.96	3	0	12
Ability to work on an interdisciplinary team	2	2.44	1.00	3	1	13
Critical Thinking	3	2.26	1.04	3	0	14
Information management	3	2.02	1.13	3	0	15
Quality Concern	4	2.01	0.93	3	-1	16
Understanding of other cultures and customs	2	1.76	1.11	3	1	17
Leadership	3	1.70	0.97	2	-1	18
Ethical commitment	3	1.50	1.03	2	-1	19
Environmental sensibility	2	1.24	1.08	2	0	20

Results

Most Valued Competencies

Analyzing the results, it can be seen from Table 2 that the most valued competence is "Ability to work in an autonomous way," with a score of 3.27, followed by "Capacity for analysis and synthesis" at 3.07, "Problem solving" at 3.03, and "Creativity" at 3.02. The most homogeneous results, that is, those with the least standard deviation, are displayed by the 5th most valued competence, "Initiative and enterprise," followed by "Decision-making."

Least Valued Competencies

According to the perceptions of the students, the least valued competencies, order from lowest to highest, are "Environmental sensibility" at 1.24, "Ethical commitment" at 1.50, and "Leadership" at 1.70 points.

Gap Analysis

If the evaluation of the rankings is an absolute indicator of the importance of the competencies, the gap analysis contributes more in-depth information. Determining the differences between the perceptions and the competence results demonstrates that there are gaps in the information delivered and, thus, indicates the necessity for academic institutions to correctly communicate such characteristics.

Gap analysis has been developed by comparing suggested values and curricula recommendation. This analysis cannot be performed comparing averages with consensus values in order to preserve scales. That is the reason why suggested values are used instead of averages to perform the comparison.

Five of the twenty competences are valued by students at a higher level than by professionals. These are: "Ability to work in an autonomous way," "Problem solving," "Creativity," "Ability to work on an interdisciplinary team," and "Understanding of other cultures and customs." On the other hand, the competencies that present the negative gap (valued lower than curricula recommendations) are "Organization and planning," "Team work," "Quality Concern," "Leadership," and "Ethical commitment."

Gender Differences

Traditionally, women have been underrepresented in IT related degrees. One of the objectives of the study is to determine whether differences in perceptions of stereotypes depend on gender. In order to perform such an analysis, the statistical method ANOVA was used to carry out one-way between-groups analysis of variance using the tool SPSS. The level of statistical significance was set at 0.05. The tests found no statistically significant differences existed between the responses of the two groups for any of the 20 variables representing the competencies. From this, we conclude that the perceptions of both groups are very similar.

Discussion

Generally, the opinions of the students appear to be driven by stereotypes. In relation to the nature of IT work, it is interesting to note that the competence "Ability to work in an autonomous way" has been judged as the most important, while "Team work" as well as "Organization and Planning" present negative gaps. Additionally, the competence "Leadership," related to people management, also displays a negative gap. The negative unsocial and isolated stereotype has been the subject of analysis of a number of different studies, such as those of Craig et al. (2002); Durndell & Thompson (1997), C. D. Martin (1998), and Symonds (2000), and has been confirmed in the

current paper. Paradoxically, the curricular initiatives used in the environment of the study by Casanovas et al. (2004), as well as other research initiatives, find social competencies to be those that are the most highly demanded and valued in new professionals. These types of claims have been supported in research studies such as those of McMurtrey et al., (2008), Chan, Stafford, Klawe, & Chen (2000), and Goleman (1998).

In the current study, the competence "Quality Concern" also presents a negative gap. In contrast, various empirical investigations in the technology field reveal that this characteristic is one of the competencies that differentiates exceptional workers from those that are not (Turley & Bieman, 1995), permits effective management of the information technology function (Jaska & Hogan, 2006), and brings about an improved maturity for organizational processes (McGuire, 1996).

One of the most interesting findings of the study concerns "Ethical commitment." It is the second to least valued competence, at 1.50. Bearing in mind the critical role of the IT function in current organizations and the possibility that many professionals have access to protected data, the expectations of the students can be viewed as being rather disheartening and may have been somewhat influenced by the unethical Hacker description. This has been discussed by C. D. Martin (1998) among others. Although this stereotype is exaggerated, it has not failed to crop up in real IT work settings. A recent study revealed that "nearly half of IT workers snoop in confidential files" (CyberArk, 2008). Thus, what is displayed is a low degree of equivalence between the expectations of industry on the one hand and the stereotypes and professional reality on the other hand. In the diverse models of professionals outlined in the literature (see, for example, Ford & Gibbs, 1996) the ethical protocol is regarded as an essential constituent of the profession, and—despite the existence of professional codes associated with the most prominent professional societies—examining the evidence (CyberArk, 2008) and research studies, such as those of McConnell (2003), these codes are not fulfilled.

One element considered important by the students is the perception of the intellectual requirements expected when performing IT work. In this way, competencies such as "Capacity for analysis and synthesis," "Problem solving," and "Creativity" enter among those that are the most valued. These findings corroborate the conclusions derived by various authors in relation to the stereotypes held of professionals (see Teague, 2002). The fulfillment of the profession requires prepared personnel with first rate intellectual capacities.

In relation to the least valued competence, "Environmental sensibility" (with 1.24 points of a maximum of 4 points), it should be noted that the low valuation of this competence goes against one of the most recent trends that has arisen: environmentally responsible computing. This movement aims to reduce IT's environmental impact and to create a sustainable environment (Murugesan, 2008)—making IT part of the solution to current environmental problems. To do so, the IT sector, IT professionals, and IT users must develop a positive attitude toward addressing environmental concerns and adopt forward-looking, green-friendly policies and practices (Murugesan, 2008).

Another of the findings of the study is the homogeneity among the responses of the genders. Previous studies have indicated the imbalance of gender in the profession (Margolis & Fisher, 2002), concluding that gender differences in the field of computing lead to negative social, economic, and scientific consequences and must, therefore, be addressed (Papastergiou, 2008). The current study indicates that both men and women share the knowledge—or equivalently, unfamiliarity—of the characteristics of professionals Thus it may be proposed that the reason why women do not opt to work in an IT environment is not so much that they are informed differently but rather that they interpret the same information in a distinct manner. It is also possible that shared stereotypes about the profession affect women more intensely in a negative sense. Earlier studies found that women prefer to work among people (Clarke, & Teague, 1996). This trait is in conflict with that

of the stereotype they hold, particularly in light of the low ranking assigned to the "Teamwork" competence. Other barriers may also exist, however. According to Papastergiou (2008) these factors may include lesser self-confidence in their computing skills, lesser exposure to computers since childhood, and lack of suitable female role models. Nonetheless, our findings lead us to conclude that combating the image of a solitary IT worker may help to attract more women to the profession.

Conclusion

The current work confirms the stereotyped visions of IT workers held by students. Analyzing the gaps between the requirements of labor markets and the perceptions of students, three distinct gaps emerge. The first group of gaps consists of the competencies related to collaborative and cooperative work in the IT profession. In this group of competencies, the most significant gaps to be found are "Leadership" and "Teamwork". The second group of gaps is comprised of "Organization and planning" and "Quality Concern," competencies related to the work methods of IT Professionals. Lastly, there is a gap in a unique competency: "Ethical commitment." It is possible that the stereotypical image of the antisocial professional (the first group of gaps), lack of ethics (the third group), and the second group's vision of the "all-powerful" and anarchic IT worker has attracted a good number of professionals in the past and will continue to do so. On the other hand, breaking the stereotypes and bringing perceptions more into line with today's workplace realties may be a better solution in light of today's IT worker shortages. If so, we must focus on changing student perceptions, both to improve the social image of IT workers and to encourage new course enrolments.

Without a doubt, stereotypes can be combated with information. Therefore, it is of utmost importance that students be correctly informed about the working styles of professionals. In order to implement such an initiative, two types of actions are proposed: direct and indirect. In relation to the first, it is suggested that students undertake guided visits to organizations in the IT sector. During these visits they can perform several activities related to IT work including role playing, games, and work simulations of the most attractive tasks. In this scenario, professionals and teachers may inform students onsite in the working environment, where they may learn through observation. A further suggestion is to encourage collaboration between organizations and academic programs by means of visits to classrooms by professionals and by presentations. Alongside such initiatives, professionals should undertake mentoring and e-mentoring roles in their daily working environment, through means such as emails and the new social networks that have come to define Web 2.0. Lastly, institutional actions, such as the earlier described initiatives in Switzerland, can serve to bring the profession closer to the population and prospective students.

With regard to indirect actions, professional associations can assume a much more active role in society. Initiatives in which organizations use all communication media necessary to fully inform the public about their activities and establish contact with cultural communities should be encouraged. The goal of these communications should be to convey the realities of the IT profession. More concretely, professional organizations should encourage more realistic portrayals of IT workers in cinema and television, offering their services to scriptwriters and producers. Another area that can influence young people is comics. Initiatives, such as courses and prizes for the creation of cartoons that reflect the reality of the profession, should therefore be encouraged. Lastly, the emphasis placed on communicating the importance of professional ethics, both in teaching environments and by professional societies, should be increased. In this way, both the requirements for accountability (i.e. moral responsibility) and the issues of potential liability (i.e. legal responsibility) for IT workers can be emphasized.

The present paper has focused on identifying the mismatches between perceived and actual values. For future research, an important priority should be placed on identifying the most effective

communication channels for informing students about these mismatches: those channels having the greatest influence at the moment of a student's decision to embark on a future IT career. The role played by television and cinema in making such decisions warrants particular emphasis.

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Appendix: Questionnaire

Age:	
Gender:	Female Male
High School:	
Date:	

Rate the importance of IT professionals' competences on a 1-4 scale
(1= Not important, 2= Not so important, 3= Quite important, 4= Very important):

IT Professionals competences (Rate each competence using the scale)	**1**	**2**	**3**	**4**
Ability to work in an autonomous way				
Ability to work in an international context				
Ability to work on an interdisciplinary team				
Adaptation/Flexibility				
Capacity for analysis and synthesis				
Creativity				
Critical Thinking				
Decision-making				
Environmental sensibility				
Ethical commitment				
Information management				
Initiative and enterprise				
Interpersonal skills				
Leadership				
Oral & written communication in mother tongue				
Organization and planning				
Problem solving				
Quality Concern				
Team work				
Understanding of other cultures and customs				

Biographies

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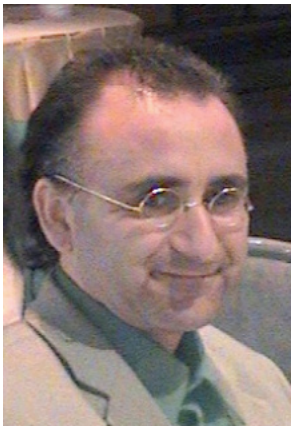

Edmundo Tovar Caro has a Ph.D. (1994) and a bachelor's degree (1986) in computer engineering from the Universidad Politécnica de Madrid (UPM). He is Certified Software Development Professional (CSDP) from the IEEE Computer Society. He has been an advisor in quality assurance for several institutions and an expert evaluator in accreditation processes with the Spanish Agency for Quality Assessment and Accreditation, ANECA. He has served as Control Quality Unit Director, School of Computer Science, UPM and currently is Vice-Dean for Quality and Strategic Planning in this school. He is an IEEE Senior Member, Chair of the Spanish Chapter and at-large member of the Administrative Committee of the IEEE Education Society.