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From academia to industry: are doctorate holders ready?

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Abstract.

In policy debates related to innovation potential, the limited mobility from academia to industry is often explained by the supposed mismatch of skills needed in these different settings. We contribute to this debate by (1) examining the attitudes of Flemish doctoral candidates towards careers in industry; and (2) by analysing the extent to which doctoral candidates and employers in industry in Flanders differ in their views on the skills needed to perform well in this sector. We combined survey data with qualitative research. The Survey of Junior Researchers provides information on the doctoral candidates' perspective on these matters, whereas the Research & Development Survey of Flemish companies reflects the employers' views. Additional data obtained through interviews with both doctorate holders and employers provide a more in depth understanding of the transition from academia to industry. A mismatch between what doctoral candidates consider important skills for a job in industry, and what employers expect from researchers is observed. The importance of technical skills and more transferable competencies such as project management and business skills are underestimated by doctoral candidates. The findings raise questions on the awareness among doctoral candidates of the skills needed for a career outside academia. Addressing possible negative attitudes, and providing adequate training and career planning could improve their preparation for work in non-academic settings, confirming findings in other countries that institutional programmes have a role to play in bridging the gap between employers' expectations and those of doctoral candidates.

Key words Doctoral training - Career perspectives - Skills development – Skills mismatch - Intersectoral mobility – Employability

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Category: Research paper

1 Introduction: on the transition from academia to industry

The employment of doctorate holders in non-academic sectors has become an issue of growing interest for policy-makers. European as well as national and regional policy agendas (crystallized among others in the Bologna Process, the Lisbon Strategy and the EU 2020 Strategy) stress the importance of a greater supply of highly educated researchers for creating a competitive knowledge economy. As a result of such policies, a growing number of postgraduates cannot be adequately absorbed by the academic system (see a.o. Kehm, 2007).

This article relates to the situation in Flanders, the Dutch-speaking part of Belgium, where the annual number of produced doctorates has more than doubled over the last fifteen years (De Grande et al., 2009). As in many other knowledge-intensive countries, the increased investment in doctoral production is not matched by an equal increase in academic career opportunities at postdoctoral and faculty levels, but is motivated by various governments' expectations that doctorate holders will contribute significantly to the knowledge economy. Indeed, more doctorate holders look to non-academic sectors for their further career development (European Commission 2000, 2010; Enders, 2003; De Grande et al, 2009). Although this increased transition of knowledge workers from academia to other sectors, and to industry in particular, is evident in many countries, including the U.K. (Vitae, 2010), France (Harfi & Auriol, 2010), Austria (Schwabe, 2011) and the U.S. (Aanerud, 2006), scientific studies on the careers of doctorate holders outside academia are limited. Nevertheless, many countries are now engaged in data collection activities relating to such careers (Auriol, 2010). According to the *Careers of Doctorate Holders* survey (OECD, Unesco, Eurostat, 2012), Belgium is one the countries in which more than 30% of its doctorate holders end up in the business enterprise sector for their future professional career, along with Denmark, the Netherlands and the U.S. – indicative of doctorate holders' integration in the knowledge economy.

Despite the considerable demand for a highly skilled workforce in industry (Jackson, 2007; VRWB, 2008), this transition process in a doctorate holder's career proves not as straightforward as expected. First, doctorate holders compete for senior research jobs in industry with experienced master-level graduates, who may have less specialist expertise than doctorate holders, but often have more relevant work experience. Some employers – especially those in smaller companies – prefer the latter over the former (McCarthy & Simm, 2006; Borrell-Damian et al, 2010). Additionally, many employers still hold quite stereotypical views of doctorate holders, inspired by the myth of the

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doctoral candidate in his/her ivory tower, isolated from other fields and people. They therefore doubt whether doctorate holders have the necessary competences to perform well in a business environment (Usher, 2002; Morgavi, McCarthy & Metcalfe, 2007). Third, many doctoral candidates still hope for an academic career and consider employment in another sector merely as second choice (Béret, Giret & Recotillet, 2003, Fox & Stephan, 2001). This focus on a future academic career may prevent doctoral researchers from investing in the specific skills needed in industry, resulting in a skills mismatch. Focusing on these issues confirms the multi-faceted structure of the researcher development conceptual model as developed by Evans (2011): while few employers doubt the *intellectual* developmental achievement of doctorate holders, the mismatch is situated primarily in the *behavioural* and *attitudinal* developmental components. Researchers' behaviour in terms of practice and organisation at operational level, as well as research outputs (e.g. research publications as opposed to patents or products) are valued differently in academia and industry (Borrell-Damian et al, 2010); similarly, the perceptions, values and motives that make up the attitudinal component of a researcher's career in academia often quarrel with those of researchers or employers in industry (Morgavi, McCarthy & Metcalfe, 2007).

In order to gain a better understanding of the issue, we study (1) the attitudes of doctoral candidates towards employment in industry and other non-academic sectors, and (2) the perception of the skills and knowledge needed for research careers in industry, through the eyes of both doctoral candidates interested in such careers and those of industrial employers and HR managers in Flanders. From the existing literature several hypotheses are derived which reflect common assumptions on this issue in current policy debates. This is followed by the description of the data and methods used and a discussion of results. The last part provides a reflection on possible policy implications of our findings and prospects for further research.

2 The skills mismatch

Within the academic system, a doctoral graduate is able to carry out original, independent research and is ready for an academic career. The way doctoral research is performed, however, has changed considerably over the past ten years (Enders, 2005; Vandevelde, 2009). By the time they graduate, doctorate holders are expected to possess a mixture of skills and knowledge, useful in different and changing environments. Nevertheless, doctoral training remains mainly focused on a future academic career. Enders (2004) remarks in this context that the idea no longer holds that a good

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preparation for an academic career is a good preparation for any career – the 'one size fits all'-approach - and that other sectors require distinct skills.

The few studies on doctorate holders' employability have shown that, according to employers, they often lack specific skills needed for an industrial working environment. Employers are quite positive about doctorate holders' specialist skills (problem solving skills, technical knowledge), but see them lacking in more non-academic skills such as commercial thinking, the flexibility to adapt to other working environments or the ability to translate research results for a larger public (MacDonald & Barker, 2000; Jackson, 2007; Borrell-Damian et al, 2010; Rubio & Hooley, 2010). In the literature on transitions from higher education to employment in general (a.o. Teichler & Kehm, 1995, Hills et al, 2003; Kellermann, 2007; Garcia-Aracil & Van der Velden, 2008) the skills discussion is ongoing: how can acquired competences be better matched to job requirements? Is this mainly a task for higher education institutions, or could this also be improved by work experience and on-the-job training?

Employers' perceptions of the skills of doctorate holders however appear to vary with their exposure to doctorate holders: the more experience employers have with doctorate holders, the higher they value their skills (VITAE, 2009). In their overview of studies on employers' views of doctorate holders, Morgavi et al. (2007) found that there is a difference in views between employers having doctorate holders on their research staff, those explicitly recruiting them and those who have not considered hiring them. While employers who intentionally recruit doctoral graduates do this mainly for their specialist skills and knowledge, employers who have doctorate holding staff merely 'by chance' or who have many masters-level staff members in general, are often not able to recognize the specific skills of doctorate holders and therefore do not actively recruit them. Morris & Cushlow (2000) and Purcell et al. (2006) also mention that the size of the company has an impact on the appreciation of doctorate holders' skills, an observation in line with other studies on employability at graduate level (Department of Employment, Education, Training and Youth Affairs, 2000; The Gallup Organization, 2010). Smaller companies often do not have the financial means to attract doctorate holders and are more in need of all-round employees rather than researchers with specialist skills. Larger companies, however, can distribute these tasks across various employees.

And what do doctoral candidates themselves think about their skills and skills training? One study shows that doctoral candidates often fail to believe that their careers will be influenced by having the appropriate skills (Hakala, 2009). There is, however, a remarkable lack of awareness of the skills mismatch problem among the doctoral candidates. Too often they focus exclusively on finishing their doctoral programme and fail to plan for their future careers. This not only blinds them to what is

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expected outside academia, but also to the skills they may have acquired during their doctoral study (see also Cryer, 1998). Orpen (1994) found that further career success is positively associated not only with one's individual career management, but also with the way in which the organization (in this case: doctoral training programmes) manages the careers of their employees (in this case the doctoral students). In other words, individuals not only make better career choices by thinking about what they personally want, but their career choices may also be influenced by the training their organisation provides, such as doctoral programmes including (or lacking) transferable skills training: critical skills, project management, language skills, etc. However, teaching transferable skills courses does not necessarily increase skills awareness or convince a person of particular skills needs - which is sometimes taken for granted (Usher, 2002). Training only becomes effective when potential benefits are acknowledged by the trainees, e.g. that they link improved career opportunities to learned skills.

The longer one stays in an academic environment, the more a person matches one's professional image to what is required in this setting (Bourdieu, 1984; Delamont, Atkinson & Parry, 2000). Such strategy creates problems when later on one has to seek employment outside academia (Manathunga, Lant & Mellick, 2007). Some disciplines (e.g., humanities, social sciences) are further removed than others (sciences, applied sciences,…) from the non-academic labour market and industry in particular. For such graduates it is more difficult to move between academia and industry (Becher & Trowler, 2001).Consequently, research fields regularly cooperating with industry and specific programmes with intense contact with industry, can help initiate 'industry readiness' of doctorate holders (Harman, 2008; Borrell-Damian et al., 2010).

In this article, we examine the following hypotheses:

(Hypothesis 1) *In terms of career orientation,* we expect that, in accordance with earlier research (Fox & Stephan, 2001; Béret et al., 2003;), doctoral candidates prefer to develop academic careers rather than careers in other sectors. The aspirations to work in specific non-academic labour markets is expected to vary according to field of study (Becher & Trowler, 2001; Manathunga et al., 2007) and phase of doctorate (Delamont et al, 2000).

(Hypothesis 2) *In terms of employers' assessment of necessary skills***,** we expect to find differences in the perceptions of employers who already employ doctorate holders and those who do not (Morgavi et al. 2007; Morris & Cushlow, 2000). We also expect differences by company size (Morris & Cushlow, 2000; Purcell et al., 2006).

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(Hypothesis 3) *In terms of awareness of the skills needed in industry,* we expect that doctoral candidates are not adequately aware of the skills required in industry. We assume there are differences in the *perception* of the skills needed to perform in industry between on the one hand employers in industry, and on the other, industry-oriented doctoral candidates. As doctoral candidates may not focus sufficiently on skills needed outside academic, this may affect their perception of the skills needed in future employment. Variation in skills awareness can be expected according to doctoral candidates' career orientation, field of study and phase of doctorate.

3 Data and methods

For this study we make use of the *Survey of Junior Researchers* (SJR) which was conducted in 2008 at the universities of Ghent, Brussels and Hasselt (ECOOM-UGent, 2008). In these universities, 4878 junior researchers, who were defined as 'non-doctorate holding research staff' were asked to participate in a web-survey. The overall response rate was 40.9% (N = 1994); data were weighed by gender and field of study. The survey contained, among others, questions on the sector researchers prefer to work in after obtaining the doctorate: they were asked to rank the following sectors from most to least preferred for future employment: the service sector (banks, insurance, recreation,…), industry (IT, chemical and pharmaceutical, …), primary sector (agriculture, fishing, forestry,…), government (local, regional, intergovernmental), non-profit sector (health care, social services, …), academia and other non-academic educational institutions. This article focuses on those respondents who ranked the industrial sector in their top three.

For *field of study,* we distinguish five clusters: humanities (arts, humanities, criminology & law), social sciences (social and political sciences, psychology, educational sciences, economics and business administration), natural sciences (biology, mathematics, physics, chemistry, informatics), engineering (technological & bio-engineers) and medical sciences (life sciences and medicine) (Jacobs et al 2010). For the *phase of the doctorate* we distinguished the first or planning phase, in which doctoral researchers define their research theme and questions; the second or executing phase, in which the (qualitative or quantitative) data are collected; the third or finishing phase in which the data are analyzed, also called the writing up phase; and finally the reporting phase, in which the thesis is finalised and the doctoral defense takes place. In addition, we distinguish between respondents who clearly want to stay in a research function, those who do not, and those who do not know yet or have no preference (*preferred function after obtaining PhD*).

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Table 1 compares the characteristics of the industry-oriented respondents (N=420) with those characteristics of non-industry-oriented respondents (N=1128): there are significant differences in terms of sex, age, nationality and field of study. The industry-oriented group contains proportionally more men, more engineers, more researchers under thirty and more non-Belgian researchers than the non-industry-oriented group. Most respondents are in the executing phase of their doctoral research and more than half want to hold on to a research position after finishing their doctorate. For part 4.4, we create a separate group consisting of those more inclined to work in industry – the 'IR restricted' group – by excluding from the sample the respondents (1) who no longer want a research position; (2) who have a doctorate in social sciences or humanities, as they are not the main target for industry recruiters and R&D managers (Borrell-Damian et al., 2010); and (3) who mentioned both industrial and academic careers as their preference, in order to better identify discrepancies in their respective expectations. The resulting sample holds 165 respondents, the majority (70.0%) of whom listed industry as their top choice of employment sector.

Table 1: Characteristics of doctoral candidates by industry orientation (SJR)

		Not industry oriented		*Industry oriented*		
		%	N	%	N	χ^2
Sex	Female	51.2	577	38.1	160	
	Male	48.8	551	61.9	260	
	Total		1128		420	20.919***
Age	22-25	30.0	337	32.0	133	
	26-30	46.8	526	52.6	219	
	31-40	17.8	200	13.2	55	
	41-61	5.5	62	2.2	9	
	Total		1125		416	13.780**
Nationality	Belgian	83.1	937	73.3	308	
	Non-Belgian	16.9	191	26.7	112	
	Total		1128		420	18.421***
Field of science	Human	19.3	218	1.7	7	
	Social	18.7	211	4.3	18	
	Natural	19.7	222	27.6	116	
	Engineering	17.1	193	47.6	200	
	Medical	25.1	283	18.8	79	
	Total		1127		420	234.789***
Phase of doctorate	Planning	21.2	202	16.2	63	
	Executing	55.8	533	58.5	227	
	Finishing	15.3	146	16.5	64	
	Reporting	7.7	74	8.8	34	
	Total		955		388	4.341
	Total		1128		420	1.744

Source: ECOOM-UGent (2008); **: p<0.010; ***: p<0.001

To measure the *perception of skills required for their future careers*, the respondents were asked to pick 7 items out of a list of 27 skills/competencies which they considered most important for their

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further careers. Rather than engaging in a discussion on the conceptual (un)clarity of generic/transferable skills in other studies (a.o. Gilbert et al, 2004), we opted for a practical approach to the skills required in a non-academic environment when composing the skills set. We combined the framework of two studies available at the time of surveying doctoral researchers. First, the joint statement on the skills doctoral researchers need to develop during their research training, published by UK Research Councils (UK Grad Programme, 2001). Second, Rudd, Nerad, Morrison & Picciano (2008) differentiate between PhD-completion skills (skills and habits needed to complete a PhD) and professional skills (including training which prepares students for non-academic environments). We grouped these detailed items into five general sets of skills: research skills and techniques (5 items), communication skills (5), general management skills (6), working with others (3) and personal effectiveness (8), see appendix.

An identical list of 27 skills/competencies was presented to the employers who completed the *Research & Development Survey,* carried out in Flanders in the spring of 2008. Of the 2597 Flemish R&D-active companies contacted, almost half (1164 or 45%) participated; 479 employers answered the question on the skills they look for in a researcher. They, too, had to list the 7 most important ones. These employers belong to different business sectors: the primary sector and construction (5.7%), industry (60.2%) and service sector (34.1%). About one third of the companies employ doctorate holders (36.3%). We compared the views of employers in industry (N=297) who have doctorate holders among their research staff (N=78) with those who do not employ doctorate holders (N = 139). The size (small-medium-large) of the companies is also taken into account.

Table 2: Characteristics of the company/organization of the employers (R&D Survey) who completed the skills questionnaire

		%	N
Sector	Service sector	34,1	168
	Industry: electro & IT	8,1	40
	Industry: metal & machinery	15,6	77
	Industry: food, textiles, wood	20,1	99
	Industry: chemical & pharmaceutical	16,4	81
	Primary sector & construction	5,7	28
	Total		493
Research staff	Including doctorate holders	36,5	162
	Not including docorate holders	63,5	282
	Total		444
Company size [a]	Micro to small	45,1	216
	Medium	27,8	133
	Large	27,1	130
	Total		479

Source: ECOOM-KULeuven (2008), own calculations.
[a]: Own calculations, based on number of employees and revenue.

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Qualitative data collected within Flemish industrial firms were used to elaborate on the situation of doctorate holders and to further illustrate the views of employers on researchers. One-to-one interviews were conducted in nine industrial companies in Flanders, all within the technological or chemical/pharmaceutical sector, both small to medium sized enterprises (SMEs) and multinationals. In total, 26 interviews were carried out: seven with employers (E) and nineteen with employees/researchers (R) who were working in or are related to the R&D department of their companies. The employers were all men and five of them held a doctoral degree themselves. Twelve of the researchers were doctorate holders, among them were two women. Their ages ranged from 23 to 50 years. The quotes in this article were translated from Dutch.

4 Results

4.1. 'Staying or going': career orientations of doctoral students

In order to better understand their career perspectives after obtaining a doctoral degree, the SJR asked doctoral candidates to rank eight sectors of employment according to their preference. As the results show, the university is by far their most preferred place to work. About half of the respondents name the university as their 'most wanted' future employer; and about 80% put it in their top three, which supports our first hypothesis.

Even though the university is favored by students in all five fields of study, important differences are apparent (see Table 3). For instance, while 88.8% of doctoral candidates in the humanities prefer to stay at the university, 'only' 73.3% of those in engineering do. Other popular sectors of future employment are government (57.0%) and non-academic educational institutions (49.4%), and these score particularly well among the social sciences and humanities. The non-profit sector comes in fourth, with high scores among social and medical scientists. Overall, industry is ranked as the fifth sector of preference, with an average of only 27.4% of the respondents ranking it in their top three. Among doctoral candidates in engineering, about half (51.2%) are interested in a career in industry, whereas interest from human (3.9%) or social scientists (7.4%) is minimal, which further confirms our first hypothesis. Although we expected the phase of the doctorate to alter doctoral students' preferences, this was not the case (not in table).

Table 3: Crosstabs of doctoral students' preferred sector (first, second or third choice) by field of study, in %

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	Human	Social	Science	Engineering	Medical	Total	χ^2
University	88.8	81.8	80.8	73.3	84.1	81.0	27.574***
Government	67.8	64.7	55.6	55.0	46.5	56.0	30.756***
Non-academic	66.5	54.1	50.4	36.5	48.8	49.4	56.775***
Non-profit	27.9	43.8	24.9	16.4	48.1	31.6	117.896***
Industry	3.9	7.4	35.1	51.2	22.1	27.4	245.623***
Service sector	18.5	28.4	26.6	35.1	14.7	25.0	51.680***
Independent	24.9	16.5	16.9	20.1	29.0	21.7	22.689***
Primary sector	2.6	3.3	9.7	12.8	6.7	7.8	32.331***
N	233	242	349	408	389	1621	

Source: ECOOM-UGent (2008): df=4; *: p<0.050; **: p<0.010; ***: p<0.001

If we consider only the most preferred sector of doctoral candidates instead of their top three, 696 respondents (or 49.8%) mentioned university as their first choice, and industry jumps to second position: 175 respondents (or 11.8%) prefer industry most (Table 4). Just over half of the respondents (56.6%) who rank university as their most desired future employer, estimate their chances to stay in academia to be high. This is in fact still considerably higher than the real chance to pursue a career at university. Of those who prefer industry, 90.1% are rather confident that they will manage to do so. Those who choose the service sector or an independent profession, are also very positive about their chances of success. Apparently they do not expect too many problems if and when moving to these non-academic sectors.

Table 4: Most preferred sector and perceived probability of future employment in this sector

	First choice	Rather low probability[a]	Rather high probability[b]	N
University	49.8	43.4	56.6	696
Industry	11.8	9.7	90.1	175
Government sector	11.3	28.1	71.9	159
Non-academic educational institution	9.2	27.3	72.7	130
Non-profit sector	6.7	18.8	81.2	90
Service sector	5.6	9.4	90.6	78
Independent profession	5.2	8.7	91.3	64
Primary sector	2.1	26.2	73.8	24

Source: ECOOM-UGent (2008); N=1621
a: includes categories very low, low and rather low
b: includes categories rather high, high, very high

We interviewed doctorate holders employed in industry about their experience of this transition and examined, among others, the push and pull factors to move out of academia and into industry. Most of the respondents had a clear view on working in industry or were already working in a more applied context during their doctorate. Although some of them had considered staying at the university, most decided relatively quickly to move to the private sector as the possibilities to stay at university were limited or the labour conditions under which they had to stay were not ideal. These two quotes illustrate common reasons not to stay in academia:

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"Working on annual contracts until I'm forty or forty-five…I wouldn't be able to explain that at home." (R1) [1]

"I worked on my doctorate for six years and then there were relatively few options to get a permanent contract at the university. So I decided rather quickly that I wanted to go to industry, where I could do something scientific, or possibly something technical." (R2)

Some would have wanted to establish a long-term career at a university, but left because there were no positions available. Most of them experienced a smooth transition to industry, do not regret their decision and are quite happy about their current situation. Differences in organizational culture were reported, but as most of the respondents were ready for a more applied, commercial setting, this proved no obstacle.

"I like the mix between research and the concept of 'time is money'. Whereas, at the university, it was research only to publish as much as possible. Working in industry then, is the ideal mix." (R3)

A common 'belief' among these doctorate holders in industry was also that the longer doctorate holders stay at the university after graduation, the harder it would be to adapt to an industrial context. The opportunity for more result-driven work with economic returns is also mentioned as a reason to make the transition, although tight deadlines sometimes limit their opportunity to study issues in depth.

On the whole, these respondents did not mention any major barriers to making the transition. It was a new experience in many ways: more stress, less freedom, higher expectations on shorter terms, but none of this came unexpected. Even for those who had underestimated the extent of the changes, the transition itself was not perceived as difficult – at least not in retrospect.

4.2. Skills doctorate holders need in industry

As mentioned before, working in an industrial environment means adapting to short-term outputs, thinking commercially, and usually doing applied rather than fundamental research. Doctorate holders acknowledge that, although they think they had a lot to offer, they missed certain skills at the start of their non-academic career. The added value of their doctorate, they believe, lies in their specialisation, their independence and their driven approach to knowledge and understanding:

[1] R= employee, researcher who is working in or is related to the R&D department of the company

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"It is the possibility to cling to a certain problem, to dig in and to unravel it. To come across complex issues, to bring them together and see what you can get out of it…[*Doing a doctorate*] *is problem-solving."(R4)*

Some of the interviewees also mention the general skills obtained throughout their doctoral research as an added value, e.g. presentation skills, networking, writing skills, whereas others stress the lack of certain skills, e.g. working in teams, coaching abilities:

"Speaking in front of an audience (…), stand up for your own opinion in meetings…"(R5)

"If you have ten people to supervise, technical capacities are not enough (…) you really have to know how to handle them, individually and together. (…) I wasn't trained for that."(R6)

Nevertheless, a number of doctorate holders remain skeptical about the transferability of their specialized research skills and other learning experiences for their current job. One of the doctorate holders being interviewed gives a firm "no" when asked whether he learned anything during his doctoral research that proved useful in his current job; another is convinced that academic research has little bearing on career opportunities:

"I think you should not overestimate the importance of a doctoral degree. You should rather do it because you are interested. (…) You do something that you enjoy. That's it. But thinking that later on you'll be able to say 'If I have this [Ph.D.] I will be able to do that… " (R7)

To get a more systematic view on what is expected of researchers in terms of skills, we also collected the views of HR-managers and employers from industry. In Table 5 we list the same 27 skills/competencies considered important for careers of highly-skilled people, but this time presented to employers in R&D-active industrial companies. The employers were split into two groups: those who have doctorate holders among their research staff, and those who do not.

Table 5: Evaluation of skills needed by researchers among employers who do and who do not employ doctorate holders (in %)

	Employers without DH[a]	Employers with DH[a]	Total	χ^2	p
		Research skills and techniques			
Technical skills	76.3	61.5	71.0	5.225	*
Analytical thinking	57.6	59.0	58.1	0.041	
Scientific knowledge	48.9	69.2	56.2	8.373	**
Research skills	43.9	65.4	51.6	9.248	**
Average	56.7	63.8	59.2		

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		Personal effectiveness			
Taking initiative	60.4	50.0	56.7	2.214	
Independence	37.4	24.4	32.7	3.866	*
Flexibility	26.6	30.8	28.1	0.426	
Learning ability	22.3	33.3	26.3	3.139	
Stress management	28.8	16.7	24.4	3.970	
Time management	12.9	5.1	10.1	3.355	
Self-confidence	12.9	3.8	9.7	2.688	*
Dealing with failures	10.8	6.4	9.2	1.146	
Average	26.5	21.3	24.7		
		Working with others			
Teamwork	61.9	69.2	64.5	1.182	
Social skills	30.2	33.3	31.3	0.226	
Dealing with diversity	9.4	12.8	10.6	0.634	
Average	20.3	23.1	21.3		
		General management			
Project management	43.2	51.3	46.1	1.325	
Business skills	43.9	33.3	40.1	2.316	
Leadership	7.9	16.7	11.1	3.891	*
Knowledge about IP	3.6	2.6	3.2	0.171	
Financial management	3.6	0.0	2.3	2.872	
Career planning	0.0	0.0	0.0	0.000	
Average	17.0	17.3	17.1		
		Communication skills			
Language acquisition	18.0	20.5	18.9	0.208	
Presentation skills	12.9	12.8	12.9	0.001	
Networking	10.1	9.0	9.7	0.069	
Writing skills	7.2	7.7	7.4	0.018	
Negotiation skills	6.5	2.6	5.1	1.588	
Teaching skills	2.9	2.6	2.8	0.018	
Average	9.6	9.2	9.5		
	139	78	217		

Source: ECOOM-KULeuven (2008), own calculations.
N=217; df=1; [a]: Doctorate Holder; *: p<0.050; **: p<0.010

Overall, employers seem to value researchers for their research skills and level of specialisation, such as: technical skills, analytical thinking, scientific knowledge and research skills. More than half of the employers mention these skills as among the most important ones on the list. The other skills sets are less homogenously valued. Within the ‘personal effectiveness’ set, taking initiative (56.7%) is by far considered the most important competence, and in terms of ‘general management skills’ project management (46.1%) and business skills (40.1%) are highly valued in a researcher. Being able to work in team (64.5%) is stated more often as an important skill than research skills (51.6%). In general, the ‘communication’ set covers only skills that are mentioned by less than one fifth of the employers. We could argue that these are additional skills which are appreciated but will not make the difference in the selection of candidates.

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Employers in general search for the same sets of competences: technical skills, teamwork, analytical thinking, taking initiative and scientific knowledge, a mixture of research methods and interpersonal traits. Some skills however are valued somewhat differently when the two groups of employers – those who employ doctorate holders and those who do not – are compared. The top five of the two groups differs by one skill: employers who already have doctorate holders amongst their workforce value research skills more than employers who do not. Scientific knowledge and leadership are also valued more by the employers of doctorate holders. Employers without doctorate holders tend to stress technical skills, independence and self-confidence more.

When we interviewed employers and asked which skills are decisive when selecting researchers, many of the same skills as indicated in the R&D survey were mentioned. Most important are research and technical skills, but sometimes this is not sufficient to get the job. 'Soft' skills such as working with others, functioning in group or working independently are at least as important as specialist skills:

> *"If we meet someone who is brilliant in his own field, but cannot function in a group because he hasn't got those skills or competencies, then we won't invite him to the next selection round."(E1)*[2]

Out of the 27 skills, only 4 differed according to company size (not in table). The most interesting and surprising one is technical skills, which is rated 'important' by 82.4% of the employers from small firms, whereas only 60.8% of employers in large firms highlight this.

Some of the employers who were interviewed do not expect researchers who start in their companies to already have all the necessary skills, but they must demonstrate an ability to improve. This reminds us of 'learning ability', which was considered important by 26.3% of the employers. Indeed, some skills can best be learned on the job. One employer stated that acquiring new skills is an issue for later, when one is familiar with the organization and its staff. Most employers, even those who have doctorate holders amongst their research staff, point out that general skills are not specific to a certain degree, as they are considered personality traits of the person in question. Doctorate holders also have to compete in this respect with master-level graduates (many of them with the advantage of work experience in the private sector).

[2] E= Employer or HR-manager of one of the cooperating companies

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"But I don't even know if the skills that are important for those functions are directly linked to obtaining a doctorate. Besides being competent engineers, they are mature men, or not just men, I mean, men and women. (…) You don't recognize a doctor in those people. If you don't know, you will not discover it." (E2)

"[The doctorate degree] has a value in itself, certainly, but for us it is not necessarily a reason to choose one person over another." (E3)

In this respect, collaborating with industry during the doctoral research phase can improve skills development and provide doctoral candidates with additional experience when competing with experienced master graduates. According to the SJR, 8.7% of the respondents collaborate with industry, mostly for contract research or knowledge exchange. Overall, they perceived this collaboration as quite positive: 83% stated it enhanced their skills and 81% thought this contact might open up career opportunities outside academia.

"The link with practice is quite important. Although it's only about a few issues, [it's about how] you can transfer the theoretical base into applications."(R8)

4.3. Doctoral candidates' views on necessary skills

The SJR also collected data on how doctoral holders value the skills they would need in their future professional career. Table 6 compares the perceived importance of various skills for future employment among doctoral graduates most likely to enter a job in R&D: those with a degree in engineering, natural and medical sciences. These doctoral candidates do not value all skills equally. For instance, general management skills as a whole are little valued (mentioned by only 9% of the respondents). In contrast each of the skills in the research skills and techniques set is mentioned on average by 52% of the respondents. The remaining three skills sets fall somewhere in between these two extremes. But also within each of the sets there are substantial differences in how the doctoral candidates value the items. For instance, within the research skills and techniques set, only 24% of the respondents mentioned technical skills compared to 70% and 67% for research skills and technical knowledge, respectively.

Table 6: Evaluation of perceived importance of skills for future career[1] by doctoral candidates from three fields of study, in %

	Natural Sciences	Engineering	Medical Sciences	Total	χ^2	p
			Research skills and techniques			
Research skills	69.8	63.5	76.9	69.9	12.190	**
Scientific	70.6	58.6	73.6	67.4	16.437	***

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knowledge						
Analytical thinking	49.2	58.8	36.5	48.4	28.660	***
Technical skills	25.2	33.8	11.9	23.8	38.093	***
Average	53.7	53.7	49.7	52.4		
			Working with others			
Social skills	35.5	39.5	41.2	38.8	1.917	
Teamwork	37.0	40.0	37.5	38.2	0.608	
Dealing with diversity	14.5	10.8	15.2	13.4	2.667	
Average	29.0	30.1	31.3	30.2		
			Personal effectiveness			
Independence	45.4	42.0	47.7	45.0	1.855	
Taking initiative	31.3	29.1	35.4	31.9	2.692	
Stress management	29.0	24.7	34.7	29.3	6.915	*
Self-confidence	24.0	30.1	30.0	28.1	3.280	
Learning ability	27.5	30.4	18.8	25.6	10.846	**
Flexibility	25.6	20.6	24.5	23.5	2.174	
Time management	14.9	16.3	19.5	16.9	2.167	
Dealing with failures	6.5	5.8	2.5	4.9	5.220	
Average	25.5	24.9	26.6	25.6		
			Communication skills			
Presentation skills	37.4	36.1	41.5	38.3	1.881	
Language acquisition	33.6	28.7	24.9	29.0	4.942	
Teaching skills	27.0	23.0	26.7	25.5	1.521	
Networking	21.3	17.9	23.4	20.8	2.670	
Writing skills	15.6	14.5	15.1	15.1	0.137	
Negotiation skills & persuasion	9.2	14.2	10.8	11.5	3.635	
Average	24.0	22.4	23.7	23.4		
			General management			
Project management	20.5	26.1	19.9	22.3	3.893	
Leadership	16.0	21.6	18.8	18.9	2.907	
Business skills	6.9	6.4	4.0	5.7	2.469	
Career planning	3.4	4.1	2.5	3.4	1.037	
Financial management	2.3	1.7	3.6	2.5	2.216	
Knowledge about IP	1.1	1.7	3.6	2.2	4.339	
Average	8.4	10.3	8.7	9.2		
Total	262	296	277	835		

Sources: ECOOM-UGent (2008), own calculations
N=811; df=2; *: p<0.050; **: p<0.010; ***: p<0.001

Also worth noticing is that there are only few differences according to researchers' field of study. No significant differences were observed in the working with others, communication skills, and general management sets. In the personal effectiveness set students in the medical sciences clearly considered learning ability less important than those in the natural sciences or engineering, while the former also found stress management slightly more important. The main differences are in the research skills and techniques set. Doctoral candidates in medical sciences consider research skills

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and scientific knowledge more often important, and analytic thinking and technical skills less often important, than their colleagues in other disciplines - engineering in particular.

Table 7: Evaluation of perceived importance of skills for future career by doctoral candidates according to phase of doctorate, in %

	Planning	Executing	Finishing/ Reporting	Total	χ^2	p
Social skills	62	41,1	29,8	42,6	11,635	**
Technical skills	26	20,1	43,9	26,3	12,192	**
Language acquisition	48	34	19,3	33,5	9,901	**
Dealing with diversity	10	3,1	10,5	6	5,774	*
Total	50	159	57	266		

Sources: ECOOM-UGent (2008), own calculations
The smaller number of doctorate holders in the finishing and reporting phases are grouped together in order to make reliable comparisons.
N=266; df=2; *: p<0.050; **: p<0.010; ***: p<0.001

No substantial differences were observed in the perceived importance of the various skills according to the phase of the doctorate, which may indicate that this perception is quite stable (table 7). As this attitude does not develop during the doctoral process it might be based on perceptions already acquired prior to the start of the doctoral process, and may have contributed to the choice for a doctorate in the first place.

4.4. Matching the views of employers and doctoral candidates

Does the reported importance of skills among doctoral candidates with an interest in a career in industry better match that of their potential employers? To answer this question, we looked at industry-oriented doctoral candidates (see section 3), hereafter named 'IR restricted'. Table 8 shows the percentages (for each item) of the respondents who find the various skills important and as such they are ranked from most important (1) to least important (27). Comparing the responses of all IR-restricted doctoral candidates with those of the total group of employers, we see their top five has three items in common: scientific knowledge, analytical thinking and teamwork. Technical skills are not included in the top ten of IR restricted doctoral candidates; only one quarter considers it important for their future career. In an interview, one of the employers underlined the importance of technological-skills for an R&D department. Obviously, doctorate holders do have such specialist skills, but perhaps they are unaware of the advantage of their technical experience with lab tests,

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protocols or data analysis. There are other large gaps as well: project management is ranked twelfth by IR restricted doctoral candidates and seventh by employers, business skills are rated important by only 10% of the IR-restricted doctoral candidates, whereas about 40% of the employers find them important. Some skills are also overrated by IR restricted doctoral candidates when compared to employers: this is the case for social skills, although this is in the top ten of all the groups, as well as for language acquisition and presentation skills. This does not mean that employers do not appreciate these skills, but when they look for a good researcher, these skills are not decisive.

There is, however, variation in doctoral candidates' response patterns. The engineers' perception does not always follow the overall view of doctoral candidates interested in working in industry, and comes closer to the perception of employers with doctorate holders in their research team. This gives us credit for our third hypothesis. The difference in views on technical skills reduces when we look at the rankings: employers with doctorate holders position this skill 4^{th}, whereas it is 6^{th} for engineers, although the gap remains in percentage: more than one third of the engineers label this skill as important compared to almost two thirds of the employers. Doctoral candidates in their finishing phase however rank it on the same level as employers already working with doctorate holders. Further, engineers underestimate the importance of project management, taking initiative, business skills, flexibility and dealing with diversity, while overemphasizing social skills, presentation skills, self-confidence and negotiation skills. Although the perception of engineers comes slightly closer to HR managers' ideal picture of a researcher in industry, their overall expectations still show substantial discrepancies, which confirms our third hypothesis that doctoral researchers are not sufficiently aware of the skills required in employment in industry. However, we observe some differences within the perceptions of employers too, especially between employers from small companies and others. Teamwork, leadership and dealing with diversity are less crucial for small companies.

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Table 8: Comparison of percentages and ranking of skills of industry oriented (IR) doctoral candidates and HR-managers/employers

	Doctoral candidates						Employers							
	Engineering		Finishing phase		IR restricted[a]		With DH[b]		Large Companies		Small Companies		Total employers	
	%	rank	%	rank	%	rank	%	rank	%	rank	%	rank	%	rank
Technical skills	41,6	6	43,9	4	26,7	11	61,5	4	60,8	2	82,4	1	71	1
Teamwork	50,5	3	43,9	5	41,8	5	69,2	1	71,1	1	48,6	6	64,5	2
Analytical thinking	61,4	1	47,4	3	54,5	3	59	5	58,8	3	59,5	2	58,1	3
Taking initiative	34,7	10	24,1	15	35,2	8	50	7	56,7	5	56,8	3	56,7	4
Scientific knowledge	49,5	4	64,9	1	62,4	2	69,2	2	49,5	7	55,4	4	56,2	5
Research skills	55,4	2	59,6	2	73,3	1	65,4	3	57,7	4	54,1	5	51,6	6
Project management	27,7	13	29,8	10	26,7	12	51,3	6	53,6	6	40,5	8	46,1	7
Business skills	9,9	21	14	19	10,9	21	33,3	8	32	8	43,2	7	40,1	8
Independence	34,7	9	43,9	6	40,6	6	24,4	12	27,8	12	39,2	9	32,7	9
Social skills	42,6	5	29,8	9	43	4	33,3	9	30,9	10	24,3	12	31,3	10
Flexibility	20,8	16	24,6	14	21,2	15	30,8	11	28,9	11	27	11	28,1	11
Learning ability	24,8	15	33,3	8	24,8	14	33,3	10	32	9	21,6	13	26,3	12
Stress management	35,6	8	26,3	12	29,7	10	16,7	14	15,5	14	35,1	10	24,4	13
Language acquisition	32,7	11	19,3	17	37,6	7	20,5	13	19,6	13	12,2	17	18,9	14
Presentation skills	35,6	7	38,6	7	35,2	9	12,8	16	12,4	16	14,9	15	12,9	15
Leadership	32,7	12	24,6	13	25,9	13	16,7	15	15,5	15	5,4	23	11,1	16
Dealing with diversity	6,9	24	10,5	23	3,6	24	12,8	17	12,4	19	5,4	25	10,6	17
Time management	11,9	19	12,3	22	15,2	18	5,1	21	7,2	22	13,5	16	10,1	18
Networking	14,9	18	22,8	16	15,8	17	3,8	22	12,4	17	9,5	18	9,7	19
Self-confidence	25,7	14	29,8	11	21,2	16	9	18	7,2	21	16,2	14	9,7	20
Dealing with failures	11,9	20	14	20	14,5	19	6,4	20	11,3	20	6,8	20	9,2	21
Writing skills	7,9	23	13,8	21	10,3	22	7,7	19	12,4	18	8,1	19	7,4	22
Negotiation skills &	19,8	17	5,3	24	13,9	20	2,6	23	5,2	23	5,4	24	5,1	23
Knowledge about IP	1	25	1,8	27	3	25	2,6	24	4,1	24	5,4	22	3,2	24
Teaching skills	8,9	22	15,8	18	9,1	23	2,6	25	3,1	25	5,4	21	2,8	25
Financial management	1	26	3,5	25	1,8	26	0	26	2,1	26	2,7	26	2,3	26
Career planning	0	27	3,5	26	1,2	27	0	27	0	27	1,4	27	0	27

Source: ECOOM-UGent (2008); [a]: industry-oriented doctoral candidates without an academic preference, want to stay in a research function; [b]: industry-oriented doctoral candidates

ECOOM-KULeuven (2008); own calculations; [c]: Doctorate Holders

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5 Discussion & Conclusions

This article discussed the mismatch between the skills that doctorate holders perceive as necessary for future employment in industry and the skills required by employers in industry, by contrasting the views of doctoral candidates with those of doctorate holders and employers in industry. Flemish doctoral candidates still prefer careers in academia after obtaining their doctorate. Although in some fields of study more than in others, overall the popularity of the university as future employer far exceeds the popularity of jobs in government or industry. However, only half of the respondents who prefer academia think they are likely to establish a career there. Respondents who prefer industry do not anticipate major problems. As the employment opportunities in academia are quite limited the overwhelming majority of doctoral holders will need to move to other sectors, including industry – indeed other evidence confirms that more doctorate holders end up in the private sector than had planned to do so (Sten, 2008). Doctorate holders who work in industry are also rather positive about the transition from academia to industry. The phase of doctorate does not play any role in their career preferences. Do these results urge us conclude that there is not really much of a transition problem after all?

Yes and no. Doctoral candidates' attitudes to skills for a career in industry differ significantly from what industry expects. This mismatch can be an obstruction to effective knowledge transfer and to individual development. Employers expect researchers to have a mix of technical skills and a broader set of transferable competencies such as being able to work with others, and having general management skills such as project management and business skills. Other studies also highlight technical skills and managerial skills (Morris & Cushlow, 2000; Borrell-Damian et al., 2010) as required in industry. Although engineers and near-to-completion doctoral candidates stress these skills more than other industry-oriented doctoral candidates do, a gap remains between what most of them perceive as important skills and what employers stress as important. Smaller companies seem to have other expectations of researchers than larger companies, but these differences are not as clear-cut as suggested elsewhere (Morris & Cushlow, 2000; Purcell et al, 2006).

Doctoral training programmes in Flanders tend to prepare for future academic careers. It should not come as a surprise, therefore, that they attract students who favour this type of career rather than business careers: over 80% of doctoral students would like to stay in academia. In addition, many doctoral candidates are further socialized towards an academic career during their training, strengthening their identity as academics. As a result little thought is given to employment outside of

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academia, and certainly not to employment in the industry sector which tends to hold values often diametrically opposed to those in academia. The only groups of doctoral students who are more favourable towards employment in industry are those from engineering and to a lesser extent also those from the natural sciences. This is not a coincidence: not only are their scientific knowledge and skills more directly applicable in industry, they also have considerably more contact with industry during their programme (Leyman et al, 2009). Nevertheless, we still observe a substantial gap with industry regarding their perception of required skills as they, too, are academics first. However, doctorate holders who have made the transition to industry overall report few difficulties. The main problem therefore may not be the lack of skills, but the identity of doctorate holders and their negative attitude toward future non-academic employment.

The question of 'how exactly' researchers may be developed into (better) professionals performing research in industry remains one that is difficult to answer. Not only researcher development is still in the process of shaping its conceptual identity (Evans, 2011), also reflections on effective processes steering such developments are limited. But policies and practices in the field are moving rapidly and we can identify at least three types of stakeholders when addressing this skill mismatch. Each may have good practices to share: first, universities, as they have a role in providing the required skills training; second, doctoral candidates, as they need to take ownership of their career and skills development; and third, industries that employ a large number of doctorate holders and who are responsible for their further progress as researchers.

Universities have started taking on responsibility in this debate, by broadening the scope of doctoral training to the development of transferable skills, in addition to scientific knowledge and skills (Roberts, 2002; EUA, 2007; Jackson, 2007). Some universities even go further and adopt a more 'entrepreneurial academic model' (Etzkowitz et al., 2000; Enders, 2005; Hakala, 2009), in which the application of knowledge is considered more important and crosses disciplinary and organizational borders. Strategic research can possibly bridge the gap between fundamental and applied research (Enders, 2005), with the expectation that doctoral candidates' training will incorporate a mix of specialist and transferable skills.

The Flemish industrial sector as a whole has remained remarkably passive when it comes to university policy changes in the field of doctoral training. Following the example of the UK sector skills councils (SSC), employers' federations in Flanders could, for example, set up competency profiles per subsector for doctorate holders or help to restructure doctoral programmes at

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universities. Also in training their own employees firms might adopt a more targeted approach in bridging the training gap for particular jobs.

The format and content of doctoral candidates' preparation for future careers affects all mentioned stakeholders. First, doctoral candidates need to be better informed on their career options and to be encouraged to plan this at an early stage in their career, as universities can employ only a small number of them. Career services can play a valuable role (Jackson, 2007), preferably in liaison with doctoral programmes or recruitment agencies. Career fairs provide a direct link to possible future employers and raise doctoral candidates' awareness of what is expected in other sectors. Last but not least, skills such as teamwork and project management are gaining importance in an academic environment, as more doctorates are now funded through larger projects (rather than the traditional individual path) or through partnerships with other institutions or companies. As such, a wider set of skills can benefit not only those who move to other sectors (e.g. industry) but also those who stay in a postdoc position or become faculty members: they will have to supervise more (PhD) students than before and could also benefit from better managerial skills (Thompson et al, 2001). The interviews with employers however informed us that not the amount but the type of skills training is important as well as the application of new skills - some skills simply cannot be acquired in a classroom context. Last but not least, triggering a change in attitude towards non-academic career options on behalf of doctoral researchers and their supervisors may well be the most challenging, but most effective tasks of all. Further qualitative research into this matter could spark off useful suggestions on 'how exactly' this can be achieved.

Confronting the various stakeholders with this evidence on the skills gap and with opportunities to bridge this gap, would facilitate cross-sectoral mobility not only in Flanders and Belgium but also in other countries investing in a highly skilled workforce. All share a rapid increase in the number of doctorates produced - far outstripping the absorption capacity of the higher education system - and an increased demand for highly-skilled workers in industry in order to boost economic growth. Currently the OECD's Careers of Doctorate Holders data suggest that the problem remains mainly limited to Western and Northern-European countries and the U.S., as in Eastern and Southern Europe far fewer doctoral holders are employed in industry (OECD, Unesco, Eurostat, 2012). However, these countries are likely to catch up in the next decades. The attention recently given to the intersectoral mobility of doctorate holders by the European Union, the OECD and UNESCO indicates a concern that this form of knowledge transfer is not (yet) reaching its full potential, possibly due to the nature of the doctoral degree and the doctoral training programme, maintaining their academic finality. Corroding the academic character of this training might result in an increased

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mobility towards industry but may in the longer term risk undermining the academic qualities of higher education. Although doctoral programmes are not designed to deliver research staff tailored to the demands of the labour market, bridging the gap between employers' expectations on the one hand and researchers' potential on the other could result in a win-win situation for the individual researchers and for the research system as a whole.

6 Appendix

As mentioned in the 'data and method' section, we used five sets of skills, which are similar to the skills list composed by the UK Grad Programme and Rudd et al. These were completed with additional skills characterized as important by employers and graduates in Flanders.

	UK Grad programme	Rudd et al.	ECOOM
Research skills and techniques			
Research skills	x	x	
Scientific knowledge	x		
Analytical thinking	x		
Technical skills	x		
Teaching skills	x		
Working with others			
Teamwork		x	
Social skills	x		
Dealing with diversity		x	
General management			
Leadership		x	
Project management	x		
Business skills			x
Career planning	x		
Knowledge about IP	x		
Financial management		x	
Communication skills			
Presentation skills	x	x	
Language acquisition			x
Networking	x		
Negotiation skills & persuasion	x		
Writing skills	x	x	
Personal effectiveness			
Independence	x		
Taking initiative	x		
Learning ability	x		
Stress management			x
Self-confidence	x		

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Flexibility	x	
Time management		x
Dealing with failures		x

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