Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

17-Oct-2011

English - Or. English

**DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INDUSTRY**
**COMMITTEE FOR SCIENTIFIC AND TECHNOLOGICAL POLICY**

DSTI/STP/RIHR(2011)7
Unclassified

# Background note for the OECD RIHR Workshop on Transferable Skills Training for Researchers: Supporting career development and research

**28 November, 2011**

*Attached is a background note, prepared by the RIHR Secretariat, that sets the scene for the RIHR workshop on transferable skills training.*

Sarah BOX, Tel: +33 1 45 24 18 69; Fax: +33 1 44 30 62 64; Email: sarah.box@oecd.org

**JT03309239**



English - Or. English

# BACKGROUND NOTE FOR THE OECD RIHR WORKSHOP ON TRANSFERABLE SKILLS TRAINING FOR RESEARCHERS: SUPPORTING CAREER DEVELOPMENT AND RESEARCH

## TABLE OF CONTENTS



**Tables**



**Figures**



**Boxes**

## Introduction

1. Researchers are a key input into science and technology activity and their formation and careers are an important policy issue. The competency of researchers and their contributions to research activity are directly related to the success of research and development (R&D) investments in boosting innovative capability and prosperity, not only at a firm-level but also at regional and national levels. Public expenditures on researcher training and support are significant in many countries; private expenditures can be considerable also. Governments are thus keen to ensure that approaches to researcher training and careers are yielding net benefits for their economies.

2. Research careers span all sectors of the economy and are continuing to increase in their diversity. Researchers work in a wide range of scientific fields, from hard sciences through to philosophy and law, and their knowledge is highly valued in many different employment contexts. As might be expected, universities and public research institutes employ a large number of research staff, but so too does the business sector. In fact, 63% of OECD researchers worked in the business sector in 2007, reflecting the importance of their knowledge to business-sector activities.[1] Potential career paths continue to evolve in response to factors such as changes in the structure of academic research, the increasing use of science and technology in some industries, large numbers of doctoral graduates relative to the demands of the academic job market, and increasing circulation of workers among different occupations, as well as policy goals to encourage inter-sectoral mobility (Gilbert *et al.*, 2004; Nature, 2011; OECD, 2006). In short, researchers are encountering new academic pathways and expanded opportunities for work in other sectors, as well as ongoing pressures to consider a wider variety of career paths.

3. To help meet career challenges, researchers need skills that allow them to work in and move between different sectors during their working lives. "Transferable" skills, which can be broadly defined as skills relevant in a wide variety of sectors and situations (for example, communication skills and problem solving abilities), can not only help researchers operate effectively within and between different work environments, but can also contribute to better research. Increasing attention is being paid to the development of these skills, particularly within higher education programmes, and the variety of training opportunities has expanded. This trend can be seen in the context of a stronger skills orientation in general within research degrees, with research being increasingly viewed as a professional practice requiring common basic standards and certain expertise (Gilbert *et al.*, 2004). It also fits with a heightened emphasis on employability, as governments seek to address concerns about graduates' readiness to work.

4. However, there is a need to take stock of current policy settings and approaches to transferable skills training for researchers (Box 1). Some studies have identified shortcomings in researchers' proficiency in certain transferable skills, such as communication, while others have pointed to a lack of training opportunities for certain groups. The relevance of training has also been highlighted as a potential area for improvement. Furthermore, as researchers continue to pursue opportunities across the globe, and education and qualifications become increasingly "tradeable" goods, cross-country analysis of transferable skills training systems is becoming more and more relevant (Scholz, 2011).

5. The OECD's Working Party on Research Institutions and Human Resources (RIHR) is undertaking a project aimed at helping governments, as major actors in researcher training, to consider whether current national approaches provide appropriate support to researchers seeking to improve their transferable skill competencies. With a focus on countries' government- and institute-level policies on

[1] The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

formal training in transferable skills for researchers, it will collect evidence on current arrangements, attempt to identify good practices in transferable skills training, and highlight possible future directions to support researcher career development and improve research. This background note sets the scene by providing a short review of relevant literature. After setting out some project definitions and data on researchers, it expands on the importance of transferable skills for career development and research, the role of training in transferable skill acquisition, and the general roles of governments, individuals and other stakeholders in the training process. Results from a cross-country sample of transferable skills training strategies and programmes for researchers, based on responses to a policy questionnaire, are presented in a companion paper.

**Box 1. Time to take stock – issues with current transferable skill training**

Various studies have suggested that researchers' transferable skills could be further enhanced. For example, a study of collaborative doctoral programmes by the European University Association (EUA) found companies were satisfied with the knowledge and research skills of doctoral graduates in Europe, but saw room for improvement in communication skills, awareness of intellectual property issues, and understanding of business operations (2009, p. 8). Similarly, a small survey of businesses in the United Kingdom (UK) found that employers valued doctorate holders' specialist knowledge, analytical thinking and research skills, but found deficiencies in skills related to employability and "commercial nous" (CIHE, 2010). An Australian study identified communication, teamwork and planning and organisational skills as areas for improvement (Commonwealth of Australia 2011, p. 21). Studies from the United States (US), cited in a review of graduate education, suggest employers want a greater emphasis on wider skills (Wendler *et al.*, 2010, pp. 35-6); other reports have raised similar issues (OECD 2011, pp. 105-6).

Some studies have pointed to potential gaps in training opportunities. For instance, the European Science Foundation (ESF) suggested that post-doctoral researchers have not been a key target for training programmes, with such researchers more often participating in other activities such as workshops, conferences and practical courses (2009, p. 22-23). A 2009 survey of research staff in higher education institutions in the UK found that there was strong interest in undertaking training in areas related to personal or transferable skills, but relatively few researchers had so far participated in such training activities (Vitae, 2009). For example, 54% of research staff wished to undertake training on "career management", while only 16% had already done so. Similar patterns were found for training in the areas of "leadership and management" and "knowledge transfer and outreach activities", perhaps suggesting an unmet demand for training.

At the same time, researchers are not always interested in transferable skills training. The UK's Hodge Review (2010, p. 25) suggested that research staff may be less motivated to participate in skills training, compared to PhD students, as their priorities (reinforced by peer pressure) are on other tasks (*e.g.* developing their specialist knowledge, publishing, seeking funding, etc). Vitae's survey results pointed to a potential lack of demand for some types of training; for example, more than 50% of researchers said training in team-working was of no interest to them. This prompted Vitae to recommend that higher education institutions should "further promote the value of transferable skills (such as team-working) for future employability in order to increase the level of take-up of development activities" (Vitae 2009, p. 26). De Grande *et al.* (2011) found doctoral candidates undervalued skills such as teamwork for their career development, compared to employers' valuations of such skills.

There may also be room for increasing the wider relevance and quality of training offerings. The Australian Government commented that universities have had little incentive to incorporate the needs and potential contributions of employment sectors other than academia in their research training activities (Commonwealth of Australia 2011, p. XII). It saw a need to ensure that training keeps pace with the changing nature of research activity and the employment environments in which it occurs (p. 21). The OECD (2006) suggested that there was scope to bring PhD training closer to market needs, and that training that helped young productive researchers to achieve independent researcher status would be beneficial. More specifically, the study by Vitae (2009) found relatively high percentages of researchers who had undertaken training in some areas of personal and transferable skills (*e.g.* career management), but had not found it useful. Improving the content and delivery of transferable skill training could make such training more attractive to researchers. Along similar lines, the Australian Government suggested that inter- and intra-institutional variations in the quality of students' research environments and the standard of resources provided to support their study could compromise their learning (Commonwealth of Australia, 2011, p. 21).

**Defining the scope of the study**

6. "Transferable skills" is a term that can span numerous competencies, and its precise definition can differ from study to study. Terminology also differs; for instance, the terms "generic competencies", "transversal competences" and "professional skills" are sometimes used to describe certain transferable skills. Drawing on definitions proposed by the European Science Foundation (ESF) (2009, p. 47)[2], the current study uses the following general definition of transferable skills:

> Transferable skills are skills learned in one context (in this case, research) that are useful in another (for example, future employment whether in research, business, etc). They can serve as a bridge from study to work and from one career to another, as they enable subject- and research-related skills to be applied and developed effectively in different work environments. They include skills such as communication skills and organisational skills.

7. As a guide, this study refers to the ESF's list of 17 transferable skills, ranging from practical skills such as grant application writing skills through to more abstract skills such as creativity (ESF 2009, p. 48). For the purposes of the current analysis, these skills were grouped into six broad categories, yielding a broad typology of "transferable" skills (Table 1).

**Table 1. Transferable skills**

| Transferable skill category | Skills included: |
|---|---|
| Interpersonal skills | * Working with others/teamworking<br>* Mentoring and supervisory skills<br>* Negotiating skills<br>* Networking skills |
| Organisational skills | * Project and time-management skills<br>* Career planning skills |
| Research competencies | * Grant application writing skills<br>* Research management and leadership<br>* Knowledge of research methods and technologies beyond the Doctoral project<br>* Research ethics and integrity |
| Cognitive abilities | * Creativity and the ability for abstract thought<br>* Problem solving |
| Communication skills | * Communication/presentation skills, both written and oral<br>* Communication/dialogue with non-technical audiences (public engagement)<br>* Teaching skills<br>* Use of science in policy-making |
| Enterprise skills | * Entrepreneurship<br>* Innovation<br>* Commercialisation, patenting and knowledge transfer |

Source: Skills drawn from ESF (2009), grouped into categories by OECD.

8. "Formal training" refers to training that is organised, systematic and, for the purposes of this study, has an explicit aim of building transferable skills in training recipients. This would include, for example, courses of study undertaken in universities, workplaces and other organisations, where participants learn about and improve their capabilities in transferable skills. Such formal training could be

[2] The ESF has moved from the term "transferable skills" to "professional skills" in its work on research careers, to help mark a change in its focus from the academic sector (particularly, doctoral candidates and post-docs) to researchers more broadly (Scholz, 2011). This study draws on the ESF's definition of "transferable skills" and encompasses researchers in all sectors. Issues with defining different groups of skills were highlighted in previous RIHR work on skills for innovation and research (OECD, 2011).

provided by academic institutions, specialised training providers, or other entities. Formal training for transferable skills does not include acquiring skills as a part of everyday activities or usual academic classes (such learning could be classed as "informal" training). Workplace experience programmes (*e.g.* student work experience, or "industrial PhDs"), which could perhaps be categorised as "formally organised informal training", are not a central focus of this study. However, selected policies are discussed in the companion paper, where countries identified these as particularly relevant in their policy questionnaires.

9. Finally, the term "researcher" as used in this study encompasses doctoral candidates, post-doctorates (defined as doctoral graduates in their first 2 years of research work after graduation), other early stage researchers (defined as non-doctorate holders in their first 2 years of research work) and research personnel (defined as research staff who have been in the research workforce for more than 2 years).[3] The intent is to identify researchers at different career points (Box 2 describes task- and job-related definitions of researchers in more depth), taking into account that there is not necessarily a linear progression from doctoral studies to research jobs. Doctoral graduates are employed in other occupations besides research and, in fact, the majority of researchers do not hold a doctoral degree (Auriol 2010, p. 16). The companion paper describes examples of formal training in transferable skills for masters-level students, where this is a significant policy focus for countries. However, the general term "researcher" as used in this study does not include this latter group.

**Box 2. Defining researchers**

The Frascati Manual provides definitions of R&D personnel, including researchers, for the purposes of gathering statistics. The definitions are used to measure the human resources dedicated specifically to R&D, although these personnel also undertake non-R&D activities such as production, quality control, education and management (OECD 2002, p. 20). In the Manual, researchers are defined as professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned (*ibid*, p. 93). This definition includes postgraduate students at the PhD level engaged in R&D.

The Canberra Manual (OECD, 1995) can be used to identify the occupations encompassed by the Frascati definition of researchers. Here, researchers include physicists, chemists and related professionals, mathematicians, statisticians and related professionals, computing professionals, architects, engineers and related professionals, life science professionals (*e.g.* biologists, pharmacologists and agronomists), health professionals (except nursing), college, university and higher education teaching professionals, business professionals, legal professionals, archivists, librarians and related information professionals, social science and related professionals (*e.g.* economists, sociologists and historians), and research and development department managers. These groups are drawn from ISCO-88[1] groups 21, 22, 23 and 24, plus group 1237.

1: Note that ISCO-88 has been updated to ISCO-08. A correspondence table is available at www.ilo.org/public/english/bureau/stat/isco/isco08/index.htm.

### *How big is the researcher population?*

10. The number of researchers and their sector of employment differ considerably by country. Figure 1 shows that the physical number of people employed as researchers, working full- or part-time, ranged from less than 3 000 in Luxembourg to over 890 000 in Japan.[4] Headcount data is not available for China or the United States; however, in full-time-equivalent (FTE) terms, these countries each had over

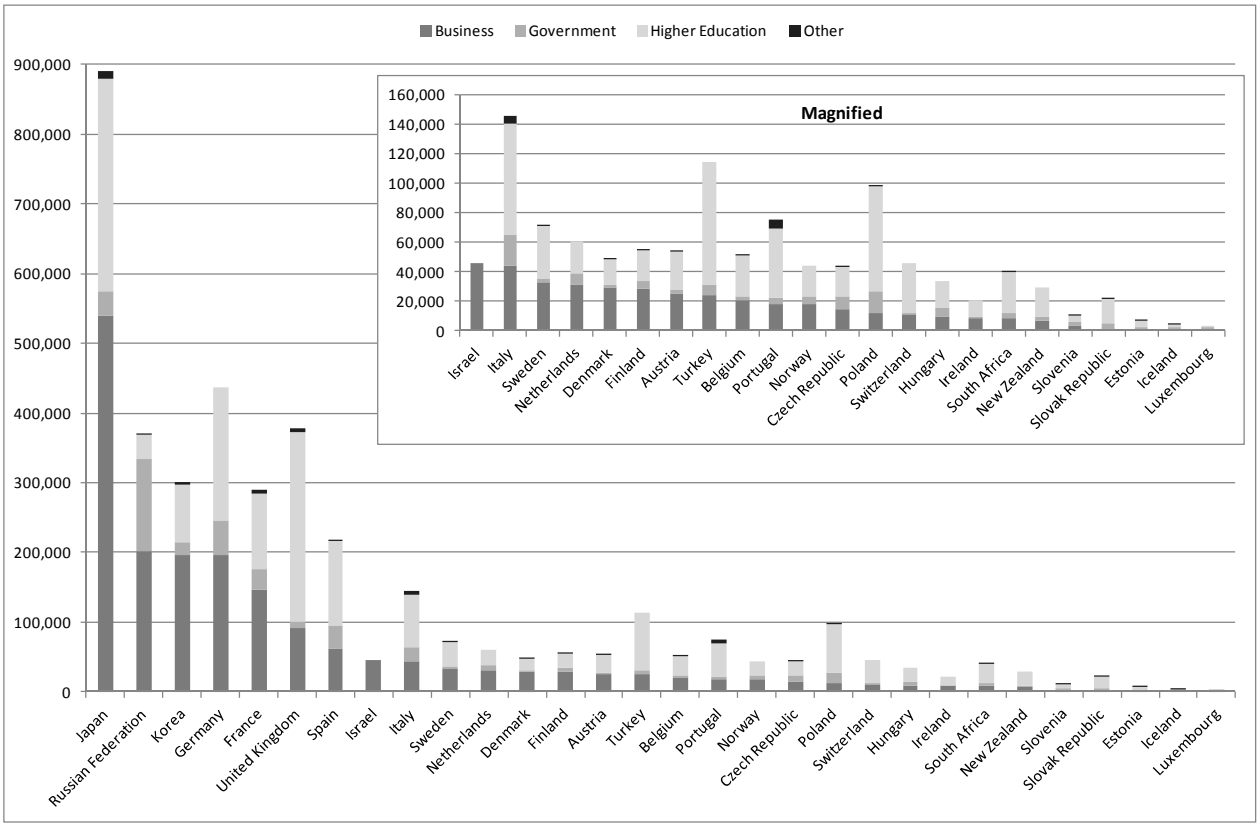
3 Note that definitions of the terms "post-doc" and "early-stage researcher" may differ between countries.

4 The charts in this section show available data for OECD member countries, as well as other major economies, where possible.

1.4 million researchers in 2007.[5] As a measure of the total number of people who are currently involved in research activity (roughly 4 million in total for the countries featured in Figure 1, plus at least 2.8 million from China and the United States), the data indicate how many individuals could potentially be affected by policies related to researcher training. Using the headcount measure of researchers, countries such as Denmark, Japan, Korea and Luxembourg had a relatively high share (over 60%) employed in the business sector. Other countries instead had relatively high shares of researchers in the higher education sector, over 60% in the case of Estonia, New Zealand, Poland, Portugal, the Slovak Republic, South Africa, Sweden, Turkey and the United Kingdom. The share employed in the government sector was generally small; only Iceland, Luxembourg, the Russian Federation and the Slovak Republic had more than 20% of researchers in this sector.

**Figure 1. Researchers by sector of employment (headcount)**

2008 or nearest year, available countries




Note: "Other" category calculated as a residual. 2007 data for Austria, Belgium, Germany, Luxembourg, the Netherlands, New Zealand, Sweden, United Kingdom and South Africa. 2009 data for the Czech Republic, the Slovak Republic, Turkey and the Russian Federation. Headcount data not available for China or the United States.

*Source*: OECD Main Science and Technology Indicators database, February 2011.

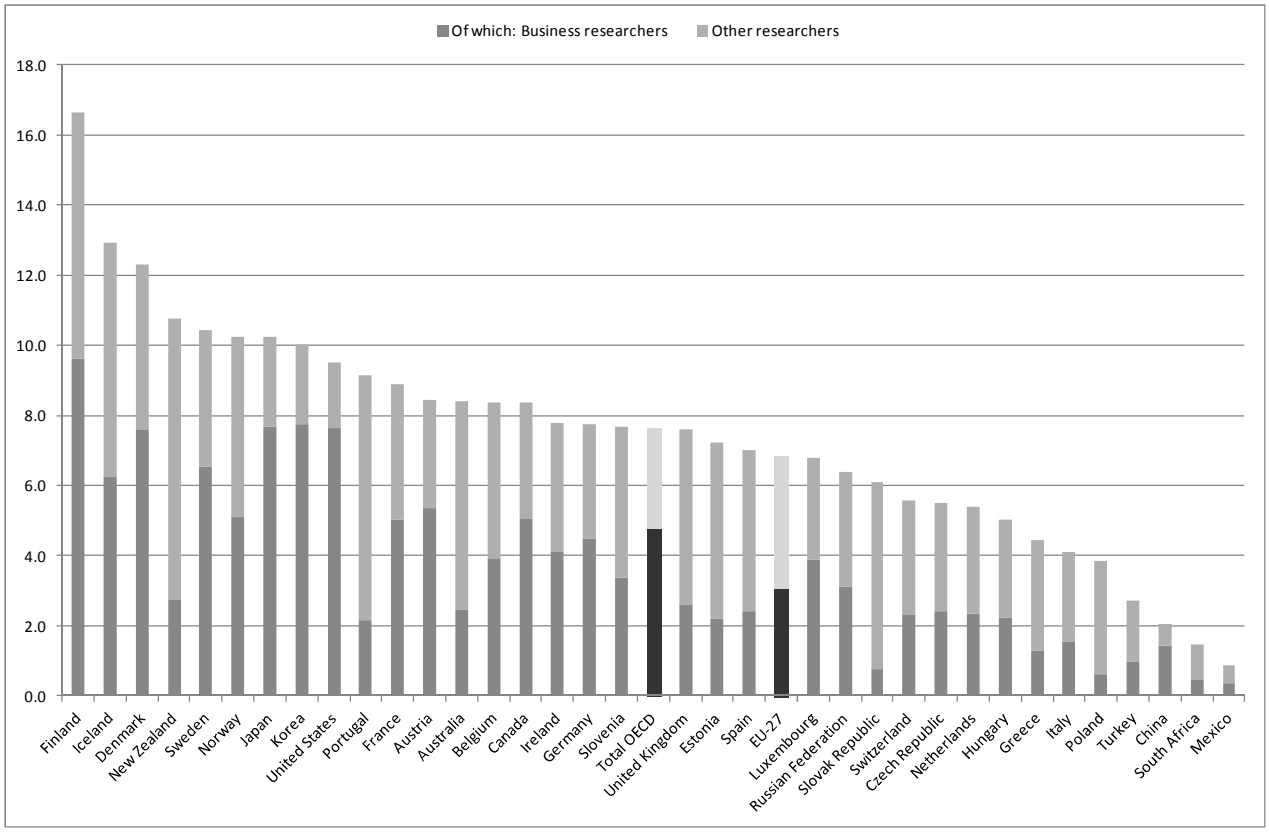
11. Figure 2 presents researcher numbers as full-time-equivalents (FTE) and compares these to total employment in each country. It shows that large absolute numbers of researchers do not necessarily translate into large researcher shares of employment. While Japan, the Russian Federation, Korea, Germany and France had the biggest groups of full- and part-time researchers in Figure 1 (along with China in FTE terms), the relatively small countries of Denmark, Finland, Iceland, New Zealand and

[5] Chinese data do not correspond exactly to the Frascati Manual recommendations.

Sweden had the biggest shares of researchers in total employment. There were more than 16 researchers per 1 000 employees in Finland in 2009, for instance, compared to an OECD average of less than 8. When measured in FTE units, the number of countries with a relatively high share of researchers in the business enterprise sector increases – Australia, Canada, China, Denmark, Japan, Korea, Sweden and the United States had more than 60% of researchers employed in the business sector (the OECD average was 63%). These patterns reflect aspects of countries' industrial structures, such as the presence of R&D-intensive sectors in the economy and the share of higher education in overall employment, as well as the incidence of part-time employment in each sector.

**Figure 2. Total researchers (FTE) per thousand total employment**

2009 or nearest year, available countries



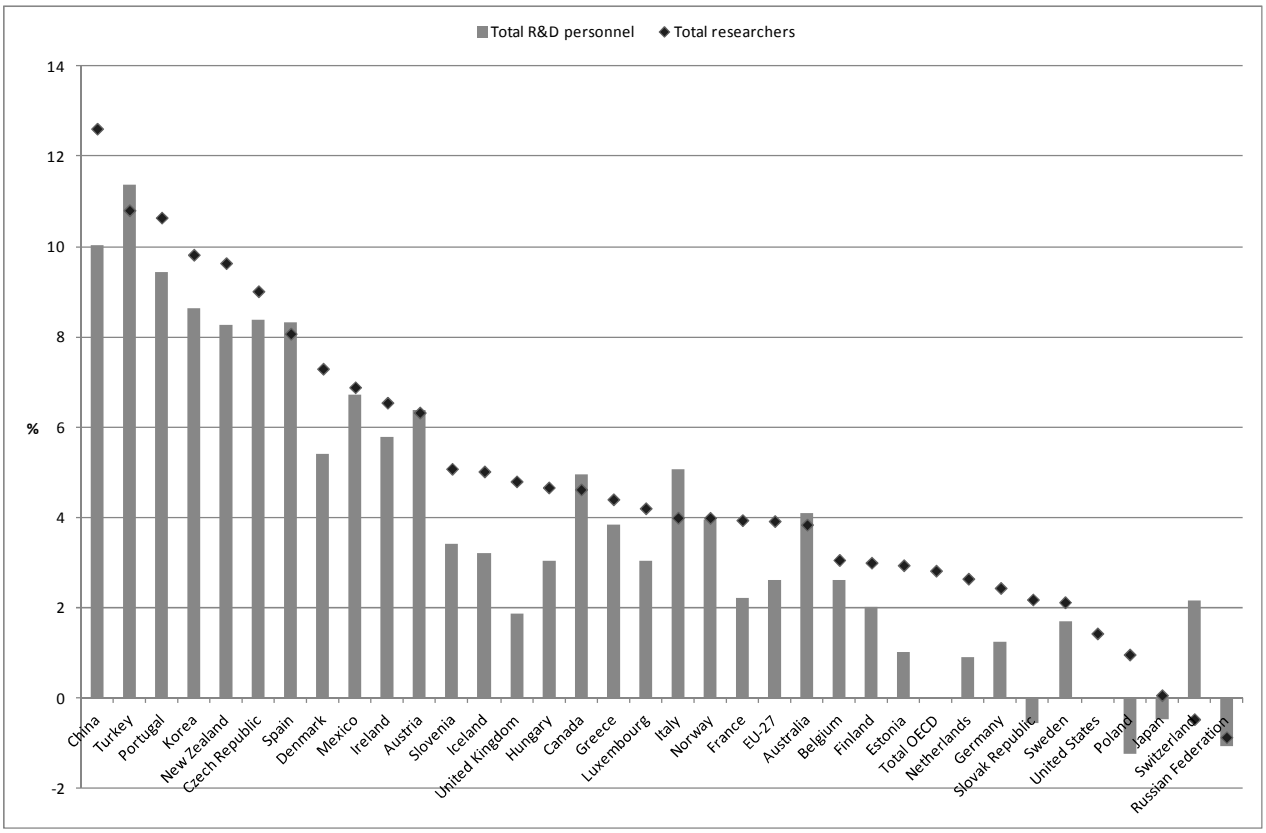

Notes: 2007 data for Canada, Greece, Mexico, New Zealand, United States, South Africa and the OECD aggregate. 2008 data for Australia, France, Iceland, Japan, Korea, Switzerland and China. Chinese data do not correspond exactly to the Frascati Manual recommendations. 2010 data for the United Kingdom.

*Source*: OECD Main Science and Technology Indicators database, February 2011.

12. Figure 3 shows that researchers as a group have been growing strongly in many countries. While China stood out with growth of over 12% per year, diverse countries including Denmark, Korea and New Zealand also had rapid growth of more than 6% annually in researcher numbers. Growth of researchers was faster than that of R&D personnel (researchers plus other related staff) in most countries. This may be partly due to rapid growth in post-graduate student numbers, as well as rebalancing between research and administrative staff groups. Growth in the total number of researchers is relatively responsive to business R&D spending (OECD 2010, p. 44); rapid increases in the intensity of business enterprise R&D expenditures in countries such as China, Korea and Turkey over the past decade accord with the growth in researchers seen below.

**Figure 3. Growth of R&D personnel and researchers (FTE), 1998-2008 (or nearest period)**

Compound annual growth rate (%), available countries

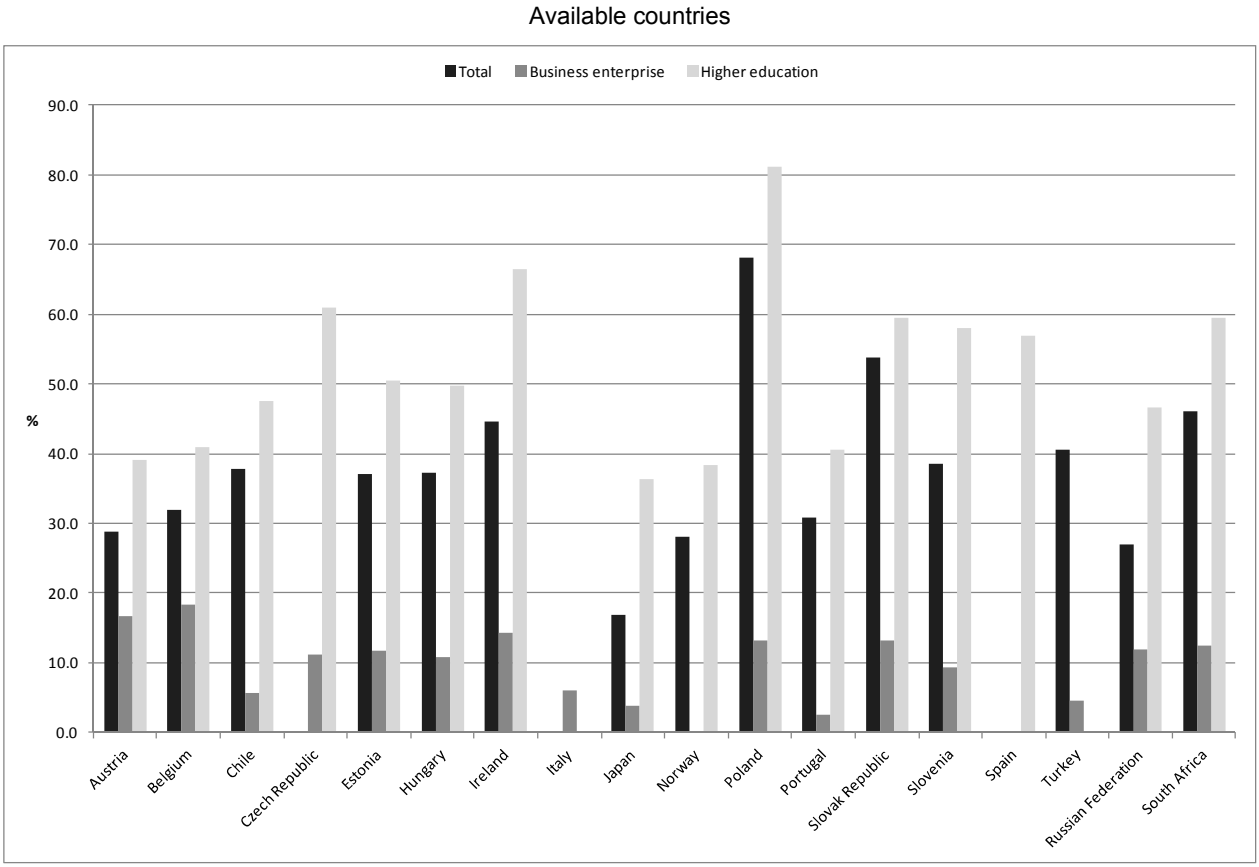



Note: For both data series, Canada 1998-2007, Denmark 1999-2008, Greece 1999-2007, Luxembourg 2000-2008, Mexico 1998-2007, New Zealand 1999-2007, Norway 1999-2008, Sweden 1999-2008 and Switzerland 2000-2008. For the data series on researchers, United States 1999-2007 and OECD aggregate 1999-2007.

*Source*: OECD Main Science and Technology Indicators database, February 2011.

13. Figure 4 shows the percentage of researchers with doctoral qualifications, in total and by sector, and illustrates the point made earlier that many researchers do not hold doctorate degrees. In general, for those countries with data, less than 50% of total researchers have doctorates, with Poland and the Slovak Republic being the exceptions. The share of researchers with doctorates is larger in the higher education sector, and for the countries shown, the share of business sector researchers with doctorates is often less than 40%.

**Figure 4. Percentage of researchers (headcount) with a doctoral degree, by sector, 2008 or nearest year**




Note: Austria, Belgium and South Africa – 2007 data.

*Source*: OECD Research and Development database, March 2011.

14. Together, these data reveal a small but growing and "employment-significant" group of people who may be affected by government- and institute-level policies on transferable skills training.

**Transferable skills for diverse careers and better research**

15. Empirical studies show that researchers follow a variety of career paths once they enter the workforce. Data on doctoral degree holders, for instance, show that careers in academia are important, but that many other options are also available, both in terms of the sector of employment and the type of work done. For example, in an analysis of 12 countries participating in the OECD/UNESCO Institute for Statistics/Eurostat project on Careers of Doctorate Holders (CDH), Auriol (2011) found that the share of recent doctoral graduates[6] employed in the higher education sector ranged from 21% in Austria to over 80% in Poland while the business sector employed more than a third of graduates in Austria, Belgium and the US. Similar results finding researchers in a range of non-academic positions have emerged from other studies also (Box 3). Participants in the European-level DOC-CAREERS study concluded that career paths of doctorate holders are highly diverse both within and outside academia and cannot easily be slotted into a typology (EUA 2009, p. 71).

6 The study focused on those who had earned their doctoral degrees in the period between 1990 and 2006.

**Box 3. Where are doctoral holders working?**

Case studies conducted for the European-level DOC-CAREERS project suggested that 50% of current doctoral holders are employed outside academia, holding both research and non-research positions in businesses, governments, service sectors and other education sectors (EUA 2009, p. 7). The report pointed out that not all doctoral candidates can or want to work in academia; doctoral-level education is simply seen by some individuals as the best possible training in their field and as good preparation for a variety of career paths (*ibid*, p. 71).

A survey of doctoral graduates in the UK reinforced that a variety of pathways may be taken by researchers. The survey provided details of doctoral graduates' employment and work characteristics approximately three and a half years after graduating (Vitae, 2010). While half of respondents were working in the higher education sector or in schools, colleges or training providers, doctoral graduates were also employed in a wide variety of other sectors, including health and social work (13%), finance, business and IT (11%), and research and development (9%). Teaching and lecturing was the most common occupation (27% of respondents), followed by scientific research, analysis and development (19%), other professional, associate professional and technical occupations (17%) and commercial, industrial and public sector managers (10%). Ninety per cent of respondents reported that they were very satisfied or fairly satisfied with their career to date.

Studies outside Europe provide similar insights. For example, in 2006, only 26% of doctorate-qualified people in Australia were employed as university and vocational education teachers, and only 28% of recent doctorate graduates in 2008 were employed in higher education (Commonwealth of Australia 2011, p. 22). The rest had found employment in a wide range of other public and private industry sectors. Data from the US show most doctoral degree holders work in occupations in service industries, generally professional, scientific and technical services or in government (Wendler *et al.*, 2010, p. 19). The share, however, differs by field; data show doctoral recipients in engineering and physical sciences are much more likely to work outside academia than those in social sciences and humanities (*ibid*, p. 17). International students (those holding temporary visas) were more likely to hold positions in industry than academia, compared to US citizens (*ibid*, p. 25).

16. A number of studies and statements at a national- and cross country-level have identified the acquisition of transferable skills as an important support for researchers' career diversity. The commentary mainly focuses on the implications for doctoral education of wider career choices and calls for increased inclusion of transferable or "workplace-relevant" skills in doctoral programmes (Box 4). These skills are seen as vital to boost graduates' employment prospects in the broader job market and to help them pursue a diverse range of professional paths. In a comparative study of seven national research systems, for instance, Technopolis commented that "utilisation and employability are new keywords beside scientific quality" in research training (2011, p. 18). Similarly, the Australian government suggested that changes in the way research is conducted and the variety of sectors in which researchers are employed "demands a contemporary approach to research training which continues to focus first and foremost on the development of the 'scholar' but places increased emphasis on the 'employee' and 'innovator' (Commonwealth of Australia 2011, p. 22). In addition, ongoing learning opportunities beyond initial training are also crucial for researchers facing more diverse careers. As noted by Wendler *et al.*, many individuals have sequential careers requiring training and retraining (2010, p. 43).

17. Evidence related to employment supports the importance of transferable skills. Sixty per cent of doctoral graduates responding to a survey conducted in the United Kingdom (UK) said they used the generic skills developed as a research student most of the time in their work (Vitae 2010, pp. 34-37). This was particularly true for graduates in social sciences, physical sciences and engineering and for those employed in research occupations, whether in higher education or another sector. Vitae noted this finding aligned with the increasing focus on developing researchers' personal and professional skills in addition to their specialist skills. Employers have expressed their needs for graduates with relevant skills and knowledge, including business, communication and leadership skills (see, for example, OECD 2011, CIHE, 2010).

**Box 4. Transferable skills for diverse careers**

Studies at the European level have clearly identified transferable skills for researchers as a crucial underpinning for diverse careers. In the early stages of launching the European Research Area, a European Commission Communication related to researchers noted that research is increasingly conducted in "non-academic" institutions such as companies, non-profit organisations and independent research centres, and that researchers needed to be trained and prepared to enter this wider job market (EC 2003, p. 14). The document highlighted some of the consequences for doctoral programmes, including enhancing employability of researchers through including wider employment related skills (*e.g.* research management, communication skills, networking and team-working) in training. Similarly, the ESF (2009, p. 12) noted that research careers are now less path-dependent and more likely to develop into "portfolio careers", and that only a small fraction of doctoral candidates continue to an academic career. It concluded that researchers in all sectors require competencies beyond simply being a good researcher and that it is essential for researchers to acquire transferable skills throughout their careers. Later, the EUA reaffirmed the importance of offering training in transferable skills, including understanding the ethics of research, and recommended this be a priority for doctoral schools and programmes (2010).

Other analyses have likewise pointed to the importance of transferable skills for researchers' careers. Acknowledging the growing trend for research careers outside academia, one of the seven key "aspirations" of Australia's Research Workforce Strategy is that higher degree by research graduates have the skills and attributes to "engage in world-class research and make productive contributions in a wide spectrum of professional roles" (Commonwealth of Australia, 2011). In an analysis of the future of PhDs, the journal Nature (2011, pp. 277-8) highlighted countries such as Germany and Singapore, where doctoral graduates go on to diverse careers and where training is seen as advanced preparation for employment in a wider workforce outside academia. In Germany, many PhD students follow structured courses in topics such as presentation, report writing and other transferable skills. Fiske (2011) suggested that focused training in areas such as communication and business basics "would go a long way towards strengthening the capabilities of PhD students and improving their career prospects". In the US, an analysis of graduate education highlighted how Masters-level degree programmes are increasingly combining theory, practical application and workplace skills (such as critical thinking) so as to open up more choices for students in business, government and non-profit organisations (Wendler *et al.*, 2010, p. 18).

18. Besides helping researchers to pursue fulfilling and diverse careers, transferable skills may also contribute to better research outputs. The Korean Institute of R&D Human Resource Development (KIRD, 2010) suggested that transferable skills can help to maximise research outputs by enabling research personnel to become more effective in their research work, as well as helping researchers to be adaptable and flexible in an increasingly mobile and global research environment.

19. One area where transferable skills may be increasingly important is in collaborative and cross-discipline work, including that undertaken in teams. At a general level, the European University Association (EUA) suggested that the capacity of researchers to communicate with others is essential for interdisciplinary work (2009, p. 87). At a team level, Mann and Marshall (2007) noted that the increased emphasis on multidisciplinary project teams at Australia's CSIRO required team leaders to successfully manage and motivate staff from a range of scientific disciplines who may be working together for the first time. In the face of an increased emphasis on collaborative, multi-disciplinary and globally-oriented approaches to research activity, the Australian Government is reassessing training programmes and researchers' preparedness for diverse careers (Commonwealth of Australia 2011, p. 11). More broadly, diagnostics on team effectiveness at CSIRO showed that the most significant differentiators between the most and the least effective teams were soft skills/interpersonal factors, such as trust, goodwill and co-operation, and leadership (Mann and Marshall, 2007). Mann and Marshall considered that leadership development and learning about conflict resolution, brainstorming, team learning and creative dialogue would have positive impacts on trust within teams, and that this would contribute to better knowledge flows and team performance.

20. Transferable skills such as communication and networking could also contribute to more effective dissemination of research and, thus, potentially enhanced use and uptake of research by other parties. The study of teams at Australia's CSIRO identified advocacy, sponsorship and strategic communication with external stakeholders and the public as important new roles for its team leaders, in order to support socio-economic integration of scientific research (Mann and Marshall, 2007).

21. Ultimately, improving researchers' transferable skills may help generate innovation and improved economic outcomes. The European Union put great weight on the quality of its human resources in achieving its *Innovation Union* aspirations. Its analysis identified skills such as creativity, entrepreneurship, teamwork, risk-taking and project management, as essential "in order to increase the innovation performance of individuals, to improve the competence of private and public organisations, to facilitate knowledge and technology transfer, and thus to improve the overall competitiveness and the attractiveness of Europe as a region" (EC 2010, p. 34). Similarly, the OECD (2011) found various "generic" or "soft" skills, as well as managerial and entrepreneurial skills and creativity, are frequently mentioned as important skills for people to contribute to innovation. Highlighting the importance of communication and teamwork, Herrmann and Peine (2011) found that the innovative capacities of scientists stemmed partly from exchanging ideas with their colleagues, and that interactions between adequately skilled employees and knowledgeable scientists were an important source of innovation.

22. National governments have also made the link to enhanced research and innovation outcomes. Policy directions in the UK have recognised the importance of researcher development to overall R&D capacity, with the allocation of around GBP 20 million per year between 2003 and 2010 for career development and transferable skills training across all research disciplines (Hodge Review, 2010, p. 9). The Impact and Evaluation Group (2010) stated that "researcher development provides a key enabling link from knowledge creation to pathways to impact". It concluded that researcher development was a crucial component in realising the potential of research and maximising outcomes from research funding, as well as benefiting individual researchers. It highlighted the opportunities for further work to link researcher training and economic impact, via longitudinal data exploration. The Australian Government stated that the combination of highly specialised skills with more generic, high-level cognitive and technical capabilities had enabled researchers "to contribute to some of the most transformative innovations developed in Australia in recent times" (Commonwealth of Australia 2011, p. 1). It noted that research and its application are often intertwined and researchers are increasingly exposed to commercial product and process development and the intellectual property and financial frameworks in which this occurs (p. 22).

**Acquiring transferable skills – the role of formal training**

23. Transferable skills are a valuable asset for researchers' careers and research work, but how should these skills be acquired? This section expands on the role of formal training as a tool for preparing researchers for the variety of activities that they must undertake in working life. For two broad researcher groups – doctoral candidates and researchers in the workplace (*i.e.* post-doctoral graduates, other early stage researchers and research personnel) – it discusses why transferable skills ought to be acquired and why formal training is a useful tool for this.

***Training for doctoral candidates***

24. Doctoral candidates benefit from acquiring transferable skills during their studies, as they aid with successfully completing the doctoral project and in gaining employment after graduation. In a survey of doctoral students and post-doctorates, perceptions of the skills required for a PhD included a number of transferable skills such as time management, writing skills, oral presentations, research skills (data gathering), teaching, interpersonal skills and computer skills (Pritchard *et al.*, 2010). Interviews with companies have shown that skills and attributes such as "originality and creativity", "team player" and

"explain and communicate to non-specialists", are highly valued alongside technical proficiency (EUA 2009, p. 86). These transferable skills are seen as vital for enabling researchers to play managerial roles, to react quickly and effectively to unforeseen situations and to be flexible. There are also wider benefits from acquisition of transferable skills at the doctoral level. For instance, Gilbert *et al.* (2004) concluded that a key purpose of research degrees is to allow students to contribute to technological, economic, social and cultural pursuits beyond the university, and to the extent that both disciplinary research skills and generic skills of application and exploitation are part of this, then both are clearly important.

25. While some transferable skills may be acquired informally during doctoral studies, the massification of post-graduate education means that formal training in transferable skills is becoming more useful. In the UK, the Hodge Review suggested that increasing numbers of postgraduate researchers have put pressure on conventional "apprentice-master" relationships that traditionally comprised researcher training, making formal training approaches more important (2010, p. 11). The traditional approach may also have delivered variable quality training – the Hodge Review noted that such training relied heavily on the personalities involved and the environment faced by individual researchers. In a number of countries, such issues have supported the growth of graduate and doctoral schools, which are specific organisational structures that cater for the needs of post-graduate and/or doctoral students, including provision of transferable skills training (Box 5).

**Box 5. Graduate schools and transferable skills**

The concept of graduate schools emerged in North America in the 1960s (Denicolo *et al.* 2010, p. 15) and has since expanded to a number of other countries. Graduate schools are usually organised across the whole of a university, while doctoral schools (a similar construct) tend to be organised along thematic lines and can cross disciplines and institutions (LERU 2010, p. 9). These schools typically provide a range of support for post-graduate students, including opportunities for training in various generic or transferable skills. For instance, doctoral schools were created in France in the early 1990s, to develop "soft skills" to facilitate the entry of new doctoral graduates on the labour market (Auriol, 2011, p. 6), while in the UK, over 75% of universities now have graduate schools, with the majority having a high degree of involvement in generic skills training programmes (Denicolo *et al.* 2010, pp. 19 and 29). A recent study of Canada, Denmark, Finland, the Netherlands, New Zealand, Sweden and the UK found that post-graduate education is increasingly delivered in graduate or research schools; this training is often multi-disciplinary, with organised networking activities and covering skills beyond the academic specialty (Technopolis 2011, p. 14).

26. Formal training in transferable skills may be a particularly valuable learning opportunity for female and international students, whom governments are often interested to encourage in post-graduate studies. In a study of late-stage PhD students in science, engineering and medical disciplines at Imperial College, London, Walsh *et al.* (2010) found that higher shares of female and overseas students considered opportunities for transferable skills training to be of high importance, compared to male and domestic students. It was suggested that females may perceive academic careers more broadly than men, and thus value transferable skills more highly; another suggestion was that women may have more difficulty accessing networks or mentoring and may obtain additional benefits from training. Walsh *et al.* proposed that the language and cultural adjustment issues experienced by some international students might also lead to greater gains being drawn from training opportunities.

27. Formal training during doctoral studies may also actively foster positive attitudes towards ongoing learning. The Impact and Evaluation Group (2010) found a focus on transferable skills training, and the resulting increase in programmes offered to researchers, had "changed the culture" within institutions; researchers and supervisors saw the benefits of transferable skills training and were positive towards the generic skills agenda. At a programme level, the study by Walsh *et al.* (2010) reported that participants in a residential training course developed more positive attitudes to skills training.

28. However, identifying the appropriate balance between transferable skills training and core research work is a difficult task; a unique approach will not suit all. Students appear to value transferable training opportunities, as evidenced by their voluntary attendance (Walsh *et al.*, 2010) and their positive feedback (Gilbert *et al.*, 2004). Walsh *et al.* (2010) also suggested that supervisors are becoming more positive, as graduate schools and other parties become more effective in describing the value and impact of training. Indeed, with respect to academic careers, Technopolis (2011, p. 19) advocated transforming research education to include more utilitarian skills and moving acquisition of the scientific specialisation necessary for ongoing academic work to the post-doctorate career stage. Nevertheless, some academics and students still consider skills training a distraction from core research work. Industry employers also differ in their emphasis on transferable skills; for instance, the EUA found that small- and medium-sized enterprises (SMEs) put a higher value on doctoral graduates having "soft skills" that complemented their research capabilities, than did large R&D companies for which "the value of hiring a doctorate holder usually lies, in the first instance, in a deep knowledge of a relevant subject and broader competencies that are likely to equip the person to handle subsequent career challenges" (EUA 2009, p. 8).

29. The balance between study components will be partly shaped by views on the desired portfolio of transferable skills to be taught to students. There is still uncertainty about which skills are most useful at different points of a researchers' career, indicating that student choice over training options should be a key feature of training agendas (Box 6). For some transferable skills, there are also concerns that formal training in educational establishments is "out of context" or too abstract, suggesting that such skills are more effectively acquired in the workplace. In some instances, these concerns may be met by better integrating skills training into students' courses; "embedding" transferable skills is an increasingly popular approach[7], although what this practically involves differs across institutes and programmes. In other instances, different teaching styles may be useful. In both cases, the quality of practitioners is vital to the success of the training.

**Box 6. Different skills for different career stages?**

There appears to be no unique view on which transferable skills are most needed at different career stages. The ESF (2009, p. 13) stated that knowledge gaps remain regarding "what kinds of skills are especially beneficial to the career development of researchers at a given stage". The transferable skills studied by the ESF were considered widely relevant, although it noted the relative importance of certain skills may vary over time (*e.g.* research leadership might become increasingly important in later career stages) (ESF 2009, p 48). Education institutions also question themselves about the appropriate mix of skills to deliver to students. Gilbert *et al.* (2004) speculated whether some skills such as writing, communication and basic research skills ought to be established before entrance to doctoral programmes, and whether some work-related skills should be delivered in a post-degree pre-vocational course. In the UK, the Concordat to Support the Career Development of Researchers (2008) suggested that employers and funders of researchers consider articulating the skills that should be developed at each stage of their career development frameworks and encourage researchers to acquire and practice these skills. However, it did not identify specific skill-career stage matches. Surveys of students provide some evidence on required skills, although these surveys often have small sample sizes and their results may be strongly driven by students' assessment requirements. Years of experience appear to influence the skills required; Pritchard *et al.* (2010) found students in their first and second years identified technical skills (*e.g.* learning to operate equipment) as important, third year students identified communications skills (particularly thesis writing and communicating with non-academics), while post-doctorates identified people management skills. Leggett *et al.* (2004) also found that students' perceptions of skill importance differed by year; they suggested that this was closely related to the assessment framework and the tasks set for students.

7 For example, in its research workforce strategy, Australia stated its aim to embed the development of transferable skills into university research training programmes to support researchers in a wide range of employment contexts (Commonwealth of Australia 2011, p. 25). The Hodge Review (2010, p. 15) also stated a long term aim of generic skills development that is embedded in research degree programmes and is part of normal staff development for research staff.

Nonetheless, there have been some attempts to explicitly set out skill requirements at certain career points. For example, the Joint Skills Statement (JSS) developed by Research Councils UK (RCUK) in conjunction with the UK GRAD programme in 2001, set out the skills that doctoral research students funded by Research Councils would be expected to develop during their training.[1] It included wider employment-related skills (*e.g.* communication and networking) although it stressed that the core element of training remained research skills and techniques. Recently, the JSS has been replaced by a Researcher Development Statement (RDS), which provides an up-dated perspective on the knowledge, behaviours and attributes that researchers need to work effectively and aims to give a common framework for researchers in UK universities and research institutes. The detailed Researcher Development Framework (RDF) that accompanies the RDS proposes 3-5 levels/phases of performance for each researcher characteristic – phases 1 and 2 generally map to doctoral-level requirements, although it notes that achievement is personal to the individual researcher.[2]

However, it is important to acknowledge that any categorisation of skills by career stage can only be a broad guide; researchers are a diverse group and so individual choice and control over training will be crucial. The Hodge Review (2010, p. 15) highlighted that researchers have different specialisations, employment arrangements, personal needs and backgrounds and that this influences the skills development required by individuals. Walsh *et al.* (2010) cautioned that training programmes must serve the needs of the whole population of research students, and that curriculum changes (*e.g.* to incorporate more enterprise training) should be implemented carefully. A similar argument was made by Craswell (2007), who felt that the tendency to view transferable skills training in the context of employability in a knowledge-based society could skew training towards the perceived needs of science students. For example, while courses in "research commercialisation" and "entrepreneurship" might hold strong appeal for some research areas, they may not be needed or desired by other sections of the research student body. Craswell also highlighted the diversity of research students across universities and cautioned against notions of best practice that are not sensitive to the local situation. Of relevance to OECD countries where international enrolments in higher education institutions are significant, Campbell (2010) noted that generic skills valued in one society may not be valued in the same way in others, due to different social and political contexts, cultures and opportunities. Leggett *et al.* (2004) noted several studies showing that the relative importance of skill categories differs across sectors – oral communication might be considered a key skill for business, for instance, while written communication might be more important within academia. Craswell (2007) highlighted that there are limits to transferability, even where skills training has been quite sophisticated – "skills will need to be adapted to accommodate workplace exigencies". Views expressed in the EUA's study of collaborative doctoral training supported voluntary transferable skills training, so that pre-existing skills would be recognised and unnecessary training that took time away from research would be avoided (2009, p. 93).

1. See www.vitae.ac.uk/CMS/files/upload/RCUK-Joint-Skills-Statement-2001.pdf (accessed 14 April 2011).

2. For information on the RDS and RDF, see www.vitae.ac.uk/policy-practice/234301/Researcher-Development-Framework.html. For details of the RDF, see www.vitae.ac.uk/CMS/files/upload/Vitae-Researcher-Development-Framework.pdf (accessed 20 May 2011).

30. Importantly, transferable skills training needs to complement other learning opportunities for students. The League of European Research Universities (LERU) suggested the core of doctoral education is research-based training via formal and informal meetings with the supervisor and peer researchers; this core is then complemented by more structured training events (2010, p. 9). Doctoral students and post-doctorates also identify their research groups and peer networking opportunities as important avenues for transferable skills acquisition (Pritchard *et al.*, 2010). Further analysis of research groups' and peers' contributions, and the way transferable skills training can best complement them, may be warranted. More generally, the EUA suggested researchers need to be more aware of the implicit acquisition of skills that takes place during their doctoral programme and to be able to convey these to potential employers (2009, p. 93).

### *Training for researchers in the workplace*

31. Post-doctoral graduates, other early stage researchers as well as more experienced researchers, all have incentives to acquire additional transferable skills during their working lives. For some, the skills obtained during doctoral studies may not be sufficient or may have a different focus to those required at work. A survey of recent UK doctoral graduates by Vitae (2010), for example, found that 47% had taken their current job to broaden their experience and develop general skills. It also found that many graduates

with jobs in non-academic settings had worked alone as students but in teams as professionals; this might suggest a potential need for skill development. In other cases, researchers may not have doctoral qualifications and may desire additional transferable skills to complement the competencies acquired at other education levels. In both cases, the variety in training received during tertiary studies may mean there are gaps in some researchers' skill sets. The ESF (2009, p. 20), for instance, noted that different faculties have different training requirements, leading to variation in the training syllabus and skills acquired by PhDs.

32. Like any professional, researchers also need to keep generally updating and building on their existing skills. This is formally recognised in several European policy documents. For example, the European Charter for Researchers considers training to be a responsibility for researchers and includes the principle that researchers should engage in continuing professional development to update and expand their skills and competencies (EC, 2005). Its principles on accountability, good research practice, dissemination and exploitation of results, public engagement and managerial duties also implicitly require good transferable skill levels. Consistent with the Charter, the UK's Concordat to Support the Career Development of Researchers (2008) also highlights the importance of training for working researchers. It requires signatories to recognise and promote the importance of researchers' personal and career development and life-long learning and calls on them to recognise the need for researchers to develop transferable skills, delivered through embedded training. The Concordat also includes the principle that individual researchers share the responsibility for pro-actively engaging in career development and life-long learning.

33. While learning-by-doing in the workplace is an important channel for gaining transferable skills, formal training can also add value. Supporting this, survey results reported by the UK's Vitae showed that while researchers gain skills through workplace experience (*e.g.* project management, presenting work at conferences), there are still a significant share of research staff who express interest in formally developing their leadership and management expertise, knowledge transfer and outreach skills, and broader research skills (2009, p. 36). This suggests that training is an important tool for skill upgrading which complements informal skill acquisition. As noted earlier, some skills are also more context-specific than others, and opportunities to undertake formal training in the work environment may be an effective way for researchers to attain these competencies.

**Roles and responsibilities in transferable skills training**

34. It is generally accepted that training for researchers, including in transferable skills, is a shared responsibility. For instance, the UK's Concordat (2008) between funders and employers of researchers shares responsibilities for ongoing learning between researchers and their managers and employers. This is consistent with the principles set out in the European Charter and Code of Conduct (EC, 2005), which also proposes particular roles and responsibilities for researchers, employers and funders related to career development. In Australia, the Research Workforce Strategy notes that while government plays a critical role in the development and deployment of a strong and productive research workforce, it is a shared responsibility relying on efforts from all levels of government, research employers, research training providers, professional associations, researchers and students (Commonwealth of Australia, 2011).

35. Ideally, roles and responsibilities in transferable skills training would be divided according to the benefits received and the knowledge held by different stakeholders. For example, in the standard analysis of education, training and lifelong learning, individuals fund their training in general skills that are portable across workplaces, while employers help fund training in workplace-specific skills that are of particular value to them (Bassanini *et al.*, 2005). With respect to doctoral studies, for instance, countries often exhibit a mixed model of finance, with contributions coming from universities, external research grants, state and private scholarships, companies and individuals (Technopolis 2011, pp. 15-16). This reflects the diverse

benefits that governments, institutions, employers and individuals gain from the pursuit of advanced research studies. Certain stakeholders may also have competencies or knowledge that puts them in the best place to design, fund, organise or deliver training activities. Some potential roles and responsibilities of stakeholders in transferable skills training for researchers are set out below.

***Government***

36. There are a number of potential roles for governments in transferable skills training, ranging from strategic oversight and co-ordination to funding. The Australian Government highlighted its role in monitoring the level and quality of skills supply in the research workforce, assessing where investments could be targeted and providing leadership in addressing challenges (Commonwealth of Australia 2011, p. 7). The EUA suggested governments were essential facilitators of workplace training for doctoral holders and should offer initiatives to address structural issues that could not be dealt with at an individual level (2009, p. 9). Its case studies suggested government involvement led to sustainability and enhanced quality. Scholz (2011) proposed that the role of government, compared to universities or individual researchers, was to provide quality assurance through a framework of skills programmes and to evaluate outcomes through impact measurement (*e.g.* career tracking). Funding could also be provided by government, although anecdotally researcher motivation and engagement in training may be higher when researchers participate in its financing. The Leitch Review (2006) also pointed to funding responsibilities for government with respect to basic skills and platform skills for employability. Governments may additionally play an important co-ordination role, to avoid unnecessary duplication and spur value for money. Support for central repositories of good practice, for instance, might be an area where governments can add value. The ESF (2009, p. 46) suggested funding organisations could support the delivery of transferable skills training through partnerships at the national and international level, and through exchanging good practices.

***Individuals***

37. Individuals have important responsibilities in transferable skills training, as they are best placed to recognise their own needs and organise their learning. The European Charter for Researchers considers training to be a responsibility for researchers and includes the principle that researchers should engage in continuing professional development to update and expand their skills and competencies (EC, 2005). Its principles on accountability, good research practice, dissemination and exploitation of results, public engagement and managerial duties also implicitly require good transferable skill levels. Similar principles are contained in the UK's Concordat (2008). For instance, researchers' responsibilities include developing their ability to transfer and exploit knowledge, to commercialise research and to engage in critical thought, and identifying training needs and opportunities for learning. Respondents to a survey undertaken by the ESF (2009, p. 49) indicated that the role of individual researchers was most important in procuring their own training. Participating in the funding of training is also important, to the extent that researchers gain from their own competency enhancement. Taking a stake in financing also increases the motivation to achieve and make the most of learning opportunities.

***Other stakeholders***

38. Besides governments and individual researchers, many stakeholders play a role in transferable skills training, including universities, research institutes and industry employers, and organisations such as research funding agencies and dedicated training organisations. Their potential responsibilities vary from indirect funding support through to hands-on delivery of training.

39. For instance, in the context of increasing the impact of funding, the UK's Warry Report (2006) recommended that Research Councils encourage universities to make enterprise training available to

researchers in all disciplines, so as to support knowledge transfer activities. Also in the UK, the Hodge Review considered that all funders of research should contribute financially, either directly or indirectly, to the skills and career development of PhD students and research staff (2010, p. 21). Earlier, the Roberts Review recommended that funding to higher education institutions be conditional on these institutions ensuring postdoctoral researchers had career development plans and access to appropriate training opportunities (2002, p. 13).

40. Organising appropriate training can be another key responsibility. For instance, respondents to a survey undertaken by the ESF (2009, p. 49) saw research organisations taking the lead role in skills training, particularly in its management and delivery. In the UK's Concordat (2008), employers and funders are asked to recognise researchers' needs for transferable skills, delivered through embedded training, that help researchers to stay competitive in internal and external job markets. A study of graduate education in the US suggested that graduate schools must provide training, mentoring and information for non-academic career options and integrate workplace training needs into their graduate education programmes (Wendler *et al.*, 2010, p. 42). It considered that to be globally competitive, US universities must develop professional education programmes that encourage creativity and entrepreneurship, personal effectiveness, project management, ethics and other skills than enhance research impact (*ibid*, p. 44). Mann and Marshall (2007) noted that Australia's CSIRO's extensive use of teams as a vehicle for research led it to invest heavily in team training and development.

41. Co-ordination between stakeholders can be crucial to good training outcomes. For example, the Hodge Review (2010, p. 22) underlined the importance of routine interaction between research organisations and employers (or other stakeholders) when designing skills strategies and programmes, so as to ensure training activities are relevant. Without external engagement, the Review considered the focus of training would be unlikely to match the environment and opportunities available to researchers. Along similar lines, Wendler *et al.* (2010, p. 46) called for employers to communicate the skills needed for jobs in the global economy.

**Key points**

42. Transferable skills play an important role in supporting researchers' diverse career paths, promoting better research outputs, and thus helping to underpin innovation and economic growth. These skills have attracted more attention over time, as non-academic employment opportunities grow and research becomes ever more interdisciplinary and international. Formal training for doctoral candidates and other researchers is one key channel for transferable skill acquisition, complementing informal training and workplace experience. Governments, individuals, universities and other stakeholders have a shared responsibility in designing, funding, organising and providing this training, and co-ordination between these groups is important if training is to be relevant and high quality. Various concerns and trends have highlighted the need to take stock of current transferable skills training activities. Subsequent steps in this study will draw on the sample of countries' transferable skills training programmes obtained through the RIHR policy questionnaire to discuss potential policy lessons.

## REFERENCES

Auriol, L. (2010), "Careers of Doctorate Holders: Employment and Mobility Patterns", *STI Working Paper*, 2010/4, OECD, Paris.

Bassanini, A., A. Booth, G. Brunello, M. De Paola and E. Leuven (2005), "Workplace Training in Europe", *IZA Discussion Paper*, No. 1640, June.

Campbell, A. (2010), "Developing generic skills and attributes of international students: the (ir)relevance of the Australian university experience", *Journal of Higher Education Policy and Management*, Vol. 32(5), November, pp. 487-497.

CIHE (2010), *Talent Fishing: What businesses want from postgraduates*, A CIHE report for the Department of Business, Innovation and Skills, London.

Commonwealth of Australia (2011), *Research Skills for an Innovative Future: A Research Workforce Strategy to cover the decade to 2020 and beyond*, Australian Government Department of Innovation, Industry, Science and Research, Canberra.

Concordat to Support the Career Development of Researchers (2008), An agreement between the Funders and Employers of Researchers in the UK, June.

Craswell, G. (2007), "Deconstructing the skills training debate in doctoral education", *Higher Education Research & Development*, Vol. 26(4), December, pp. 377-391.

De Grande, H., K. De Boyser, K. Vandevelde and R. Van Rossem (2011), "The Skills Mismatch: What Doctoral Candidates and Employers Consider Important", *ECOOM Briefs*, No. 4, 31 August, Gent.

EC (European Commission) (2003), Researchers in the European Research Area: One Profession, Multiple Careers, Communication from the Commission to the Council and the European Parliament, COM(2003) 436 final, July, Brussels.

EC (2005), *The European Charter for Researchers. The Code of Conduct for the Recruitment of Researchers*, Luxembourg.

EC (2010), *A Rationale For Action*, Accompanying document to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Europe 2020 Flagship Initiative: Innovation Union, Commission Staff Working Document COM(2010) 546, Brussels.

ESF (European Science Foundation) (2009), *Research Careers in Europe: Landscape and Horizons*, A report by the ESF Member Organisation Forum on Research Careers, ESF, Strasbourg.

EUA (European University Association) (2009), *Collaborative Doctoral Education: University-Industry Partnerships for Enhancing Knowledge Exchange*, DOC-CAREERS project, Brussels.

EUA (2010), *Salzburg II Recommendations: European universities' achievements since 2005 in implementing the Salzburg Principles*, Brussels.

Fiske, P. (2011), "What is a PhD really worth?", *Nature*, Vol. 472, p. 381, 21 April.

Gilbert, R., J. Balatti, P. Turner and H. Whitehouse (2004), "The generic skills debate in research higher degrees", *Higher Education Research & Development*, Vol. 23(3), August, pp. 375-388.

Herrmann, A. and A. Peine (2011), "When 'national innovation system' meet 'varieties of capitalism' arguments on labour qualifications: On the skill types and scientific knowledge needed for radical and incremental product innovations", *Research Policy*, Vol. 40, pp. 687-701.

Hodge Review (2010), *Review of progress in implementing the recommendations of Sir Gareth Roberts, regarding employability and career development of PhD students and research staff*, A report for Research Councils UK by an Independent Review Panel, October.

Impact and Evaluation Group (2010), *The impact of researcher training and development: two years on*, September, Cambridge.

Korean Institute of R&D Human Resource Development (KIRD) (2010), *RIHR Draft Proposal: Boosting the Career Development of Researchers*, Room Document for the 97th Session of CSTP, 26-27 October, OECD, Paris.

Leggett, M., A. Kinnear, M. Boyce and I. Bennett (2004), "Student and staff perceptions of the importance of generic skills in science", *Higher Education Research & Development*, Vol. 23(3), August, pp. 295-312.

Leitch Review (2006), *Leitch Review of Skills: Prosperity for all in the global economy – world class skills*, December, London.

LERU (League of European Research Universities) (2010), *Doctoral degrees beyond 2010: Training talented researchers for society*, March, Leuven.

Mann, L. and R. Marshall (2007), "Teams in CSIRO: Reorganising for national research imperatives", *Innovation: management, policy & practice*, Vol. 9(2), September.

Nature (2011), "The PhD Factory", *Nature*, Vol. 472, pp. 276-279, 21 April.

OECD (1995), *The Measurement of Scientific and Technological Activities: Manual on the measurement of human resources devoted to S&T: "Canberra Manual"*, OECD, Paris.

OECD (2002), *Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development*, OECD, Paris.

OECD (2006), "Research Careers for the 21st Century", Summary Report of the Joint OECD-Spanish Ministry of Education and Science Workshop, 26-27 April, Madrid, www.oecd.org/document/58/0,3343,en_2649_34293_36286330_1_1_1_1,00.html.

OECD (2010), OECD Science, Technology and Industry Outlook 2010, OECD, Paris.

OECD (2011), *Skills for Innovation and Research*, OECD, Paris.

Pritchard, J., J. MacKenzie and M. Cusack (2010), "The response of physical science post-graduates to training courses and the connection to their PhD studies", *International Journal for Researcher Development*, Vol. 1(1), pp. 29-44.

Roberts Review (2002), *SET for Success: The supply of people with science, technology, engineering and mathematics skills*, The report of Sir Gareth Roberts' Review, April, United Kingdom.

Scholz, B. (2011), "Research Careers in Europe: Transferable and professional skills", Presentation to the OECD Working Party on Research Institutions and Human Resources, 5 May, Paris.

Technopolis (2011), *Research Support to the Fagerberg Committee: Volume 1*, Final report, 18 February, Brighton.

Vitae (2009), *Careers in Research Online Survey (CROS) 2009: analysis of aggregated UK results*, Cambridge.

Vitae (2010), *What do researchers do? Doctoral graduate destinations and impact three years on*, The Careers Research and Advisory Centre, Cambridge.

Walsh, E., P.M. Seldon, C.E. Hargreaves, E. Alpay and B.J. Morley (2010), "Evaluation of a programme of transferable skills development within the PhD: views of late stage students", *International Journal for Researcher Development*, Vol. 1(3), pp. 223-247.

Warry Report (2006), *Increasing the economic impact of Research Councils*, Advice to the Director General of Science and Innovation, DTI, from the Research Council Economic Impact Group, July.

Wendler, C., B. Bridgeman, F. Cline, C. Millett, J. Rock, N. Bell and P. McAllister (2010), *The Path Forward: The Future of Graduate Education in the United States*, Princeton, NJ: Educational Testing Service.