chapter 4

COMPETENCIES FOR THE KNOWLEDGE ECONOMY

SUMMARY

Pressures to increase the role of information and knowledge in national economies have provoked a wide-ranging debate about what kinds of competencies young people and adults now need.

The workforce is "upskilling", both in terms of the average educational level of workers and the types of job that they are performing. White-collar, high-skilled jobs are driving employment growth. This is not just a question of the growth in knowledge "sectors". Work is becoming more skilled across industries and within individual occupations.

A group of "knowledge workers" can be identified as those performing knowledge-rich jobs. Such workers are typically but not universally well educated. Some knowledge workers have high levels of literacy and lower levels of education, implying that basic skills obtained beyond education are recognised in the knowledge economy.

There are additional "workplace competencies" needed in the knowledge economy. Communication skills, problem-solving skills, the ability to work in teams and ICT skills, among others, are becoming important and complementary to basic core or foundation skills. Even more than other workers, knowledge workers rely on workplace competencies.

However, further research is needed to inform education policy makers about how to develop the right skills for a knowledge economy, rather than assuming that high levels of education alone, as conventionally defined, will be enough.

1. INTRODUCTION

This chapter examines what is known about competencies needed in the knowledge economy …

The emergence of the knowledge economy, partly attributed to globalisation and technological advances, has ushered in a wide ranging debate about the demand for higher levels of competencies. While there is growing agreement on the importance of skills *per se* as a key engine for economic growth (OECD, 2000*f*) and the spread of the knowledge economy, there is far less agreement on which competencies and skills make the difference. Within and outside of the education sector, the discourse often refers to higher educational attainment in general, focused on the development of broadly-based competencies that can support further lifelong learning. From a labour market perspective, there is also an increased attention given to specific competencies such as the ability to use information and communication technologies (ICT), to solve problems, to work in teams, to supervise and lead and to undertake continuous learning. If not necessarily new, these so-called "workplace competencies" now tend in the wider public debate to be distinguished from what is taught and learned in the course of regular schooling and tertiary education study programmes.

… including the role of education and literacy as well as "workplace competencies".

What kinds of competencies are important for success in the knowledge economy? This chapter seeks to inform the on-going debate by trying to answer some questions related to the competencies required to participate effectively in the knowledge economy. Such an understanding is important for reforming curricula, developing appropriate assessments and providing the kinds of incentives most likely to promote the development of needed competencies.

– Section 2 surveys evidence on how the demand for competencies appears to be evolving in response to the forces at play.
– Section 3 surveys the literature to offer evidence on the different types of competencies required to participate in the knowledge economy:
  - It reviews the importance of basic education and literacy skills in the knowledge economy and for so-called "knowledge workers".
  - It analyses the extent to which further "workplace competencies" are becoming commonplace.
– Section 4 draws together what is known about the demand for competencies in the knowledge economy, drawing attention to information gaps and needs.

2. THE KNOWLEDGE REVOLUTION

2.1 Technological change and ICTs

The knowledge economy is based on the production and use of information and knowledge …,

The concepts of "knowledge economy" and "knowledge worker" are based on the view that information and knowledge are at the centre of economic growth and development. The ability to produce and use information effectively is thus a vital source of skills for many individuals (OECD, 2000*e*).

… driven partly by possibilities opened up through technological change.

Technological change and innovation drive the development of the knowledge-based economy through their effects on production methods, consumption patterns and the structure of economies. Both are closely related in recent growth performance. Some changes in innovation processes could not have occurred without ICTs and conversely, some of the impact of ICTs might not have been felt in the absence of changes in the innovation system (OECD, 2000*a*). These changes also have affected the way in which organisations

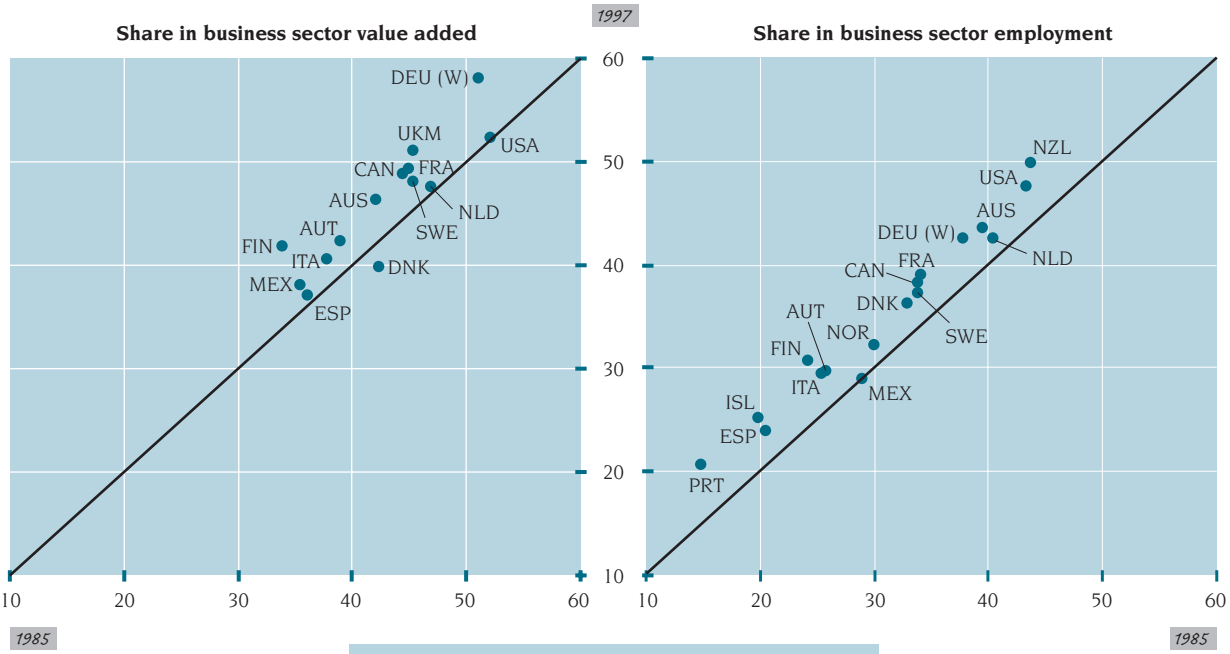
interact in the economy, with networking, co-operation and the fluid flow of knowledge within and across national borders gaining in importance.

Efforts are currently underway at the OECD to learn more about the effects of ICTs and other factors on recent growth patterns. Preliminary findings point towards technology and innovation as important drivers of recent economic growth performance (OECD, 2000*a*). Other work has also identified technological change as an important determinant of employment growth (Blanchflower *et al.*, 1991) and of increased demand for more highly educated and skilled workers (Berman *et al.*, 1997; Kiley, 1999; Machin *et al.*, 1996).

Knowledge-based industries, which include the main producers of high-technology goods, high- and medium-high technology manufacturing and the main users of technology (namely knowledge-intensive services such as finance, insurance, business, communication and community, social and personal services), account for more than half of OECD GDP and continue to grow rapidly (OECD, 2000*g*). As shown in Figure 4.1, the share of knowledge-based industries and services in business-sector value added and in employment increased over the past decade in almost all countries.

Knowledge-based industries already account for more than half of OECD GDP.

Figure 4.1 Increasing importance of knowledge-based industries, 1985 and 1997



In most countries, knowledge-based industries represent, in 1997, a significantly greater share of both value-added and employment in the business sector than they did in the mid-1980s.

Countries above the diagonal are those for which knowledge-based industries' share of value-added or employment was greater in 1997 than in 1985.

Source: OECD (2000), *Science, Technology and Industry Outlook*.

Data for Figure 4.1, *p.* 150.

The growth of knowledge-based industries is taking place at a time of increased investment in ICTs and growth in the use of the Internet. Investment in IT hardware, software and services and telecommunications accounted for almost 7% of OECD GDP in 1997, with the highest shares in Sweden, the United States, the United Kingdom, Switzerland, Australia, Japan, New Zealand and Canada. In the two years prior to 1997, investment increased by 13% in real terms.

2.2 Upskilling of the labour force

Globalisation, changes in technology and organisations are altering the demands for different types of labour…

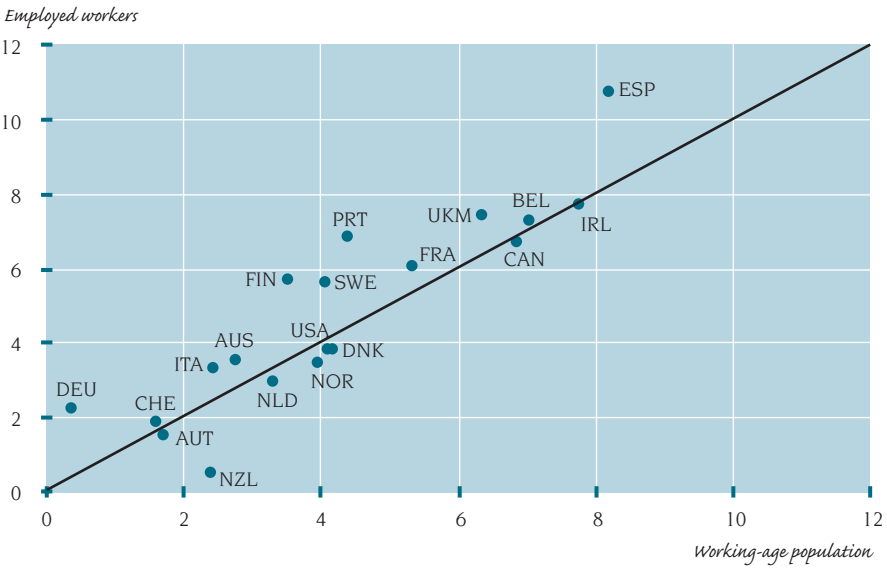
To adapt and maintain competitiveness in response to changing consumer preferences and technological change, companies need appropriate organisational structures, a skilled workforce and able management. These changes are having a significant impact on the structure of employment and on the type of labour required. The most obvious manifestation of this is the rising human capital levels of the populations and workforces in OECD countries, as measured by educational attainment and as implied by an increased demand for more highly-educated and highly-skilled workers.[1]

Over the past generation, as documented in Chapter 2 of this volume, the proportion of adults in OECD countries with at least secondary-level education

In many OECD countries, the share of workers with tertiary education has increased more rapidly than the share of the population educated at this level.

Figure 4.2 Growth in the proportion of the population and employment with tertiary-level qualifications, 1989-96

Percentage point change in the share of individuals with tertiary education



Countries above the diagonal are those in which the growth of people with tertiary education has been more rapid in employment than in the working-age population.

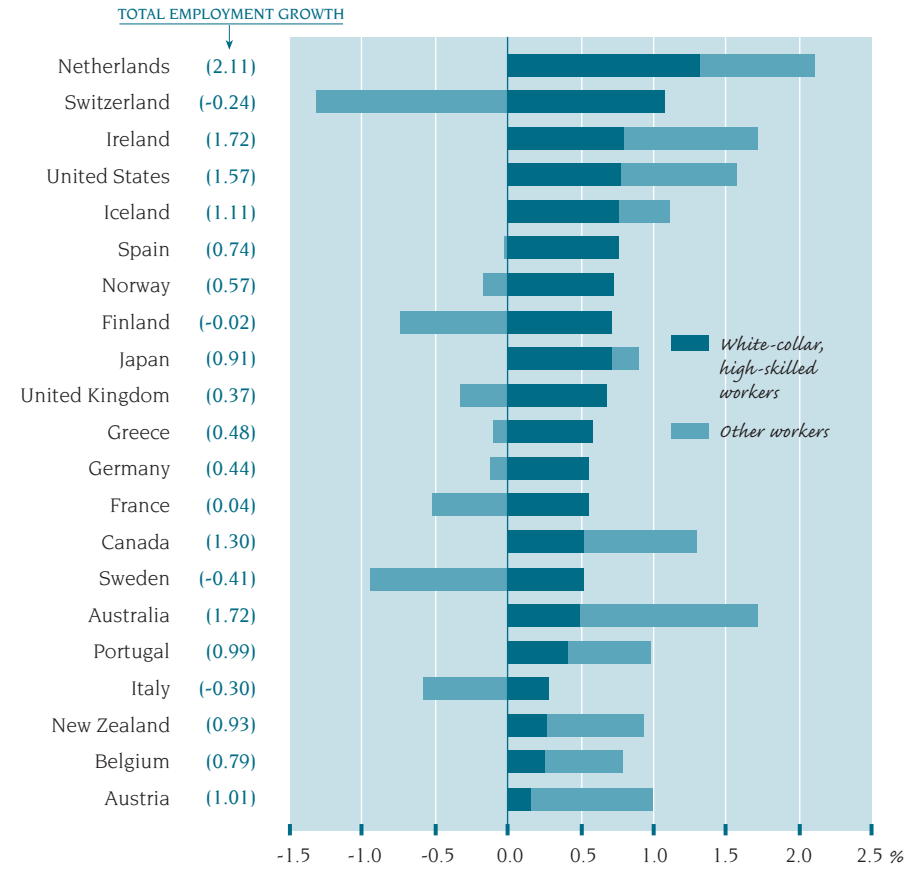
Source: OECD (2000), *Economic Outlook*.

Data for Figure 4.2, p. 150.

1. A number of recent and ongoing OECD efforts seek to develop better definitions and measures of skills: the International Adult Literacy Survey (IALS), the programme on Definition and Selection of Competencies: Theoretical and Conceptual Foundations (DeSeCo), and the Adult Literacy and Life Skills (ALL) survey.

Figure 4.3 Upskilling in total employment growth, 1980-98

Average annual percentage change in total employment



Countries are ranked in descending order of average annual percentage growth in white-collar, high-skilled workers.

Sources: ILO database (2000) and OECD (1998), *Technology, Productivity and Job Creation*.

Data for Figure 4.3, p. 150.

Employment is being driven by white-collar, high-skilled jobs in almost all countries.

has risen, on average, from 44% to 72%, and the share with at least tertiary education has almost doubled, from 22% to 41% (OECD, 2000*c*). This is largely due to the increase in the educational attainment of younger generations, which has contributed to widen differences between younger and older adults in almost all OECD countries.

… manifested in a more highly educated workforce …

Evidence that upskilling is taking place is indicated by a bias in most OECD countries towards better educated individuals in the labour market. Figure 4.2 shows the changes in the proportion of persons with tertiary education in employment and the changes in their share in the total working-age population. The fact that most countries are located above the diagonal reveals that labour markets over the 1990s have benefited from more highly educated workers.

… and more rapid growth in white-collar, high-skilled occupations.

Figure 4.3 illustrates the importance of this upskilling in accounting for employment growth. Over the past two decades, in 14 out of 21 countries for which data are available, growth in the professional, technical, administra-

tive and managerial occupations ("white-collar, high-skilled") has increased more than employment in other occupational categories.

Upskilling, in terms of the growth of white collar, high skill jobs, is evident both within manufacturing and service sectors …

More detailed analyses of employment trends within industries confirm a true upskilling process (Berman *et al.*, 1997; Machin *et al.*, 1996; Steedman, 1998). Those studies suggest that employment shifts within industries, as opposed to between industries, represent a real change towards higher skills. This is so because it reflects a rather generalised upskilling process occurring within each industry rather than solely a shift from sectors characterised by low-skilled activities to sectors characterised by more skilled activities. The growth of white-collar, high-skilled employment in both manufacturing and services reflects this upskilling, rather than just an increase in service sector activities. In fact, although total manufacturing employment has decreased in most countries, it has increased for white-collar, high-skilled occupations within the sector.

… and within individual occupations.

From another angle, there appears to be upskilling within occupations. Two United Kingdom surveys show a considerable increase in the average qualification levels of new recruits and an increase in job complexity (Green *et al.*, 1997). In the United States, jobs were also found to require higher levels of skills than in the past within occupations, especially in professional and technological occupations (Osterman, 1995).

Some analyses go further. They report that, in addition to upskilling of the labour force in terms of education and occupation, there is also a new and distinct demand for a certain set of "workplace competencies" and "interpersonal skills" usually associated with the introduction of ICTs and new work practices. Several studies (Section 3.2) have identified these competencies and skills as team-working, problem-solving and communication, together with specific computing skills (Bresnahan and Brynjolfsson, 1999; Green, 1998; Green *et al.*, 2000; Stasz, 2000).

So, upskilling and a growing demand for diversified competencies are key features of the knowledge economy.

3. WHAT COMPETENCIES ARE DISTINCTIVE IN THE KNOWLEDGE ECONOMY?

Although there is no clear agreement on the specific competencies needed for the knowledge economy …

How should education and training systems respond to on-going changes in the knowledge economy that demand higher and more diversified skills? This is a difficult question to answer because there is no clear agreement on the definition and measurement of these skills and on how such skills contribute to the knowledge economy. One way to approach this issue is to examine the different evidence available on general competency trends and on how these can be related to the knowledge economy.

… both basic skills and other non-academic skills are now required for improved job performance…

Some analysts suggest that basic reading, writing and arithmetic skills are no longer enough for workplace performance (Carnevale *et al.*, 1990), but they are the starting point. Further findings stress the fact that there are new or changing competencies which are highly valued in the labour market. In addition to basic foundation or core skills based on formal education and

literacy, other non-academic skills are being widely included in the literature as important and as part of a multidimensional vision of skills (Stasz and Brewer, 1999).

Table 4.1 **Employers' hiring criteria in the United States, 1994 and 1997**

Employers' responses to the question: "After you have established your applicant pool and obtained information about potential (job title) employees, what characteristics or attributes are most critical in making your hiring decision?"	Average of responses on a scale of 1 to 5: 1 = not at all important; … to 5 = essential	
Characteristics	1994	1997
Applicant's attitude	4.6	4.6
Applicant's communication skills	4.2	4.1
Previous employer references	3.4	3.9
Previous work experience	4.0	3.8
Industry based credentials	3.2	3.2
Years of completed schooling	2.9	2.9
Academic performance	2.5	2.5
Score on tests administered as part of the interview	2.5	2.3
Teacher recommendations	2.1	2.0
Experience or reputation of applicant's school	2.4	2.0

Source: Shapiro *et al.* (1998).

… and employers give as much attention in hiring decisions to general workplace competencies as to specialised job skills at given levels of education …

In hiring decisions, employers say they give as much attention to workplace competencies as they do to technical skills. However, most of the available surveys refer to hiring at a particular level, requiring a given level of education as a first prerequisite. From this perspective, the focus on intra-personal and workplace competencies should be seen as supplementary to the established educational requirements. In the United States, a qualitative survey on firms' recruitment strategies for entry-level jobs found that not only mathematical and English skills were required for today's entry-level jobs, but intra-personal skills were also quite important (Rosenbaum and Binder, 1997). Table 4.1, based on data from the National Employer Survey (run in 1994 and 1997), shows that among the hiring criteria for potential employees, intra-personal and communication skills were the highest ranked, followed by work experience. In the United Kingdom, employers reported that communication skills, learning ability, problem-solving skills, team work and the capacity for self-management were more important than technical, ICT or numeracy skills as criteria in the recruitment of graduates (Hesketh, 2000). Employers placed high importance on inter-personal and intra-personal skills and gave rather less weight to narrower, learned skills. According to the employers surveyed, initiative, motivation and communication skills were considered as particularly relevant, because a motivated new hire easily could obtain the necessary specific skills through training or on-the-job experience (Industry in Education, 1996).

Box 4.1 Workplace competencies

A literature review reveals that the different types of workplace competencies that are most agreed upon by different analysts, surveys and country reports are:

Inter-personal skills:
- Team work and the ability to collaborate in pursuit of a common objective.
- Leadership capabilities.

Intra-personal skills:
- Motivation and attitude.
- The ability to learn.
- Problem-solving skills.
- Effective communication with colleagues and clients.
- Analytical skills.

Technological or ICT skills.

For further reading, refer to Stasz (2000).

... with some countries' skills or qualifications frameworks distinguishing between workplace competencies and foundation or core skills.

In some countries, workplace competencies have been defined within frameworks in which these competencies are distinguished from core or foundation skills. Examples include the United States' SCANS competencies (Wise *et al.*, 1990), the Australian key competencies (Australian Education Council, 1993), and the Conference Board of Canada's employability skills profile (Conference Board of Canada, 1992) or the United Kingdom's National Curriculum for Vocational Qualifications (QCA, 1997). Most of these reports agree on a certain set of skills that are also stressed in employer surveys and observation of workplace practices (ERT, 1995) (See Box 4.1).

In the same vein as these reports, the rest of this section distinguishes between academic and cognitive skills and workplace competencies, based on a view that the former are the core or foundation skills that workers require. Workplace competencies are viewed as complementary for participating in the knowledge economy and in new production processes. The analysis focuses on so-called "knowledge workers" (Box 4.2), *i.e.* those workers who are participating most effectively in the knowledge economy, on the grounds that their competencies strongly reflect the emerging dynamics of technological change and globalisation.

3.1 Knowledge workers are highly educated and/or highly literate

Knowledge workers typically have a high level of initial education and/or a good level of literacy (see Technical Annex at the end of the chapter). On one hand, the recognition of formal knowledge obtained upon leaving the initial education and training system can provide the basis for becoming a knowledge worker through the recruitment process which, in most OECD countries, very often depends heavily on official certificates. At the same time, individuals can obtain the required competencies to be designated as knowledge workers through experience, training or more informal ways, well-documented in the literature about informal or non-formal learning.

Box 4.2 Different definitions of knowledge workers

The term "knowledge worker" has been coined to describe those workers who are participating most effectively in the knowledge-based economy. However, if the definition of the knowledge economy is challenging, so is that of the knowledge worker. It can be people who are working in knowledge-based sectors or workers who have specific skills and competencies. At the heart of all the suggested definitions lies the idea that knowledge workers are participating in the utilisation and creation of knowledge. Different definitions of high-skilled or knowledge workers use a combination or reclassification of the different occupational measures available:

– Symbolic analyst

Reich (1991) distinguishes the "symbolic analytic services" from direct personal services and routine production services. Workers in the first of these categories are professionals, upper-middle managers and above, and others who create, modify, and synthesise knowledge. Such workers account for about 20% of the U.S. labour force.

– Science and technology (ST) personnel as high-skilled workers

According to the OECD *Canberra Manual on the Measurement of Human Resources Devoted to Science and Technology* (OECD, 1995), there are different ways to classify science and technology workers. Science and technology personnel comprise those who are either highly educated or employed in occupations requiring at least a first university degree. By combining qualification and occupation, the definition identifies both education and skills needed for different types of jobs (Cervantes, 1999).

– Knowledge worker according to new occupational groupings

According to Lavoie and Roy (1998), the main feature of a knowledge-based economy is the increasing need to rely on highly-skilled workers whose skills are not exclusively related to science and technology but also to the control, management and co-ordination of tasks. To define knowledge workers, they reformulate occupational categories based on the use and production of knowledge by workers and reclassify economic activities according to tasks performed by workers (from the more conventional industrial activies). Drawing on Osberg *et al.* (1989), they regroup occupational categories in five domains: knowledge, management, data, services and goods. Knowledge occupations, under this definition, account from 7.9% of the labour force in Portugal to 25.4% in Finland (OECD, 2001).

– Knowledge worker by occupations and tasks

Knowledge workers are defined according to their occupation and tasks for the purpose of this chapter. Specifically, knowledge workers are those employed in occupations considered to be white-collar, high-skilled *and* perform a set of tasks that revolve around creating and processing information (reading, writing and quantitative tasks). The Technical Annex provides further details on the definition and measurement of knowledge workers using the International Adult Literacy Survey (IALS). According to this definition, knowledge workers account for an estimated 18.6% of the labour force in those OECD countries participating in IALS, ranging from 6.4% in Poland to 25.5% in Sweden.

Those who are more highly educated are more likely to be knowledge workers, particularly those who have followed broadly-based academic studies throughout…

Analyses based on the International Adult Literacy Survey (IALS) data confirm this (see Technical Annex). Among adults who test at similar literacy levels and share other common characteristics, those who are more highly educated are more likely to be knowledge workers. Indeed, those with more years of education (excluding repeated years) are *ceteris paribus* more likely to be knowledge workers. However, those with vocational preparation at the upper secondary level, even if they continue on to tertiary education, are less likely to be knowledge workers. This suggests that the competencies needed for the knowledge economy are likely to be more broadly-based rather than narrowly vocational.

… but also those with high literacy skills are more likely to be knowledge workers …

But, analyses of the IALS data also show that those who have higher levels of literacy are more likely to be knowledge workers. This applies regardless of the level or years of education. So, skills and competencies acquired through means other than formal education can be important.[2] Moreover, generally, knowledge workers are highly skilled in *any* type of literacy skill.[3]

Table 4.2 **Education and literacy skills of knowledge workers**

Proportion of knowledge workers by education and literacy levels

	Educational attainment (%)		
	Upper secondary and below	Tertiary	Total
Literacy			
Levels 1/2	6.9	3.7	10.6
Level 3	20.0	17.5	37.5
Levels 4/5	17.1	34.8	51.9
Total	**44.0**	**56.0**	**100.0**

Source: International Adult Literacy Survey (1994-98).

… and about one in five knowledge workers lack advanced educational qualifications, but have high literacy skills.

As presented in Table 4.2, about one-third (34.8%) of knowledge workers are, at the same time, highly educated (completed some tertiary education) and highly literate.[4] Moreover, 73% of knowledge workers are either highly educated *or* highly literate (as highlighted in blue in the table). So, knowledge workers may well acquire the necessary skills and competencies to be a knowledge worker through means other than formal education. In fact, knowledge workers are also more likely to participate in training. An estimated 67% undertook training in the last year before the survey, compared to a 41%

2. Having reached only secondary education, a man can increase his possibility of being a knowledge worker to that of somebody who has upper secondary education by increasing his literacy score by 49 points, and to that of somebody with tertiary education with 74 points (on a scale from 0 to 500). For women, the differences are larger.

3. The findings do not vary markedly according to differences in performance among the three literacy scales – prose, document and quantitative. The main exception is that men who score lowest on the prose or quantitative scales are less likely to be knowledge workers than men who score lowest on the document scale.

4. That is, perform at the top levels (4 or 5) on the literacy scale.

training rate for all other workers. In this connection, participation in training can be viewed as both a consequence and a cause of being a knowledge worker: such workers are more likely to receive training, but they are also more likely to be skilled which can reflect in part a prior disposition toward training.

3.2 Workplace competencies

Workplace competencies are linked to the ability to function effectively in firms that have adopted new work practices …

Workplace competencies refer to a set of skills that are complementary to academic or more technical skills. As noted above, employers report that they give weight to these skills in hiring decisions and more generally such skills appear to be required for workers to function effectively within the new organisational structures adopted by leading-edge firms. To the degree that most of these studies link these requirements to recent economic developments and the demand for a highly skilled workforce, it seems reasonable to assume that they can also be associated with the knowledge-based economy.

… which requires abstraction, system thinking, experimentation and collaboration skills, according to Reich …

Indeed, this interpretation is consistent with the literature. Reich's (1991) definition of knowledge workers refers to the ability for problem-identifying, problem-solving and strategic brokering capabilities. A main characteristic of knowledge workers, apart from having tertiary education, is that facts are not central to their skills profiles because whatever data are required will be available to them at the touch of a computer key. The more important skill these workers bring to their work is an ability to conceptualise problems and solutions. Reich calls for attention to the development of four basic skills: abstraction, system thinking, experimentation and collaboration.

… while a Canadian analysis identifies communication and management skills along with cognitive skills as the domains knowledge workers use more than other workers.

Further evidence on the use of workplace competencies by knowledge workers is provided by an analysis of detailed occupational data for the Canadian workforce. This assesses the degree to which knowledge workers are more likely than other workers to use cognitive, communication and management skills. Figure 4.4 shows that knowledge workers (according to the "new occupational groupings" definition; see Box 4.2) have much higher average scores than the rest of Canadian workforce for cognitive skills, people skills (direct and team-work) and communication skills (Béjaoui, 2000). These are some of the skill domains frequently identified for those working in a knowledge-based economy (Massé *et al.*, 1998).

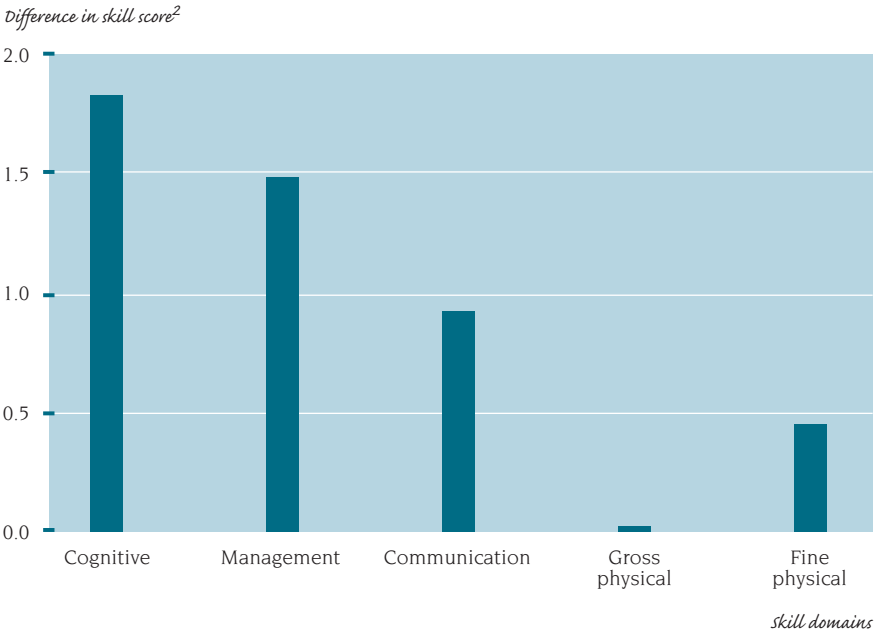
Such workplace competencies are needed as new work practices are introduced …

Most of these workplace competencies have been related to new work organisation practices. Such practices include job rotation, team-based work organisation, greater involvement of lower-level employees and flattened management structures (OECD, 1999*a*). Some analyses have found that, as different new work organisation practices are set into motion, the use of different workplace competencies increases (Green *et al.*, 2000).

… in the service sector …

Organisational changes taking place in the service sector, which employs the largest proportions of knowledge workers, provide further support for these findings. A 1988 survey of developments in France, Germany, Japan, Sweden and the United States showed then that the emergence of the new workplace environment was accompanied by greater demands for competencies specifically to cope with the changes being introduced: the ability to operate in an unclear and ever-changing environment, the capacity to deal with non-

Figure 4.4 Skill requirements of knowledge workers in five domains,[1] Canada



1. The scoring is based on the Canadian Classification and Dictionary of Occupations (CCDO) which give scores to 6 500 occupations according to the requirements of the job. There are 43 indices representing general education, physical abilities and other different aptitudes. Running a Principal Component Analysis gives a clustering of the indices and each cluster represents a specific skill.

2. The score is the difference between the average score of knowledge workers and the average score of all workers.

Source: Béjaoui (2000), *Sur la mesure des qualifications.*

Data for Figure 4.4, p. 150.

Knowledge workers in Canada require much more cognitive, management and communication skills than other workers.

routine and abstract work processes, the ability to handle decisions and responsibilities, group and interactive work and system-wide or broad understanding (Bertrand and Noyelle, 1988). The study also suggested the need for better interaction and communication skills for all workers, stronger abilities to work in group situations and more workers with high levels of specialised professional expertise and entrepreneurship, especially among middle-level professional and managerial personnel.

... and in public utilities, among other industries.

A study of practices in production work by those employed in public utilities in the United States concluded that greater use of innovative work practices increased the need for higher skill levels and workplace competencies (Capelli and Rogovski, 1994). Those competencies most commonly required by new work practices are team work, communication skills, problem-solving and analytical skills. Although new work practices may lead to greater demands on workers' technical skills, the study further concluded that the new practices appear to focus more on workplace competencies than specific technical or vocational skills. Similar findings are reported in a study of commercial vehicle

manufacturing (Thompson *et al*,. 1995). This study found that increases in new forms of production led to growing demand for organisational and technological knowledge and the ability to work in teams, with an emphasis on behavioural or "extra-functional" skills. Findings from a survey of German employers provides yet more support for the view that workplace competencies are required for modern work processes (Dybowski, 1998).

New work practices – and upskilling – have also followed the introduction and greater use of technology in enterprises and sectors…

New work practices have also been associated with the introduction and greater use of technology on the job, in firms and in the economy. Apparently, these changes have implications for the levels and types of workplace competencies. Analyses carried out on firm-level practices show a strong correlation between information technology, human capital and workplace organisation (Bresnahan and Brynjolfsson, 1999; OECD, 1999*a*). Other studies have found links between the introduction of ICTs and the demand for skills or skills upgrading (Baldwin *et al.*, 1997; Berman *et al.*, 1997; Machin *et al.*, 1996). All of these studies find evidence of capital-skill complementarity and strong positive correlations between the level of computer investment in an industry and changes in the skill composition of the workforce.

… but while the demand for specific ICT skills appears to be growing in all sectors and for all workers, such skills are relatively easily acquired …

To further analyse the aspect of ICT skills demand, a distinction can be made between workers employed in ICT industries and workers in other sectors who may need to acquire ICT skills to function effectively in their jobs or everyday life. With respect to the latter, demand for ICT skills appears to be growing in all sectors of the economy and society and not only for knowledge workers. Some experts suggest that as democratisation of ICTs takes place, workers may be required to have the necessary generic skills for acquiring, through short training spells,[5] ever-changing ICT skills requirements (OECD, 1999*b*). The response needed to meet this challenge may, in fact, be a matter of balance. The Skill Survey of the Employed British Workforce found that, in most cases, people easily acquire the necessary computer skills when computers are introduced. The study goes on to conclude that a possible over-investment in computer skills may mask shortcomings regarding other skills that can be more crucial for the job. According to the authors, although computers have contributed to changes in the demand for skills in the labour market, computer skills *per se* do not play a key role in this process (Borghans and Weel, 2000).[6]

5. One study estimates that about one-half of all computer users in France received some specialised computer training. Such training exceeded one week for about one-quarter of all users (Gollac and Kramarz, 1997).

6. There is an unresolved debate about the impact of computers on wages. One British study suggests that people with computer skills obtain wage premiums in excess of 20%, although it is not clear whether the premiums are due to higher overall skills of the workers who use computers (Green, 1998). Another study found that workers who used computers obtained wages about one-third (36%) higher than others, although the increment is not a direct return to computer skills. Instead, computer skills are associated with other competencies, such as basic education and generate certain non-wage benefits, identified as better integration in the firm or improved professional recognition. The data are for 1993 and refer to France (Gollac and Kramarz, 1997). Some studies of workers find not only a strong association between higher levels of education and computer skills, but also that those with higher levels of education are more productive in the use of ICTs (Krueger, 1993; Autor *et al.*, 1997). In Germany, wage premiums have been associated with handwriting as well as with computer use (DiNardo and Pischke, 1997), while in Canada wage premiums were found for computer and fax use (Morissette and Drolet, 1997). These results suggest that the returns to computer use reflect unobserved characteristics of workers or of the nature of their work.

... so even ICT-intensive firms seek in their employees a broader combination of technical, business, management and personal skills.

ICT-intensive firms in particular seek a combination of technical, business and management and personal skills (among which communication, leadership, team work and problem-solving skills) (OECD, 2000*d*). This conclusion is supported by findings from studies in a number of OECD countries: United States (NRC, 2000; ITAA, 2000), Canada (ACST, 2000; Sangster, 1999), Ireland (ISC, 2000) and the United Kingdom (DfEE, 2000). A further finding of interest is that workers entering ICT jobs now develop, certify and present qualifications through private firms, business associations and commercial ICT bodies as much as through ICT study programmes in schools, colleges and universities (Adelman, 2000).

4. CONCLUSIONS

This analysis suggests that while further increases in the levels of education are needed, for knowledge workers and others ...

The development of the knowledge economy is changing labour market demands for competencies and skills. There is evidence that upskilling has taken place throughout OECD economies, partly derived by an increase in demand for skills and partly in response to rising educational attainments in populations. The forces at play suggest that further increases in the overall levels of education are needed. Higher levels of education are needed not only just to better prepare knowledge workers. They also improve the likelihood of participation in further learning throughout adult life, and reduce the chances of long-term unemployment and marginalisation.

... knowledge workers also need a wider range of competencies ...

At the same time, many commentators have argued that new or additional competencies and skills are required from workers. On the basis of evidence available on general trends in competencies and on their relation to the knowledge economy, we conclude that high levels of education and literacy are the key principal competencies demanded in the knowledge economy. Basic general education provides workers with the core academic and cognitive competencies required to participate most effectively. These core competencies provide the base to facilitate further training and further upgrading of those specific technical skills required for knowledge workers.

Knowledge workers, *i.e.* those in jobs requiring the production and use of knowledge, require high levels of competencies and skills. These are not delineated solely in terms of educational attainment: almost one in five knowledge workers lack advanced formal qualifications but demonstrate high literacy skills. To some extent, knowledge workers have acquired and are applying relevant, advanced levels of skills not developed through formal education – a finding which seems to apply more to men than to women.

... including workplace competencies of team-work, communication skills and problem-solving skills.

There are other competencies that, although not necessarily new, are now seen to be more important for knowledge workers. For example, so-called "workplace competencies", *e.g.* team-work, communication skills and problem-solving skills, have been associated with new organisation practices and knowledge workers. These workplace competencies are not seen as substitutes for education and literacy skills, but rather as complementary to them. Moreover, the extent to which these competencies are developed independently or are convex to educational attainment, on-the-job training and/or off-the-job training remains unclear.

In the light of these questions, policy directions are less clear. Improving the educational foundations, literacy skills and ICT literacy for everyone seems warranted. But, more research is needed to justify and guide substantial changes in the context, contents and methods of teaching and learning aimed at developing new competencies and skills. ■

Further research is needed to improve understanding of how and where needed competencies are best developed.

TECHNICAL ANNEX

1. Definition of knowledge workers using the International Adult Literacy Survey (IALS)

The definition of knowledge workers used in this chapter relies on occupations and tasks performed most often at work as measured in the International Adult Literacy Survey (IALS).They are identified on the basis of responses to two sets of questions in the IALS background questionnaire.

The first set of questions has to do with the tasks workers do on a regular basis. These tasks revolve around processing information or documents (reading, writing and mathematics) and are considered good proxies for assessing what people do at work. The second set of questions includes workers' occupations on a one-digit coding.

In relation to tasks, the questions are:

The following questions refer to the job at which you worked the most hours in the last 12 months.

E1. How often (do/did) you read or use information from each of the following as part of your main job? Would you say every day, a few times a week, once a week, less than once a week, rarely or never?

– Letter or memos

– Reports, articles, magazines or journals

– Manuals or reference books, including catalogues

– Material written in a language other than the mother tongue of the person

E2. How often (do/did) you write or fill out each of the following as part of your main job? Would you say every day, a few times a week, once a week, less than once a week, rarely or never?

– Letter or memos

– Reports or articles

– Estimates or technical specifications

E3. In your main job, how often do you use arithmetic or mathematics (that is, adding, subtracting, multiplying or dividing) to:

– calculate prices, costs or budgets?

For each item, those answering "Every day" are given a score of 10 points; those answering "A few times a week", 5 points; followed by 3, 2 and 1 point for "Rarely or never". The scores are added up with a maximum score of 80 (doing everything "Every day") and a minimum of 8 (doing everything "Rarely or never").

In relation to occupations, the question is:

What kind of work were you doing at this job? (Give full description or occupational title, *e.g.* office clerk, machine operator, computer programmer)

which is coded according to ISCO:

0: Armed Forces

1: Legislators, Senior Officials and Managers

2: Professionals

3: Technicians and Associate Professionals

The worker is considered a "knowledge worker" when s/he scores 40 or above on tasks involving the use of information and is working in: the armed forces; as a legislator, senior official or manager; professional; or technician and associate professional (occupations 0, 1, 2 and 3). The value 40 on the score range between 8 and 80 represents at the same time the middle of the range and the value a worker would score if s/he were doing all the tasks "a few times a week" (8 times 5). It is also the score a worker would attain by doing 4 of the 8 tasks every day. For these reasons, the value 40 has been retained as the threshold to define a knowledge worker.

2. The Probit model

The statistical modelling used to quantify the key determinants of the probability of being a knowledge worker is based on econometric tools dealing with limited dependent variables (explained variables whose values are not continuous). In this case, the dependent variable takes on the value of 1 if the individual is a knowledge worker and 0 otherwise. The methodology adopted relies on a two-step process, with a first-step equation to control for the probability of being in the labour force in the main model.

Different specification have been tested and the final set of explanatory variables is:

- Country dummies.
- Age (continuous) and age squared.
- Born in the country or not.
- Best score in literacy (out of the three possible ones – continuous).
- Living in a rural area or not.
- Dummy for individual's best literacy score (prose, document or quantitative).
- Dummy for individual's worst literacy score (prose, document or quantitative).
- Educational attainment (5 levels).
- Number of years of schooling (not included the repetition of years – continuous).
- Type of preparation at upper secondary level (vocational, academic or other).
- Dummy for being currently unemployed.
- Training and type (occupational, personal or other reasons).
- Dummy for following a course in order to improve literacy.
- Dummies for industry where individual works or had worked (unemployed).
- Type of job (employee or self-employed, with supervision or not).
- Number of hours worked per week (continuous).
- Number of employers (continuous).

Two models are estimated by gender because the selection equation and the labour market behaviour vary according to gender. A model has been run for each country for men only. There are slight differences of explanatory variables between the different models because some variables are not present for some countries. The results of these probit estimations are available from the Secretariat on request.

Note: The goals of IALS was to develop estimates of literacy, based on performance on a common set of literacy tasks undertaken by samples of adults in 18 OECD countries. IALS collected biographical information, such as educational attainment, and details on occupations and job tasks, from each participating adult. In each participating country, samples of 2 500 to 6 000 adults were drawn to be broadly representative of the civilian, non-institutionalised population aged 16 to 65. Response rates ranged from 45% to 75% across countries. See Pont and Werquin (2000) and OECD and Statistics Canada (2000).

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