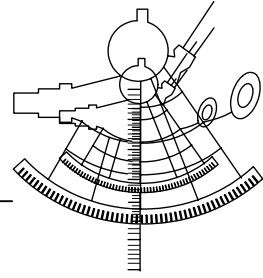


European Trend Chart on Innovation



2002 European Innovation Scoreboard Technical Paper No 5 Thematic Innovation Scoreboard – Life Long Learning for Innovation

December 6, 2002



The European Trend Chart on Innovation

Innovation is a priority of all Member States and of the European Commission. Throughout Europe, hundreds of policy measures and support schemes aimed at innovation have been implemented or are under preparation. The diversity of these measures and schemes reflects the diversity of the framework conditions, cultural preferences and political priorities in the Member States. The 'First Action Plan for Innovation in Europe', launched by the European Commission in 1996, provided for the first time a common analytical and political framework for innovation policy in Europe.

Building upon the Action Plan, the *Trend Chart on Innovation in Europe* is a practical tool for innovation policy makers and scheme managers in Europe. Run by the European Commission (Innovation Directorate of DG Enterprise), it pursues the collection, regular updating and analysis of information on innovation policies at national and Community level, with a focus on innovation finance; setting up and developing innovative businesses; the protection of intellectual property rights; and the transfer of technology between research and industry.

The Trend Chart serves the "open policy co-ordination approach" laid down by the Lisbon Council in March 2000. It delivers summarised and concise information and statistics on innovation policies, performances and trends in the European Union. It is also a European forum for benchmarking and the exchange of good practices in the area of innovation policy.

The Trend Chart products

The Trend Chart on Innovation has been running since January 2000. It tracks innovation policy developments in all EU Member States, plus Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Iceland, Israel, Latvia, Liechtenstein, Lithuania, Norway, Poland, Romania, Slovak Republic and Slovenia. The Trend Chart website (www.cordis.lu/trendchart) provides access to the following services and publications:

- the European Innovation Scoreboard and other statistical reports;
- regular country reports for all countries covered;
- a database of policy measures across Europe;
- a "who is who?" of agencies and government departments involved in innovation;
- regular trend reports covering each of the four main themes;
- benchmarking reports from the Trend Chart workshops;
- a news service and thematic papers;
- the annual reports of the Trend Chart.

The present report was prepared by Anthony Arundel of MERIT (www.merit.unimaas.nl). The information contained in this report has not been validated in detail by either the Member States or the European Commission.

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European Innovation Scoreboard

The European Innovation Scoreboard (EIS) was developed at the request of the Lisbon European Council in 2000¹. It focuses on high-tech innovation and provides indicators for tracking the EU's progress towards the Lisbon goal of becoming the most competitive and dynamic knowledge-based economy in the world within the next decade.

The EIS contains 17 main indicators, selected to summarize the main drivers and outputs of innovations. These indicators are divided into four groups: Human resources for innovation (5 indicators); the creation of new knowledge (3 indicators of which one is divided into EPO and USPTO patents); the transmission and application of knowledge (3 indicators); and Innovation finance, outputs and markets (6 indicators).

The EIS complements the *Enterprise Policy Scoreboard*² and other benchmarking exercises of the European Commission. It mainly uses Eurostat data, or private data of sufficient reliability if official data is not available. Six indicators are drawn from the European Commission's Structural indicators.

All indicators have been updated based on data availability as of September 15, 2002. Four indicators could not be updated due to delays in the execution of the third Community Innovation Survey³. As a result, the 2002 EIS does not provide trend results for these indicators and it does not contain a summary innovation index similar to the one offered in 2001. Subject to the availability of new CIS data, the 2003 EIS is expected to offer again an updated composite innovation index and a comparison between the index and average trends for each country, which was one of the most interesting features of the 2001 EIS.

The EIS is complemented by six technical papers:

- (1) Technical Paper No 1: Member States and Associate Countries
Detailed results for current and trend data, innovation leaders, relative strengths and weaknesses per country, convergence and divergence analysis between member states and different groups of member states, and country pages with trend diagrams and main policy changes.
- (2) Technical Paper No 2: Candidate Countries
Detailed results for current and trend data, innovation leaders, relative strengths and weaknesses per country, and country pages with both current and trend graphs.
- (3) Technical Paper No 3: EU Regions
Detailed results for currently available data, leading regions, two tentative composite innovation indicators, indicator graphs, and preliminary steps towards the 2003 regional scoreboard.
- (4) Technical Paper No 4: Indicators and Definitions
Full definitions and graphs for all indicators.
- (5) Technical Paper No 5: Thematic Scoreboard "Life long Learning for Innovation"
Prototype of a complementary scoreboard on "Life long Learning for Innovation".
- (6) Technical Paper No 6: Methodological Report
Overview of five different methods for constructing composite indices, and review of the similarities and differences between the EIS and other European Commission scoreboards.

All technical papers are available from the Trend Chart website (www.cordis.lu/trendchart).

¹ A first provisional EIS was published in September 2000: COM(2000) 567. The first full version of the EIS was published in October 2001: SEC(2001) 1414.

² SEC(2002) 1213.

³ These are indicators 3.1, 3.2, 3.3 and 4.3.

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1. Introduction

The European Council defines life long learning as: ‘all purposeful learning activity, whether formal or informal, undertaken on an ongoing basis with the aim of improving knowledge, skills and competence’⁴. Life long learning has attracted a substantial amount of interest within Europe, with 55 EU funded research projects on life long learning as of December, 2001 (EC, 2001d), several international surveys of relevance to life long learning during the 1990s and planned for the 2000s⁵, and attention paid to life long learning by several Directorate Generals, including the Directorate for Education And Culture (DEAC) (EC, 2001a).

The current interest and support for life long learning is based on the belief that continuous learning is required to address several economic, technological and demographic changes in modern economies. These include a shift in the modes and distribution of knowledge due to information and communication technologies (ICT), a shift in employment from manufacturing to services, and a speeding up of the rate of technical change (EC, 2000; Tomlinson, 2002). Almost all of these changes will both influence and be influenced by the innovative capabilities of modern ‘knowledge’ or ‘learning-based’ economies. For this reason, the dynamic relationship between life long learning and innovation should also be of great interest to innovation policy, although to date this relationship has attracted considerably less attention than the benefits of life long learning to social goals such as reducing social exclusion and income inequality, or counteracting demographic ageing (OECD, 2001)⁶. The purpose of this thematic TrendChart scoreboard is to address this gap by identifying several indicators that can track the relationship between life long learning and innovation.

Our interest in a thematic scoreboard for life long learning and innovation was sparked by a strong correlation coefficient of 0.85 between Trend Chart’s 2001 Innovation Scoreboard (www.cordis.lu/trendchart) indicator for life long learning and this Scoreboard’s summary innovation index and, secondarily, for a few key innovation indicators: high technology patents in the United States (0.80), venture capital investments as a percentage of GDP (0.73), and

⁴ This definition was accepted at the Cologne European Council in June 1999. A close variation is from the European Commission’s Communication on Life long learning: “all learning activity undertaken throughout life, with the aim of improving knowledge, skills and competences within a personal, civic, social and/or employment related perspective”.

⁵ These include the Continuous Vocational Training Survey (CVTS), the International Adult Literacy Survey (IALS), the Programme for International Student Assessment (PISA), and the Labour Force Survey (LFS). Three surveys plan to cover education or life long learning in the near future: the European Adult Education Survey, the Time Use Survey, and the Adult Literacy and Life Skills Survey (Eurostat, 2001).

⁶ The presumed benefits of skills upgrading on income is not strongly supported by econometric research. For example, Devroye and Freeman (2001) report that higher skills (as measured by literacy levels) account for only 7% of pay differentials between Europe and the United States. In fact, by income quintile, there is little difference in the average literacy score within three EU countries, although there are large differences in income by literacy in the US. These results suggest that income support policies have a much greater effect on income in Europe than differences in skills. However, this could change if Europe adopts more ‘flexible’ labour market policies.

high tech services employment (0.75). These correlations do not establish a causal relationship between life long learning and innovation. However, they suggest, along with other research, that there could be a link. If true, this would suggest that many EU countries are failing to adequately invest in life long learning, given the substantial variation between EU member states for this indicator in both the 2001 and 2002 Innovation Scoreboards⁷. Furthermore, the difference between the member states for this indicator has been growing between the mid 1990s and 2000.

We believe that life long learning could play an important role in innovation, although the benefits of life long learning will vary both by the type of learning and by the type of innovation activity. In order to adequately cover these variations, this report contains 15 indicators on life long learning of possible relevance to innovation.

Due to data constraints, two indicators refer to 1993 or 1995, while the remaining thirteen refer to conditions in or after 1999. Unlike TrendChart's Innovation Scoreboard, trend analyses are not provided because reliable trend data are only available for three indicators.

Section 2 provides a brief review of the relationship between innovation and life long learning. The following four sections (sections 3 through 6 inclusive) discuss each of the four indicator categories and describe the specific indicators. Section 7 provides the main results.

2. Innovation and Life long learning

We use a broad definition of life long learning. This includes all types of learning; the educational system from kindergarten through university, formal courses taken later in life to learn a range of skills, such as reading, mathematics, computer literacy or vocational training; and informal learning outside of formal coursework, which may or may not be directly applicable to the workplace. Learning is often divided into two main groups: traditional (or formal) education from kindergarten through the completion of advanced university degrees, and other forms of training and learning. The traditional education system is oriented towards children and young adults, with most completing their education by their mid to late 20s. Conversely, further training and learning occurs outside the traditional education stream, and includes mature students that take tertiary education courses. Most life long learning indicators are relevant to non-traditional education.

Life long learning can positively influence three types of innovation: innovation as a creative activity, innovation as a diffusion process, and consumer demand for innovative products.

2.1 Innovation as a creative activity

The first innovative activity consists of major innovations that are developed through years of creative activity – usually requiring R&D and highly skilled scientists and engineers. This group of creative individuals will be highly motivated to continually learn in order to upgrade their skills and knowledge. Much of this learning will probably be informal. Other than ensuring a continuous supply of well-trained scientists and engineers, there is probably little need for policies to support life long learning among this group.

⁷ In the 2001 Innovation Scoreboard, the coefficient of variation for this indicator was the third highest among the 17 indicators, exceeded only by the coefficient of variation for the amount of new capital raise and for high technology patents. The coefficient of variation for this indicator increased in 2002.

There are possibly two basic models of creative innovation in respect to learning. The United States is a highly innovative economy with a highly educated elite, but a comparatively high percentage of the population has low levels of literacy. In contrast, the Scandinavian countries are also highly innovative, but literacy is more widely spread among the population, with only a small percentage of the population at or below the lowest literacy level. The innovative success of the United States shows that broad-based educational achievement is not necessary for innovation. Instead, the need for creative innovators can be met by an elite educational system.

2.2 Innovation as diffusion

The second type of innovation consists of the application (or diffusion) of new technical and organisational innovations by firms, government organisations, and other economic institutions. Some of these are major innovations that destroy existing modes of production and create new ones – requiring major technology-related shifts in skill requirements. These shifts will increase the skill requirements of many jobs and place a premium on flexibility, adaptability, continuous learning, and the ability to transfer experience and skill development between activities (OECD, 2001). In countries with ageing workforces, policy may need to provide support for older workers to learn completely new skills and overcome inflexible labour markets that have tended to favour younger over older workers.

Many other workplace innovations are incremental and build on existing technology, but these could require continual, ongoing minor adaptations of existing skills. This is probably the most common type of innovation experienced by workers, with surveys in the United States finding that most work-related learning concerns how to do existing tasks better, rather than how to do entirely new tasks (Tough, 2002).

A variant of innovation as a diffusion process is the shift in most modern economies from industrial to service employment. Current employment data suggest that this could require a higher skilled workforce, with 66% of all medium skilled and 80% of all high skilled workers employed in services (EC, 2001c), compared to 55% of low skilled workers. Tomlinson (2002), using the results of the 1997 UK Skills Survey of 2,467 individuals between 20 and 60 years of age, determined that the manufacturing sectors required problem-solving skills, while the service sectors required skills in literacy and planning. The most highly-skilled workforces are in high technology manufacturing, knowledge intensive business services, the public sector, and utilities/construction.

The diffusion rate for both major and incremental innovations could be affected by the uptake of new skills by a large fraction of the workforce. In particular, countries such as Sweden where a high percentage of the workforce has a high level of basic skills – which provide a solid basis for learning new skills - should do better than countries in which skills are concentrated among a smaller fraction of the population. Life long learning could therefore play a major role in ensuring the rapid diffusion and efficient application of technical and organizational innovation.

2.3 Consumer demand for innovative products and services

The third type of innovation involves the adoption of innovative technology and services by the general population - consumer demand that creates a market for innovation. This includes the adoption and successful use of mobile telephones, or the use of the Internet to access

information, purchase products, etc. Some of these products could require substantial learning by the user, although competition can also make new technologies simpler to use over time. Much of this learning will probably be informal.

2.4 Innovation and life long learning

To sum up, indicators of life long learning for innovation must focus on learning that is of benefit to one or more of these three innovation activities. Most life long learning outside of the traditional education system is relevant to innovation as a process of diffusion or consumer demand for innovative technology. In contrast, only a few indicators are of relevance to creative innovation. For this reason, other than a few measures of basic educational achievement that provide a foundation for all types of further learning, we do not include many indicators for traditional education⁸.

We evaluate four different types of indicators of relevance to the effect of life long learning on innovative capabilities:

1. The learning economy,
2. 'Foundation' skills,
3. Participation in life long learning
4. Enterprise-level investment in life long learning

Each of the following sections evaluates the basic purpose and problems with each indicator category, provides a basic description of the individual indicators within each category, and discusses alternative indicators that would be of value but which are not yet available. Full details on each specific indicator are given in Annex A⁹.

3. The learning economy

Four indicators measure the shift towards a 'learning' economy where life long learning is an economic necessity, due to the distribution of important knowledge for innovation among a wide range of firms and institutions (Smith, 2002). Much of this knowledge is embodied in new equipment or organizational routines. The effective adoption and application of many of these innovations will depend not only a few key engineers or scientists, but on appropriate skills held by a comparatively high percentage of the working population. The acquisition and maintenance of these skills will partly depend on life long learning.

The four indicators for a learning economy include the percent of the employed population with high skill levels, the change in employment in the share of the workforce with high skill levels, the failure to learn new skills, as proxied by the long-term unemployment rate among men 25 to 54 years of age; and the maintenance of economically useful skills among older workers (55 – 64 years of age), as proxied by their employment rate. Of note, the indicator for long-term unemployment, unlike all other indicators, is a negative indicator. Good performance occurs when the indicator is as low as possible.

⁸ This contrasts with the choice of indicators from the Working Group on Quality Indicators of Life long Learning (WGQILL, 2002) and published in the document '*15 quality indicators of life long learning performance in Europe*'. The document includes indicators on total educational spending and teacher training that are not as relevant for maintaining innovative capabilities among older workers. For a list of current education and training indicators across the EU, plus relevant national surveys, see Eurostat (2001), Annex 2.

⁹ See Eurostat (2001) for an overview of current work on life long learning indicators.

None of these indicators are ideal measures of a learning economy, largely because of possible biases from non-learning related factors. However, these four indicators provide a valuable context for interpreting other indicators. For example, we would expect indicators for participation in life long learning (Section 5 below) to be greatest in countries that have moved farthest towards a learning economy.

3.1 Alternative economic indicators and future developments

Life long learning is not a panacea for all mismatches between the supply and demand for skills. It is also possible for countries to provide more training than required, or to train the ‘wrong’ groups. For these reasons, it would be of interest to have an indicator for the match between current skills and current job requirements.

A few countries, such as Canada, provide survey results on the percentage of the workforce whose skills are higher than those needed for their job and the percentage whose skills are lower than needed (Statistics Canada, 2002). The ratio between the over and under skilled is a possible future indicator of interest to life long learning. A high imbalance would show excessive training and skills given the current structure of the economy, or that training is going disproportionately to the already skilled, while the low-skilled are not receiving adequate training (or formal recognition for their skills). The main disadvantage of such an indicator is that some imbalance towards over-skilling is expected from recent entrants to the workforce, but it is difficult to estimate an acceptable rate of over-skilling. Over-skilled individuals will probably change jobs over time until they reach a job that is more appropriate for their skills.

4. Foundation skill levels

The ability of individuals to continually learn throughout their lives depends on the basic literacy and numerical skills that they acquired as children. A failure to obtain these basic skills can undermine further education and skills development. Therefore, life long learning and innovation (particularly as diffusion) depend on a large percentage of the population having good literacy, numerical, and computer skills.

In the absence of these skills, a significant fraction of life long learning will be remedial and of less value to innovation (see section 5 below). In contrast, when foundation skills are in place, life long learning can focus on skill upgrading.

The indicators for foundation skills are based on reading literacy, quantitative literacy, and computer skills. There are three indicators for youth and one for adults. The former are obtained from the 2000 PISA survey of 15 year olds. The three indicators are: the percentage that read at level 3 or above, the percentage that read at level 5 (the highest level), and an index for comfort with using computers. These indicators provide a measure of the future innovative capacity of an economy, based on the ability for further learning. Conversely, indicators for adults (beyond the age when most traditional education has been completed) provide a current measure of learning abilities that could be of value to innovation. The scoreboard includes one indicator for adult foundation skills, which is the percentage of adults (16+) at level 4/5 for quantitative literacy. These results are obtained from the IALS surveys between 1994 and 1998.

We do not use formal educational qualifications as indicators of foundation skills, such as the percentage of the population that has completed secondary or tertiary education, because these

indicators are often unsatisfactory for cross-national comparisons, due to differences in the types of foundation skills provided by traditional education systems. As an example, a very high percentage of the US population has a secondary or tertiary level education, but the average document literacy score for Americans with upper secondary education is 266 (level 2) versus 308 (level 3) in Sweden. The US also has an above average percentage of citizens with *less* than a level 3 rating for prose, document and quantitative literacy (OECD, 2001)¹⁰.

Level 3 literacy is generally thought to be the basic level required for further education or training. Furthermore, traditional educational qualifications, particularly among adults, will miss adults that have improved their foundation skills through their own efforts. In Canada, literacy has a strong effect on an individual's occupation, independent of education (Statistics Canada, 2002), suggesting that literacy is a better measure of job skills than formal qualifications.

4.1 Alternative indicators and future developments

Both the PISA and IALS surveys will be implemented again in the near future. An update of IALS is expected in the fall of 2002, with first results ready in 2004. The next PISA survey, in 2003, will focus on science education. The results will also be available in 2004.

5. Participation in life long learning

Constructing comparable indicators for participation in life long learning raises two main issues: whether or not the inclusion of remedial education in life long learning indicators will create a serious problem and whether or not informal learning should be included in these indicators.

Adults can undertake further learning after the completion of their traditional education either to improve their foundation skills, as in remedial education, or to expand their skills. Remedial learning to overcome deficiencies in foundation skills will often have little relevance to innovation, unless the individual continues their education to acquire more advanced skills. This can create problems for international comparisons, since we often do not know if adult learning is remedial or not. For example, part of the reason why the percentage of adults taking training courses is higher in the UK than in other EU countries could be due to lower average qualification levels in the UK after completion of formal education (NSTF, 2000).

This raises the question: does training to raise the basic skills of the least skilled fraction of the population improve the innovative capacity of a country? This type of learning is unlikely to have an effect on innovation as a creative activity, but it could improve innovation as diffusion or consumer demand for innovative technology. Another possibility is that improving the skills of the least skilled could 'free up' more skilled individuals for other work, and so on down the skill chain. This would be possible if there is a general skills shortage and if employers are consequently forced to hire people with poor skill levels for jobs that require higher skill levels. However, the evidence from several countries suggests that the opposite is occurring. Aggregate educational attainment has increased *faster* than

¹⁰ The relatively high percentage of adults with very low literacy skills is partly due to a higher percentage of immigrants in the United States than in European countries, although this explanation does not hold when comparing the US with Canada and Australia. Both of the latter two countries have higher literacy rates and a higher proportion of the workforce that are foreign-born.

aggregate educational requirements for work in both Canada and the US – people are overeducated for their work in the current job structure (Livingstone, 2001). Although there are pockets of skill shortages in some areas, such as for IT skills¹¹, these jobs require highly advanced skills that are unlikely to be acquired entirely through adult education.

A second concern for developing life long learning indicators of relevance to innovation is who takes further education and the types of education that they pursue. Research shows that the percentage of the population that pursues further training (after the completion of their traditional education) is often ‘U’ shaped, with the lowest incidence among individuals with a secondary level education. The participation rate is higher among individuals with less than and more than a secondary level education (Hum and Simpson, 2001). Many of the individuals with less than a secondary education are probably in remedial education courses. However, there is a lower cut-off in participation rates - only a very small percentage of adults with very low literacy and numerical skills ever enroll in programmes to improve their reading or writing skills.

The type of learning could also influence innovation. Mature university students who have decided to go to university after several years or more in the workforce are substantially more likely to pursue studies in the humanities instead of in the sciences (Bourgeois, 2001). Only 5% of adult students in the UK, 14% in Germany, and 15% in Sweden are in the sciences. Most mature students are unlikely to become scientists or engineers involved in creative innovation, although they could acquire skills of value to the diffusion of innovations.

The second main issue is the role of formal, coursework based learning versus informal learning. Much of the latter occurs on the job. It is more difficult to measure informal than formal learning, although informal learning could be more valuable, as shown by a 1998 survey of managers in the UK (NSTF, 2000). Research in Canada finds that informal learning, mostly on-the-job, accounts for approximately 75% of all learning activity. Livingstone (2001) reports that 70% of all job training is informal, while Tough (2002) estimates that 80% of all learning in the US is informal.

On-the-job informal learning increases in importance when firms adopt organizational innovations such as team-based working, JIT production, TQM, or a ‘learning culture’. Job switching or mobility also increases informal learning (NSTF, 2000).

Informal learning can be very important for the acquisition of technical skills such as using computers or ICT. For example, a Canadian survey (Statistics Canada, 2001) asked respondents to name their most important source for learning how to use their main computer application. Informal learning, either from on-the-job training from co-workers and supervisors or self-instruction, was cited by 79% of the respondents. Formal training, paid for by the employer, was cited by only 13% of the respondents while another 8% cited other sources. In Europe, 45.4% of computer users stated that they learnt how to use the computer ‘alone at home’, 30% learnt at work either alone or assisted by colleagues, and only 24.1% learnt at school or in a training course (EC, 2001b, Table 6.2).

The difficulty for indicators that include informal learning is that it is often not clear what is measured in surveys of informal training or if the results are comparable between individuals or countries. Betcherman et al (1998) argue that it may not be necessary to try to measure

¹¹ The NSTF (2000) gives results that estimate that about 8% of UK employers cited a ‘significant’ shortfall in the IT skills of their employees.

informal learning because measures of informal training show that it is evenly distributed among populations. The real difference between groups is in the amount of formal training or learning. Aside from these reservations, a broad indicator for life long learning that includes all forms of training is probably of value for innovation. One reason is that basic skills such as reading literacy decline with age, even after standardizing for education. This suggests that people must continue to use their skills in order to maintain them (OECD, 2001). This suggests that any type of ongoing education –either formal or informal - may both maintain existing skill levels and ensure that individuals retain a capacity to learn new skills.

5.1 Indicators for participation in life long learning

The scoreboard includes four indicators for participation in life long learning. The first indicator, obtained from the Eurobarometer survey in the last quarter of 1995, is the estimated percentage of the adult population (over 15 years of age) that wish to “keep learning all their lives”. This indicator provides a measure of a positive attitude to life long learning. A key indicator for life long learning is derived from the Labour Force Survey and gives the percentage of the working-age population (24 – 64) undertaking any form of learning in the four weeks before survey. The indicator includes both informal and formal learning and is not restricted to learning that is related to employment. The third indicator is the percentage of adult men (25 to 54) in 2000 that are not employed and who are students, in further training, or in unpaid work experience. This indicator measures more intensive learning than that measured by the life long learning indicator above, including men in full-time retraining. The fourth indicator for participation in life long learning is the percentage of the adult (over 15) population with home Internet access. Although not a direct measure of life long learning (or even of actual Internet use), home Internet access can provide citizens with a useful tool for many different types of learning. This could include learning of value to both employment skills and to innovation.

5.2 Alternative indicators and further developments

Several possible variations of these indicators for participation in life long learning are available in some EU countries. For example, the UK collects data that can be used to estimate the percentage of adults that are enrolled in adult education courses. This could provide valuable information if it is possible to identify participants in remedial courses. A second alternative indicator is to use household budget surveys to estimate the percentage of household expenditures that are spent on education. One disadvantage is that a substantial share of spending will be for formal education by both adults and children. Therefore, this indicator will not be of value unless it is possible to exclude household spending for traditional (not mature) students.

As noted above, an indicator for adult ICT literacy would be of great value. The International ICT Literacy Panel, including representatives from the US, Canada, Australia, Brazil and France, are developing an ICT literacy survey modeled on the IALS¹², but the survey is still several years off.

Several surveys have highlighted the importance of informal learning at work with the assistance of colleagues, either for learning how to use ICT equipment (EEIG, 2000; Statistics

¹² The report (ETS, 2002) defines ICT literacy as ‘using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate and create information in order to function in a knowledge society’.

Canada, 2001) or when firms adopt organizational innovations (NSTF, 2000). Informal learning could be enhanced via job mobility, both by individuals changing positions in the same firm (job rotation or switching), and by job mobility between firms. Conversely, high job mobility rates would be expected in a flexible labour market or in response to poor wages, so that workers seek slightly better or different jobs. To avoid this problem, we would be particularly interested in job rotation or mobility data among the highly skilled. A second-best indicator would be job mobility rates in high technology sectors.

6. Enterprise investment in life long learning

The indicators listed in section 4 above cover all types of further learning, which includes learning that is of no direct relevance to current employment. The indicators in this section are limited to learning activities that are of direct relevance to firms, and consequently mostly funded by firms. The indicators for most countries are drawn from the 2000 Continuing Vocational Training Survey (CVTS2) (Nestler and Kailis, 2002) and for a few countries from the 1994 CVTS (DG Research 1999). The CVTS indicators refer to job-related training among employed individuals¹³. These indicators are of value because job-related training is thought to be more effective in improving skills than job-related training by the unemployed (OECD, 2001). The difference could be due to higher motivation levels among the former, partly due to a clearer understanding of the future application of new skills.

Most of the published indicators from the CVTS concern the percentage of firms that provide training to their staff, or the participation rate and characteristics of individuals in firms that offer training. These indicators are not very useful for our purposes because training rates vary substantially by firm size and sector, which can bias international comparisons. Instead, we use two universal indicators from the CVTS that are free of such possible biases.

The three indicators for enterprise investment are as follows. The first indicator is the percentage of all employees (of any age) in 1999 that have taken job-related training courses (both outside and within the firm)¹⁴. The second is a 1999 estimate of total business spending on job-related training as a percentage of total labour costs. The third is the percentage of the employed population that has taken a computer training course, obtained from the November 2001 Eurobarometer survey.

6.1 Alternative indicators and further developments

The indicator for business expenditures on training covers all types of training, which possibly includes remedial or other training that is only indirectly related to innovation. In contrast, the third Community Innovation Survey (CIS-3) of the European Union includes a ‘yes’ or ‘no’ question that asks specifically if the firm spent anything on “internal or external

¹³ Indicators obtained from surveys of firms could be increasingly unrepresentative, however, due to an increase in self-employment (especially in services) and part-time or flexible work. Under these conditions, employers will be less committed to employee training, except for a core group of skilled employees (Betcherman et al, 1998). Individual workers will be increasingly responsible for their own training. For these reasons, it is vitally important to include data on life long learning that is not obtained from the workplace, such as household surveys.

¹⁴ This excludes other forms of job-training covered in the survey, including on-the-job training, attending conferences and workshops, job rotation, and self-learning.

training for your personnel directly aimed at the development and/or introduction of innovations”. Results for this question should be available in the Spring of 2003¹⁵.

7. Results and interpretation

The complete results for the Life long Learning Scoreboard are given in Annex B. Table A defines each indicator, gives the reference year, and provides the data sources. Table B gives the results for each indicator for the 15 EU member states. Four indicators are not available for four or more member states (indicators 1.2, 2.3, 2.4, , and 4.3). The result is that the median number of indicators per country is 13, with a range from 11 to 15. Table B also gives results for the United States, Japan, Switzerland, Iceland, and Norway, but data coverage for these countries is much poorer, ranging from only three indicators for Japan to nine for Norway. Due to poor coverage, these countries are excluded in the discussion of the results. Where relevant, we compare the Life long Learning Scoreboard to Trend Chart’s 2001 Innovation Scoreboard¹⁶.

7.1 EU leaders and the coefficient of variation

Table 1 summarizes some of the main findings, giving, for each indicator, the EU mean, the two leading EU countries, and the coefficient of variation. As with Trend Chart’s 2001 Innovation Scoreboard, the EU leaders are dominated by the Nordic countries. Sweden is in a leading position for eight indicators, Denmark for six, and Finland for three. The Netherlands is leading for four indicators and the UK for three.

The last column of Table 1 gives the coefficient of variation (CV). A high value shows that there is a large variation in the indicator across the member states for which data are available. The two highest values of the CV are for indicator 1.2 (the change between 1998 and 2000 in the share of all employees with high skills) and for indicator 2.3 (computer comfort of 15 year olds). However, both of these two CVs are unreliable because data are missing for a relatively large number of countries¹⁷. After these two indicators, the highest CV is for two indicators of life long learning among adults: indicators 3.2 and 3.3, followed by indicator 2.2 on high-level reading skills among 15 year olds. All three of these indicators concern the education infrastructure and can therefore be directly influenced by government policy.

One of the three lowest CVs is for indicator 1.1 (the share of all employees with high skills), which shows that all EU member states are experiencing similar shifts towards a knowledge based economy. The second lowest is for indicator 2.1 (the percentage of 15 year olds reading at level 3 or above), which shows that most EU countries have similar success rates in

¹⁵ Similar versions of this question were asked in the second CIS referring to 1996 and in the first CIS referring to 1992. However, the first CIS combined training expenses with trial production and tooling up. The second CIS limited the question to ‘training directly linked to technological innovations’, but there was a very high non-response rate to this question, which reduces the reliability of the answers. Hopefully, the more careful definitions in the third CIS will provide useful results, although data on expenditures for training are combined with expenditures on marketing and design.

¹⁶ We do not make a comparison with the 2002 Innovation Scoreboard because the collection date for most of the data in the life long learning scoreboard is more similar to that of the 2001 Innovation Scoreboard.

¹⁷ In addition, the CV for indicator 1.2 is strongly influenced by the very high value for Austria, which could be due to sampling variation in the Labour Force Survey.

teaching basic reading skills¹⁸. The third indicator with the lowest CV is for indicator 3.1 (percent of adults with a positive attitude to further learning).

An additional point of interest is that the average CV for the 15 indicators in the life long learning scoreboard is 47.8, which is lower than the average CV of 60.0 in Trend Chart's 2001 Innovation Scoreboard. This is probably because policy has a greater influence over many of the indicators in the former than in the latter scoreboard, which tends to reduce differences between countries¹⁹.

Table 1. Main findings for Life long Learning Indicators for Innovation

No	Indicator	EU mean ¹	EU leaders		CV ²
1.1	% highly skilled employees / all employees	40.5	50.0 (FIN)	48.1 (NL)	17.6
1.2	% change in high skilled employee share	2.9	8.3 (A)	5.7 (DK)	93.1
1.3	Long-term unemployment rate for men 25-64 ³	2.1	0.4 (L)	0.6 (NL)	49.7
1.4	Employment rate for older workers (55-64)	40.9	66.5 (S)	58.0 (DK)	28.9
2.1	% 15 year olds reading at level 3+	59.6	77 (FIN)	71 (IRL)	16.3
2.2	% 15 year olds reading at level 5	8.6	16 (FIN)	16 (UK)	51.3
2.3	Computer comfort of 15 year-olds (index)	-0.11	0.15 (B)	-	118.8
2.4	% adults (16+) level 4/5 quantitative literacy	21.1	35.8 (S)	28.4 (DK)	37.5
3.1	% adults (15+) positive attitude to learning	72.7	92 (DK)	89 (EL)	16.7
3.2	% adults in any education/training	9.8	21.7 (UK)	21.6 (S)	75.9
3.3	% adult men (25-54) in formal education	1.6	4.4 (S)	2.9 (I)	69.2
3.4	% adults (15+) with home internet access	37.7	63.8 (NL)	60.7 (S)	34.9
4.1	% employees taking job-related training	35.5	60 (S)	53 (DK)	36.8
4.2	Training costs as % of labour costs	1.9	3.0 (DK)	2.8 (NL/S)	35.5
4.3	% employees with computer training	34.1	55.2 (DK)	48.3 (S)	34.6

1: Mean based on the value for each country without weighting by population etc.

2: Coefficient of variation.

3: Inverse indicator: best performance equals the lowest percentage of long-term (over 1 year) unemployment.

7.2 Composite index for life long learning

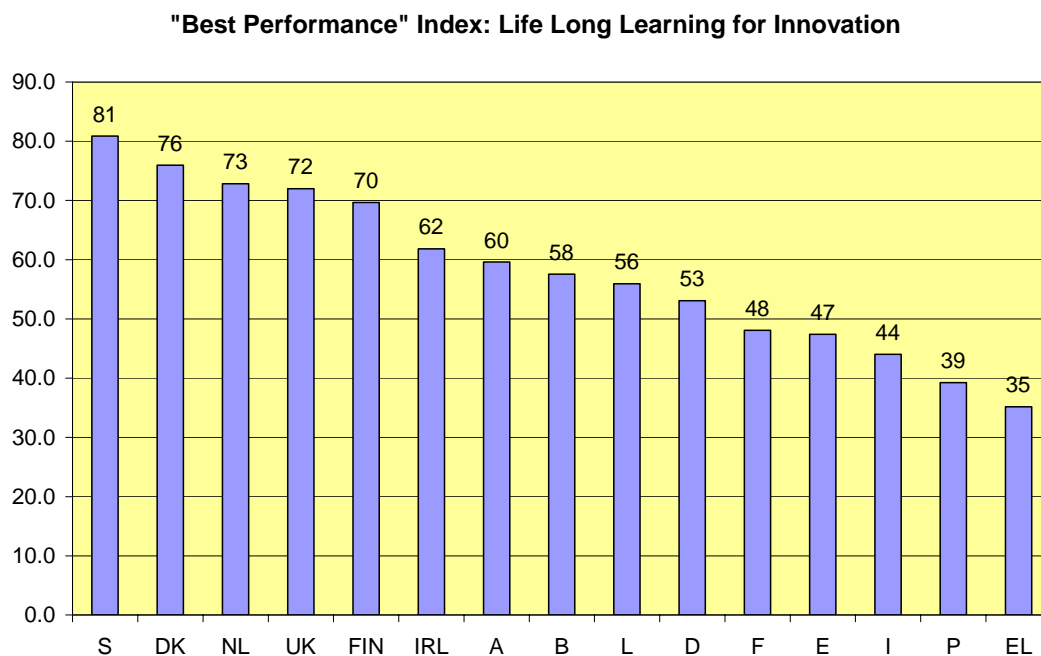
Figure 1 ranks each member state using a composite index based on the relative performance of each country compared to the leading country for each indicator. For example, assume that country A is the best performer on indicator 1.1 at 50%, while country B has a score of 40%

¹⁸ The EU mean of 59.5% for this indicator should not be compared to the mean of 60% for the US because the EU mean is not weighted by population size. Similar constraints apply to indicator 2.2.

¹⁹ There is a similar difference within the Innovation Scoreboard, with lower CVs for indicators that are influenced by policy compared to indicators that directly measure business innovation investments and outcomes.

for indicator 1.1. The relative performance of country B is 80% ($40\%/50\% \times 100$). The Best Performance Index (BPI) for each country is its average relative performance for all indicators for which data are available²⁰. We also calculated the BPI after excluding five indicators that were not available for over two countries. The two are highly correlated with an R^2 value of 0.95.

Figure 1



The rank order of countries using the BPI must be interpreted cautiously. Small differences in the BPI are not meaningful due to sampling variation in the underlying indicators, many of which are based on the Labour Force and other surveys with 95% confidence limits of several percentage points. In addition, estimates of training participation rates, as with indicators 3.2 and 4.1, can vary due to subjective recall and other biases, as shown by comparisons of the results of different surveys (Heller, 2002; Zamorra, 2002). Aside from these caveats, many of the countries that do well in the Life long Learning Scoreboard also do well in Trend Chart's Innovation Scoreboard (see www.cordis.lu/trendchart and click on 'Innovation Scoreboard'), as shown by an R^2 value of 0.85 in a correlation between the BPI for both scoreboards.

²⁰ TrendChart has experimented with four other methods of creating a composite index (see the forthcoming methodology report on the TrendChart website). All are closely correlated. However, the advantage of the BPI compared to some of the alternative methods is that the BPI does not assume that 'more' is always 'better'. For example, other methods of constructing a composite index for life long learning would give a very high score to a country in which its entire population is highly educated and continues to be in school or training. Although the high level of education would be an advantage for innovation, too much school would be enormously costly and severely limit the ability of the economy to provide other inputs into innovation – let alone the basic requirements of modern life. Clearly, too much of a good thing can be too much.

Of interest, the rank order of some countries changes by two or more positions between the two scoreboards. Finland, Germany and France rank lower on the Life long Learning Scoreboard than on the Innovation Scoreboard, while Austria, Belgium and Luxembourg rank higher on the Life long Learning Scoreboard. There are two possible explanations. First, the BPI for Life long Learning could be a leading indicator of future changes in innovative capabilities. If true, Austria, Belgium and Luxembourg could catch up in the future to other more innovative European countries. A second possible explanation is due to the focus of each scoreboard on different types of innovation. The Innovation Scoreboard is probably better at capturing creative innovative activities, while the Life long Learning Scoreboard is a better measure of national capabilities in the adaptation of innovations (or innovation as a diffusion process). This would suggest that the better score for Finland, Germany and France on the Innovation Scoreboard could be due to greater emphasis on creative innovation, as shown by Finland's strengths in telecommunications, Germany's strengths in the automotive and machinery sectors, or France's strengths in luxury consumer goods. Austria, Belgium, and Luxembourg may lag in creative innovation, as captured by the Innovation Scoreboard, but be more successful in diffusive innovation. If this interpretation is correct, this would also imply that Sweden and Denmark are successful at both creative and diffusive innovation, while Portugal, Italy and Greece could be lagging in both.

7.3 Relative strengths and weaknesses of each country

A major interest for policy is to identify the main strengths and weaknesses of each country, so that policy can be designed to address the latter and continue to support the former. Table 2 identifies the major relative strengths and weaknesses of each country. These are limited to a maximum of three indicators that are at least 25% above or below the EU mean. The countries are ranked in order of their BPI.

Not surprisingly, the EU leading countries on the BPI have few relative weaknesses, and this is entirely for the percentage of adult men in formal education, with the exception of Denmark, which shows also a relative weakness in the index for comfort with computers by 15 year-olds. This could be due to other means of increasing qualifications in this group, such as via job-related training or other forms of further learning. Conversely, the EU lagging countries have few areas of strength. The percentage of adult men in formal education is the only relative strength for Italy and Greece. These two countries could be using this method to improve skills, since they are relatively weak on other measures of further learning.

Table 2. National Strengths and Weaknesses for Life long Learning for Innovation

Country	Major relative strengths	Major relative weaknesses
Sweden	Participation in further learning (3.2), adult men in formal education (3.3), employees with job-related training (4.1)	None
Denmark	Increase in high-skilled employment (1.2), long-term unemployment (1.3), adult participation in further learning (3.2)	15 year-olds computer comfort (2.3), adult men in formal education (3.3)
Netherlands	Long-term unemployment (1.3), adult participation in further learning (3.2), home internet access (3.4)	None
UK	15 year-olds reading at level 5 (2.2), participation in further learning (3.2), enterprise spending on training (4.2)	Adult men in formal education (3.3)
Finland	15 year-olds reading at level 5 (2.2), adult participation in further learning (3.2), employees with job-related training (4.1)	Adult men in formal education (3.3)
Ireland	15 year-olds reading at level 5 (2.2), home internet access (3.4), enterprise spending on training (4.2)	Long-term unemployment (1.3), adult participation in further learning (3.2) and adult men in formal education (3.3)
Austria	Increase in high-skilled employment (1.2), long-term unemployment (1.3), adult men in formal education (3.3)	employment of older workers (1.4), attitude to further learning (3.1), enterprise spending on training (4.2),
Belgium	15 year-olds reading at level 5 (2.2)	Increase in high-skilled employment (1.2), long-term unemployment (1.3), employment of older workers (1.4)
Luxembourg	Long term unemployment (1.3)	15 year-olds reading at level 3+ (2.1), 15 year-olds reading at level 5 (2.2), adult participation in further learning (3.2)
Germany	None	Long-term unemployment (1.3), 15 year-olds computer comfort (2.3), adult participation in further learning (3.2)
France	None	Long-term unemployment (1.3), adult participation in further learning (3.2), adult men in formal education (3.3),
Spain	None	15 year-olds reading at level 5 (2.2), adult participation in further learning (3.2), employees with computer training (4.3)
Italy	Adult men in formal education (3.3)	Long-term unemployment (1.3), employees with job-related training (4.1), enterprise spending on training (4.2)
Portugal	Long-term unemployment (1.3)	High-skilled workforce share (1.1) 15 year-olds reading at level 5 (2.2), adult quantitative literacy (2.4), adult participation in further learning (3.2),
Greece	None	Adult participation in further learning (3.2), home internet access (3.4), employees with job-related training (4.1)

Notes: Limited to three leading indicators that are above or below 25% of the EU mean.

7.4 Internal correlations

We conducted an analysis of the 15 life long learning indicators in order to 1) identify which indicators are correlated with the Trend Chart Innovation Scoreboard BPI, 2) which indicators

are correlated with the four indicators for a learning economy, and 3) to identify ‘key’ indicators for life long learning²¹. The first and second set of analyses identify indicators for life long learning that are more closely related to innovation, with implications for the focus of policy actions. The last set of analyses also provides a short list of key indicators that could be easier to collect across EU countries, thereby improving comparability.

All correlation coefficients are given in Annex B in Table C. It is important to note, however, that the correlations are exploratory. A significant correlation does not indicate causality, particularly because all of the indicators are contemporaneous. However, a significant correlation does suggest that there may be a causal relationship, although considerably more research would be required to establish the form and cause of any such linkage.

7.4.1 Correlations with the Innovation Scoreboard BPI

The correlations exclude indicator 2.3 (too few observations) and two indicators that are also included in the Innovation Scoreboard (3.2 and 3.4). Of the remaining 12 indicators for life long learning, eight are significantly correlated with the BPI for the Innovation Scoreboard. This further suggests that there is a link between many of the life long learning indicators and innovation. Of the four indicators for the learning economy, two are significantly correlated with the Innovation Scoreboard BPI: indicator 1.1 for the percentage of the workforce with high-level skills and indicator 1.4 for the employment rate for older workers. The first correlation is expected, but the second is more surprising, since high employment rates among this group should largely benefit diffusive innovation. Alternatively, the latter correlation could be confounded by below average unemployment rates among several of the more innovative economies in Europe.

All of the indicators for foundation level skills and for enterprise investment in life long learning are significantly correlated with the Innovation Scoreboard BPI. This potentially highlights the importance to innovation of both foundation skills and employment involvement in learning. In contrast, neither of the two remaining personal indicators for participation in life long learning is correlated with the Innovation Scoreboard BPI: positive attitudes to life long learning and the percentage of adult men in formal training or work experience.

One possibility that can be evaluated using an indicator from the Innovation Scoreboard is that countries with an excellent formal education system (including both vocational and academic education) could do poorly on the life long learning indicators compared to a country with a poor formal education system (see discussion in section 5 above). This is because the population in the first country could have considerably less need for further learning, while the latter country could use further learning for remedial education. We explored this possibility by correlating all of the four life long learning indicators in the category “participation in life long learning” and the three indicators in the category “enterprise investment in learning” with Trend Chart’s Innovation Scoreboard indicator for the percentage of the population with a tertiary level education (ISCED 5 and above, which includes two year diploma programmes). If countries that are good performers in formal education require less further learning (and vice versa), then we would expect a negative correlation between the tertiary education share and the life long learning indicators. However, there are no negative correlations between the tertiary education and the seven

²¹ All analyses were limited to results for the 15 EU countries and exclude, due to many missing values, indicator 2.3 on computer comfort among 15 year-olds.

other indicators. Conversely, tertiary education is positively and significantly correlated with four of the seven relevant life long learning indicators and of borderline statistical significance ($p = .06$) with a fifth. This suggests either that excellent foundation skills, as shown by a high percentage of the population with tertiary education, is likely to lead to further education, or that high foundation skills provide an incentive for skill upgrading on the part of the population that did not acquire them through formal education.

7.4.2 Correlations with the learning economy

None of the four indicators for a learning economy are correlated with each other. This indicates that these four indicators capture different aspects of a learning economy. However, the first indicator for the percentage of the workforce that is highly skilled is the key indicator among this group, as it is most closely linked to concepts of an innovative economy. This indicator is significantly correlated with the three foundation skill indicators and with the three enterprise investment indicators. It is also correlated with indicator 3.2 on the percentage of adults in any type of education or training, and indicator 3.4 on home Internet access. These results suggest that a highly-skilled economy is linked to good foundation skills, high levels of enterprise investment in learning, and broad-based learning by adults.

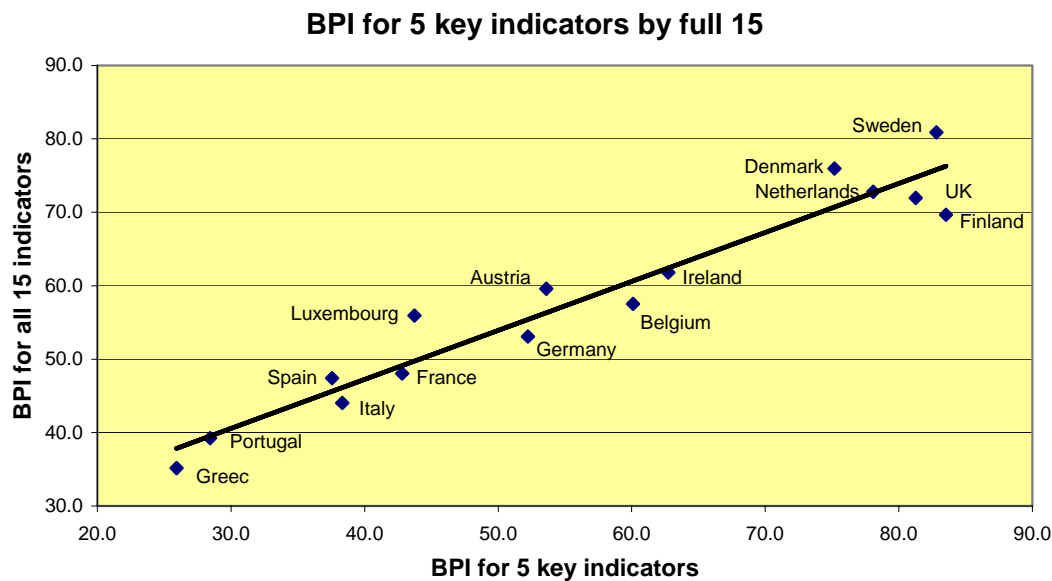
The indicator for the change in the high skilled workforce is not correlated with any of the other indicators, although this could partly be due to the small number of countries with data. Indicator 1.3 on the long-term employment rate is negatively correlated with home Internet access and the percentage of employees with computer training, suggesting that ICT skills could be crucial to retraining. Indicator 1.4 on the employment rate for older workers is positively correlated with indicator 3.2 on adult participation in any type of education or training and indicator 4.2 on training costs as a percentage of labour costs.

7.4.3 Key indicators for life long learning and innovation

Based on the number of significant correlations for each indicator, we identify five key indicators: 1.1 on the high-skilled workforce share, 2.2 on the percentage of 15 year-olds reading at level 5, 3.2 on adult participation in any type of education or training, 3.4 on home internet access, and 4.1 the percentage of employees taking job-related training. Of interest, all four life long learning categories are included among the five key indicators, with two indicators in the category ‘participation in life long learning’.

With the exception of indicator 2.2, which is not available for the Netherlands, all other key indicators are available for all EU member states. The BPI based on the five key indicators is highly correlated with the BPI using all 15 indicators, with an R^2 value of 0.93. This suggests that the key indicators can be used to estimate the status of each country on life long learning. A comparison of each BPI is given in Figure 2. As shown in the Figure, there is little variation in the relative ranking for all but the top five countries, where shifts of between 3 and 4 rank orders are observed, depending on whether the key 5 or all 15 indicators are used. The top five countries also form a more visible cluster in Figure 2, compared to Figure 1.

Figure 2



8. Conclusions

Knowledge-based or ‘learning economies’ require a well-educated population with excellent foundation skills and a capacity for continuous learning. Life long learning should therefore form a key component of national innovative capabilities. This thematic Innovation Scoreboard assembles 15 indicators for measuring life long learning in each EU member state.

The most innovative countries in Europe, as identified in TrendChart’s Innovation Scoreboard, are also the leaders in life long learning: Sweden, Denmark, Finland, the UK, and Ireland. Conversely, some of the least innovative countries also have the lowest Best Performance Index in life long learning: Italy, Portugal and Greece. This result is confirmed by a high correlation (R^2 of 0.85) between comparable Best Performance Indices for the Innovation and Life long Learning scoreboards. Although these results do not establish that good performance on life long learning can directly improve innovative performance, the results are suggestive of such a link. Unfortunately, good quality trend data is only available for three of the life long learning indicators, which prevents a direct analysis of the causal relationship between life long learning and innovation.

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Annex A: Indicator definitions

1.1 High-skill employment share

This indicator is the percentage of the workforce in 2000 that is highly skilled. This includes employees in three highly-skilled occupational categories (managers and legislators, professionals, and technicians) and employees in other occupational categories with some tertiary education²². The other occupational categories include clerical, service and sales, agriculture, craft, plant operators, and other elementary jobs. Employees in these six categories with some tertiary education (ISCED 5 and above) are classified here as highly-skilled. On average, this group accounts for 10% of highly-skilled employees, with a range by country between 3% and 24%²³. It is important to include them within the high-skilled group because some of the jobs in low and medium-skilled occupational categories will require higher skill levels, although part of this group could be over-educated for their job.

1.2 Shift towards high-skill employment

As a country moves towards a knowledge-based or learning economy, the mix of low/medium and high-skilled employment should shift towards the latter, resulting in an increase in the percentage of all employees with high level skills. The indicator gives the percentage change between 1998 and 2000 in the share of highly-skilled employees in total employment. Unfortunately, due to gaps in the time series, data are unavailable for six EU countries.

1.3 Long-term unemployed

Long-term unemployment (over 12 months) is an indicator of structural unemployment that partly reflects a lack of useful skills for the current job market in each country. Some of this skill shortfall could be remedied by adult education. However, long-term unemployment is often prevalent among new labour force entrants, many of whom will be highly skilled, while women that have left the workforce for many years may be discouraged from joining it again. To avoid these distortions, we limit the indicator to the long-term unemployment rate among all men between 25 and 54 years of age in each country. Very few men in this age group voluntarily exit the labour force and most of them have been employed before (OECD, 2002). The indicator is still not perfect, since long-term unemployment among this group will also vary by age discrimination, such as difficulties for older men to find work, and disincentives to seek work, such as good unemployment benefits or early retirement plans²⁴. In addition, long-term unemployment will decline as the general unemployment rate falls, possibly because firms will hire staff with less than the desired skills in a tight labour market.

²² All occupational categories are at the ISCO 1 digit level.

²³ For Ireland, data on the number of employees in the six 'other' ISCO occupational categories with some tertiary education are only available for 1998. Consequently, the share of high skilled employees from these six occupational classes in 2000 is estimated, using their percentage share of all high skilled employees in 1998. This will slightly underestimate the final indicator for Ireland if this share has increased between 1998 and 2000.

²⁴ Of note, the indicator includes all men in the cohort and is not limited to the labour force. However, almost all men in the EU in this age range are employed, ranging from a low of 83.3% in Finland to a high of 92.8% in Luxembourg. On average, only 5.6% are not in the labour force or in education due to retirement, disability, or other reasons.

This is a negative indicator for life long learning. A high long-term unemployment rate for men in this age group suggests an inadequate level of life long learning to retrain or upgrade skills.

1.4 Employment rate of older workers

High employment rates for older workers between 55 and 64 years of age will partly be due to their maintaining or acquiring economically valuable skills, although it is difficult to identify the effect of either poor pension plans as a motive for remaining in work, or good pension plans as a motive for early retirement. This indicator is available from Eurostat's Structural Indicators.

2.1 Percentage of 15 year olds reading at level 3 or above

This indicator is derived from the PISA (Programme for International Student Assessment) survey. In 2000, PISA tested a sample of 15 year-old students in all OECD countries on their reading and numerical skills and their science knowledge²⁵. Age 15 was chosen because almost all youth of this age are still in school and because 'by the age of 15, young people will have had a series of learning experiences, both in and out of school, that allow them to perform at a particular level in reading, mathematics and science literacy'. This assumes that 15 year olds should have had sufficient time to acquire foundation skills²⁶. Reading ability at level three is viewed by PISA as the basic foundation level for further learning.²⁷

2.2 Percentage of 15 year olds reading at level 5

The percentage of 15 year olds reading at level 5 is of relevance to future creative innovation. PISA claims (although without providing supporting evidence) that students at level 5 are capable of "extending their home country's knowledge and influencing world-class knowledge".

2.3 Index for comfort with computers by 15 year olds

The PISA index for computer use is based on self-reported levels of ability and comfort with using computers, including respondent views on how their ability compared to other 15-year olds²⁸. This information was aggregated into an index that was scaled using a weighted maximum likelihood estimation technique. The index is imperfect for international comparisons because the relative ability and comfort of a 15 year old with using computers will depend on the background average familiarity of his or her peers. However, in the absence of direct measures of computer literacy, we include this indicator because familiarity with computers could play a vital and increasing role in both traditional education and in adult learning. Furthermore, the statistical evidence provided by the PISA report shows that the

²⁵ PISA excludes students with severe mental or physical disabilities and non-native language speakers with less than one year of instruction in the language of assessment. Due to sample problems, no results are available for the Netherlands.

²⁶ However, differences in the age of school entry could reduce comparability, particularly for Denmark where children do not start elementary school until seven years of age, versus five or six in most other OECD countries.

²⁷ In contrast, the EU report *15 quality indicators for life long learning* uses the percent of students at level 1 or below. The difference is due to the purpose of the indicators. This report focuses on innovation, which requires a higher level of reading competence, while the EU report identifies the need for further learning.

²⁸ The index is based on the z-scores of the original data and has a mean of zero and a standard deviation of 1.

index for computer use is positively correlated with reading literacy²⁹. In the future, both computer and reading literacy may be essential components of the foundation skills for further learning and for broadening and strengthening the future innovative potential of a country.

2.4 Percent of adults with quantitative literacy skills at level 4/5

Adult literacy is an important component of the ability to learn new skills. The International Adult Literacy Survey (IALS) between 1994 and 1998 measured the prose reading, document reading, and quantitative literacy of a sample of adults in several OECD countries. The results are divided into five levels, based on an *a priori* estimate of the complexity of successfully answered questions. An adult at a given level has an 80% probability of answering correctly questions with the same level difficulty and a higher probability of successfully answering easier questions. Individuals will also be able to correctly answer some questions above their level, but with a lower level of probability. The probability distributions for the three forms of literacy are not similar, which prevents averaging scores for prose, document, and quantitative literacy (Kirsch, 2001).

For simplicity, the thematic scoreboard only includes the results for quantitative literacy because this is likely to be most useful for innovative activities, such as implementing new equipment on a process line, or successfully following a set of instructions for using new consumer products. The indicator is the percentage of adults (16-65) with a level 4 or level 5 in quantitative literacy. Level 4/5 indicates higher order information processing capabilities that are probably required for innovative activities for both creation and diffusion³⁰. The results for quantitative literacy are also highly correlated with prose and document reading literacy. Of note, quantitative literacy is not entirely equivalent to numerical or mathematical skills³¹. The main disadvantage of this indicator is that it includes young adults between 16 and 25. Many of them will still be in school and improving their foundation literacy level. Unfortunately, the publicly available data do not give separate results for adults over 25.

3.1 Percent of adults with a positive attitude to life long learning

This indicator is the estimated percentage of the adult population (over 15 years of age) that wish to “keep learning all their lives”. The results are from the Eurobarometer survey in the last quarter of 1995, which surveyed a total of 19,308 Europeans. The indicator is of value because a positive attitude towards life long learning is a basic requirement for future participation in learning.

Attitudes to life long learning could partly depend on two factors. First, the percentage of the population that wants to keep learning could be positively correlated with 1) the percentage of the population that are young and still in education or 2) with a high unemployment rate,

²⁹ The index for computer use is more strongly correlated with the reading literacy score than any of the other indices for learning strategies (memorising, control, co-operation, and competition), and for most of the indices for school characteristics (disciplinary climate, teachers morale, and physical infrastructure). The only factors that are more strongly correlated with reading literacy are a few indicators for the student’s family background, such as the parents’ occupation.

³⁰ In some countries, the results on the IALS are correlated with the age of the respondents, with 16 to 25 year olds doing better than 46 to 55 year olds. For document literacy, a much higher percentage of younger than older adults are at level 4/5 in the Netherlands, Belgium and Switzerland, whereas there is little difference in the UK and the United States (Statistics Canada, 1999). These differences by age will slightly reduce international comparability, due to differences in population age distributions.

³¹ The survey questions require the respondent to be able to arithmetically manipulate or interpret information from written texts and tables. However, tests for ‘numeracy’ also measure other mathematical abilities, such as abstract tasks or those involving geometric shapes (ALL, 2002).

which could increase the perceived need for further education in order to find or retain employment. Both factors possibly have a small effect on a positive attitude to life long learning. The R^2 value is 0.21 in a correlation between the indicator and the percentage of the 1995 national population between 15 and 24 and 0.12 in a correlation between the indicator and the 1995 unemployment rate. In both correlations, the positive R^2 values were due to the effect of a few outlier countries. The correlation results also need to be treated cautiously because of the limited number of observations, with only 15 countries. Nevertheless, these results suggest that the proportion of young adults and greater economic uncertainty both increase awareness of the need for further education. Therefore, an interest in life long learning could decline as the population ages or when unemployment is low. Of concern, both of these factors could occur during demographic ageing, which is precisely when an increase in life long learning could be essential in order to maintain high productivity.

3.2 Percent of adults participating in learning

A key indicator for life long learning is derived from the Labour Force Survey and gives the percentage of the working-age population (24 – 64) in 2001 undertaking any form of learning in the four weeks before survey. The indicator includes both informal and formal learning and is not restricted to learning that is related to employment. These are advantages, given evidence showing that any type of learning can maintain skills, including literacy. Therefore, ongoing learning of any types maintains the ability to learn future skills that could be of value to innovative activities at work, or the ability to use new products outside of work. The main disadvantage of the indicator is that it could be affected by national differences in the timing of formal courses for adults. The indicator is obtained from Eurostat's structural indicators.

3.3 Percent of adult men in formal training or education

The third indicator is the percentage of adult men (25 to 54) in 2000 that are not employed and who are students, in further training, or in unpaid work experience. This indicator measures more intensive learning than that measured by the life long learning indicator above, including men in full-time retraining. There is no correlation between this indicator and the measure of life long learning for 2000 ($R^2 = 0.02$), which suggests that they measure different aspects of adult learning. Unfortunately, the source (the OECD's *Employment Outlook*) does not provide similar results for adult women.

3.4 Home Internet access

The fourth indicator for participation in life long learning is the percentage of the adult (over 15) population in 2001 with home Internet access. Although not a direct measure of life long learning (or even of actual Internet use), home Internet access can provide citizens with a useful tool for many different types of learning. This could include learning of value to both employment skills and to innovation. The indicator is obtained from Eurostat's structural indicators.

4.1 Percent employees taking job-related training

The 2000/2001 CVTS provides results for the percentage of all employees (of any age) that have taken job-related training courses (both outside and within the firm)³². The survey expressly excluded initial training for new staff. The data were obtained from questionnaires

³² This excludes other forms of job-training covered in the survey, including on-the-job training, attending conferences and workshops, job rotation, and self-learning.

sent to firm managers rather than to individual staff. Results are available for 1999 for 11 member states, while the results for Greece, France, Italy and the UK are derived from the 1994 CVTS and refer to 1993³³.

4.2 Business expenditures on training as a percentage of total labour costs

The CVTS provides national estimates of total expenditures on job-related training as a percentage of total labour costs. Results are available for 1999 from the 2000 CVTS. The indicator provides an estimate of private sector investment in life long learning.

4.3 Percent employed adults that have taken computer training

Life long learning is likely to be increasingly dependent upon computer literacy as a basis for further formal and informal learning. The thematic scoreboard includes an indicator for the percentage of the employed population that has taken a computer training course, obtained from the November 2001 Eurobarometer survey. The same survey also includes data on the percentage of the employed population that uses computers at work. For some countries, the percentage that use computers at work is considerably higher than the percentage that have taken a computer training course, probably due to widespread self-learning or informal learning on the job³⁴. However, we prefer the indicator for training to that of computer use at work because the former could indicate a higher level of expertise in computer use³⁵. In contrast, the use of computers at work could be distorted by differences in how respondents define computer use. For example, surveys show a high use rate of use for ‘computer assisted technology’ in the retail sector, but much of this is due to the use of scanners, for which skill requirements are minimal (Statistics Canada 2001).

³³ The 1994-1996 IALS surveys asked individual participants in Switzerland, Sweden and the US survey several questions on job-related training. However, the IALS and the CVTS produce very different and inconsistent results for four EU countries that were covered in both surveys. Therefore, it is not possible to estimate results for Switzerland, Sweden and the US using the IALS.

³⁴ The Autumn 2000 Eurobarometer 54 survey (EEIG, 2000) found that 75.4% of European computer users learnt how to use computers through informal learning. They either taught themselves at home or at work, or received help from work colleagues. Only 24.1% stated that they learnt how to use computers at school.

³⁵ There is a moderately strong correlation (R^2 of 0.43) by country in the 2000 percentage of computer users that are self-taught at home and the 2001 percentage of the employed population that have taken computer courses. This suggests that computer courses may be taken to extend and enrich skills, rather than to learn the basics about how to use a computer.

Annex B Table A: Definitions and sources

N°	Date	Definition of indicator	Source
1.	The learning economy		
1.1	2000	Percent of employed population with high skills (in one of three high skilled occupational classes (legislators/managers, professionals, technicians) or in another occupational class and with educational qualifications at ISCED class 5 and above)	Eurostat Labour Force survey results, 1998 - 2000
1.2	2000	Change since 1998 in the percentage of the employed population with high skills	Eurostat Labour Force survey results, 1998 - 2000
1.3	2000	Long-term unemployment rate (> 12 months) among all men 25 – 54	OECD, Employment Outlook 2002, Chart 4.4 and Table 4.2
1.4	2001	Percent of older population (55 – 64) that are employed.	Eurostat, Structural Indicators
2.	Foundation skills		
2.1	2000	Percent 15 year olds reading at level 3 or above	PISA, OECD, 2000.
2.2	2000	Percent 15 year olds reading at level 5	PISA, OECD, 2000.
2.3	2000	Index for comfort and familiarity with computers among 15 year olds.	PISA, OECD, 2000.
2.4	1995	Percent adults (over 16) at level 4/5 for quantitative literacy ¹	International Adult Literacy Survey (OECD, 2000).
3.	Participation in life long learning		
3.1	1995	Percent adults (15 and over) who report that they want to keep learning all their lives	Eurobarometer, 1996
3.2	2001	Percent adults (25-64) in any education or training in the four weeks before the survey	Eurostat, Structural indicator, derived from the Labour Force Survey
3.3	2000	Men (25-54) that are students, in training, or in unpaid work experience	OECD, Employment Outlook 2002, Table 4.2
3.4	2001	Percent of population over 15 with home internet access	Eurostat, structural indicator, derived from Eurobarometer.
4.	Enterprise investment in life long learning		
4.1	1999/1993	Percent of all employees taking job-related training courses	For Greece, France, Italy and the UK: 1994 CVTS-1, Table 8. For other countries: 2000/2001 CVTS2, Nestler and Kailis, 2002b
4.2	1999/1993	Training costs as a percentage of all labour costs	For Greece, France, Italy and the UK: 1994 Continuing Vocational Training Survey, DG Research analysis, Table 27. For all other EU countries: 2000 CVTS2, Nestler and Kailis 2002a, Table 9
4.3	2001	Percent employed adults that have taken computer training	Eurobarometer, November 2001; europa.eu.int/information_society/Europe/benchmarking/list/testmichel/ca/computer_training/index_en.htm

Annex B Table B: Scoreboard for life long learning and innovation

No	Indicator	EU	A	B	D	DK	E	EL	F	FIN	I	IRL	L	NL	P	S	UK	US	JP	CH	IS	NO
1. The learning economy																						
1.1	% higher-skilled	40.5	34.9	47.4	44.4	42.6	38.2	32.4	40.0	50.0	34.7	43.3	40.3	48.1	21.5	45.3	45.0					
1.2	% change in higher skilled	2.9	8.3	1.0		5.7	3.1	-2.0	2.6	3.4					1.7	2.5						
1.3	Long-term unemployment	2.1	1.1	2.7	3.0	0.7	2.7	3.0	2.9	2.4	3.6	3.2	0.4	0.6	1.2	1.5	2.0			0.5	0.1	
1.4	Employ of older workers	40.9	28.6	26.3	37.5	58.0	38.9	38.0	30.3	45.7	28.0	46.8	26.7	39.6	50.3	66.5	52.3					66.0
2. Foundation skill levels (percent of target population)																						
2.1	15 yr. reading (level 3+)	59.6	64	64	55	59	58	50	61	77	55	71	38		48	67	67	60	72	58	64	61
2.2	15 yr. reading (level 5)	8.6	9	12	9	8	4	5	6	16	5	14	2		4	11	16	12	10	9	9	11
2.3	15 yr. computer comfort	-0.1		0.15	-0.31	-0.15				-0.12		-0.13	-0.09			-0.09		0.62		-0.26		-0.01
2.4	% 16+ quant. Literacy 4/5	21.1		22.6	23.4	28.4			19.7			16.2		19.9	5.2	35.8	18.6	22.5		19.2		27.4
3. Participation in life long learning																						
3.1	% positive Attitude to LLL	72.7	49	72	60	92	84	89	75	79	65	77	57	62	78	66	86					
3.2	%Adults education/training	9.8	7.8	7.3	5.2	20.8	4.7	1.1	2.7	19.3	5.1	5.2	4.8	16.3	3.3	21.6	21.7			18.3	23.5	14.2
3.3	% adult men in formal training/education	1.6	2.7	1.5		0.4		1.8	0.6	0.3	2.9	1.1	1.6	2.0	1.1	4.4	0.7			1.1	2.0	1.5
3.4	Home internet access	37.7	41.3	36.4	38.4	58.6	24.7	9.9	30.1	50.2	33.5	47.6	43.0	63.8	26.1	60.7	49.3	46.7	34.0		69.7	58.2
4. Enterprise investment in life long learning																						
4.1	% employees taking job-related training courses	35.3	32	40	32	53	26	13	37	50	15	41	36	41	18	60	39					49
4.2	Training % of labour costs	1.9	1.3	1.6	1.5	3.0	1.5	1.1	2.0	2.4	0.8	2.4	1.9	2.8	1.2	2.8	2.7					1.7
4.3	% employees with computer training	34.1	35.9			55.2	20.1	18.2	26.1		21.4		39.2	40.4		48.3	36.6					

Notes: EU averages are unweighted. For indicator 2.4, the original data on the percentage of the population at level 4 or 5 in Switzerland was given separately for the French, German and Italian speaking regions. The data in this table is the average of the three original percentages weighted by the proportion of survey target population speaking each language.

Annex B Table C. Pearson Correlation Coefficients for Life long learning indicators (two-tailed significance)

	Q1.1	Q1.2	Q1.3	Q1.4	Q2.1	Q2.2	Q2.4	Q3.1	Q3.2	Q3.3	Q3.4	Q4.1	Q4.2	Q4.3	ISBPBI
Q1.1	1.00	0.14	0.01	0.12	0.61	0.69	0.69	-0.06	0.60	-0.09	0.64	0.76	0.68	0.69	0.76
Sig		0.72	0.97	0.67	0.02	0.01	0.04	0.84	0.02	0.77	0.01	0.00	0.01	0.03	0.00
Q1.2	0.14	1.00	-0.66	0.02	0.39	0.21	0.40	-0.51	0.40	0.03	0.66	0.40	0.30	0.53	0.42
Sig	0.72		0.05	0.96	0.30	0.59	0.51	0.16	0.29	0.94	0.06	0.29	0.43	0.28	0.26
Q1.3	0.01	-0.66	1.00	-0.25	0.29	0.17	-0.09	0.23	-0.42	-0.05	-0.54	-0.37	-0.44	-0.82	-0.19
Sig	0.97	0.05		0.36	0.31	0.55	0.82	0.40	0.11	0.87	0.04	0.17	0.10	0.00	0.49
Q1.4	0.12	0.02	-0.25	1.00	0.35	0.38	0.32	0.46	0.68	0.04	0.44	0.52	0.64	0.63	0.60
Sig	0.67	0.96	0.36		0.22	0.18	0.40	0.08	0.01	0.89	0.10	0.05	0.01	0.05	0.02
Q2.1	0.61	0.39	0.29	0.35	1.00	0.88	0.44	0.17	0.56	-0.09	0.50	0.58	0.50	0.23	0.73
Sig	0.02	0.30	0.31	0.22		0.00	0.27	0.55	0.04	0.79	0.07	0.03	0.07	0.55	0.00
Q2.2	0.69	0.21	0.17	0.38	0.88	1.00	0.27	0.15	0.64	-0.19	0.58	0.59	0.58	0.43	0.72
Sig	0.01	0.59	0.55	0.18	0.00		0.53	0.61	0.01	0.56	0.03	0.02	0.03	0.25	0.00
Q2.4	0.69	0.40	-0.09	0.32	0.44	0.27	1.00	-0.16	0.60	0.57	0.63	0.90	0.57	0.72	0.83
Sig	0.04	0.51	0.82	0.40	0.27	0.53		0.67	0.09	0.14	0.07	0.00	0.11	0.17	0.01
Q3.1	-0.06	-0.51	0.23	0.46	0.17	0.15	-0.16	1.00	0.17	-0.60	-0.27	-0.01	0.23	-0.11	0.03
Sig	0.84	0.16	0.40	0.08	0.55	0.61	0.67		0.54	0.03	0.32	0.98	0.42	0.76	0.93
Q3.2	0.60	0.40	-0.42	0.68	0.56	0.64	0.60	0.17	1.00	0.02	0.81	0.77	0.81	0.81	0.86
Sig	0.02	0.29	0.11	0.01	0.04	0.01	0.09	0.54		0.95	0.00	0.00	0.00	0.00	0.00
Q3.3	-0.09	0.03	-0.05	0.04	-0.09	-0.19	0.57	-0.60	0.02	1.00	0.14	-0.02	-0.20	0.01	0.05
Sig	0.77	0.94	0.87	0.89	0.79	0.56	0.14	0.03	0.95		0.65	0.96	0.52	0.99	0.88
Q3.4	0.64	0.66	-0.54	0.44	0.50	0.58	0.63	-0.27	0.81	0.14	1.00	0.83	0.81	0.89	0.85
Sig	0.01	0.06	0.04	0.10	0.07	0.03	0.07	0.32	0.00	0.65		0.00	0.00	0.00	0.00
Q4.1	0.76	0.40	-0.37	0.52	0.58	0.59	0.90	-0.01	0.77	-0.02	0.83	1.00	0.88	0.90	0.89
Sig	0.00	0.29	0.17	0.05	0.03	0.02	0.00	0.98	0.00	0.96	0.00		0.00	0.00	0.00
Q4.2	0.68	0.30	-0.44	0.64	0.50	0.58	0.57	0.23	0.81	-0.20	0.81	0.88	1.00	0.82	0.86
Sig	0.01	0.43	0.10	0.01	0.07	0.03	0.11	0.42	0.00	0.52	0.00	0.00		0.00	0.00
Q4.3	0.69	0.53	-0.82	0.63	0.23	0.43	0.72	-0.11	0.81	0.01	0.89	0.90	0.82	1.00	0.77
Sig	0.03	0.28	0.00	0.05	0.55	0.25	0.17	0.76	0.00	0.99	0.00	0.00	0.00		0.01
ISB-PBI	0.76	0.42	-0.19	0.60	0.73	0.72	0.83	0.03	0.86	0.05	0.85	0.89	0.86	0.77	1.00
Sig	0.00	0.26	0.49	0.02	0.00	0.00	0.01	0.93	0.00	0.88	0.00	0.00	0.00	0.01	