

CHAPTER IV

Enhancing creativity and innovation, including entrepreneurship at all levels of education and training

Main messages

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MAIN MESSAGES

Enhancing creativity , Innovation and Entrepreneurship

Creativity and Innovation

- As measured by the European Innovation Scoreboard (2009) **three Nordic countries (SE, FI, DK), together with Germany, and the UK, make the highest innovation performance in the EU**, with an often strong concentration of the “creative class” in and around capital cities with very high levels of educational attainment. A process of EU convergence of innovation performance can be observed with low growth rates of performance among mentioned high performers and high growth rates among low performers (RO, LV and BG).

Mathematics, Science and Technology graduates and researchers

- **With a growth of over 33% the number of graduates in Mathematics, Science and Technology has already in 2000-2007 grown by more than twice the rate set as target for 2010 by the EU benchmark.** The targeted growth of 15% implies an increase of some 100 000 graduates by 2010. However, an increase of some 230 000 MST graduates has already been achieved reaching 917 000 new graduates in 2007.
 - There is a strong difference in growth in the number of Mathematics, Science and Technology graduates between fields of graduation. **The number of computing graduates has increased by about 80% since 2000, while the number of graduates from life sciences and physics increased only slightly or even decreased.**
 - **Some 45 000 or about 5% of Mathematics, Science and Technology graduates in the EU are PhD graduates** (2007) compared with 22 400 in the USA (5.3%) and only 6 500 in Japan (2.9%).
- § **The EU has significantly fewer researchers per 1000 employees on the labour market (some 6 in 2006) than the US (about 9) and especially Japan (more than 10).** The total number of researchers on the labour market in the EU (1.3 million) is slightly lower than in the USA and in China (both 1.4 million) but nearly twice as high as in Japan.

Entrepreneurship

- **Entrepreneurship is a recognised objective of the education systems and embedded explicitly in national framework curricula in only six EU countries (CY, ES, FI, IE, PL, UK)**

1. Creativity and innovation

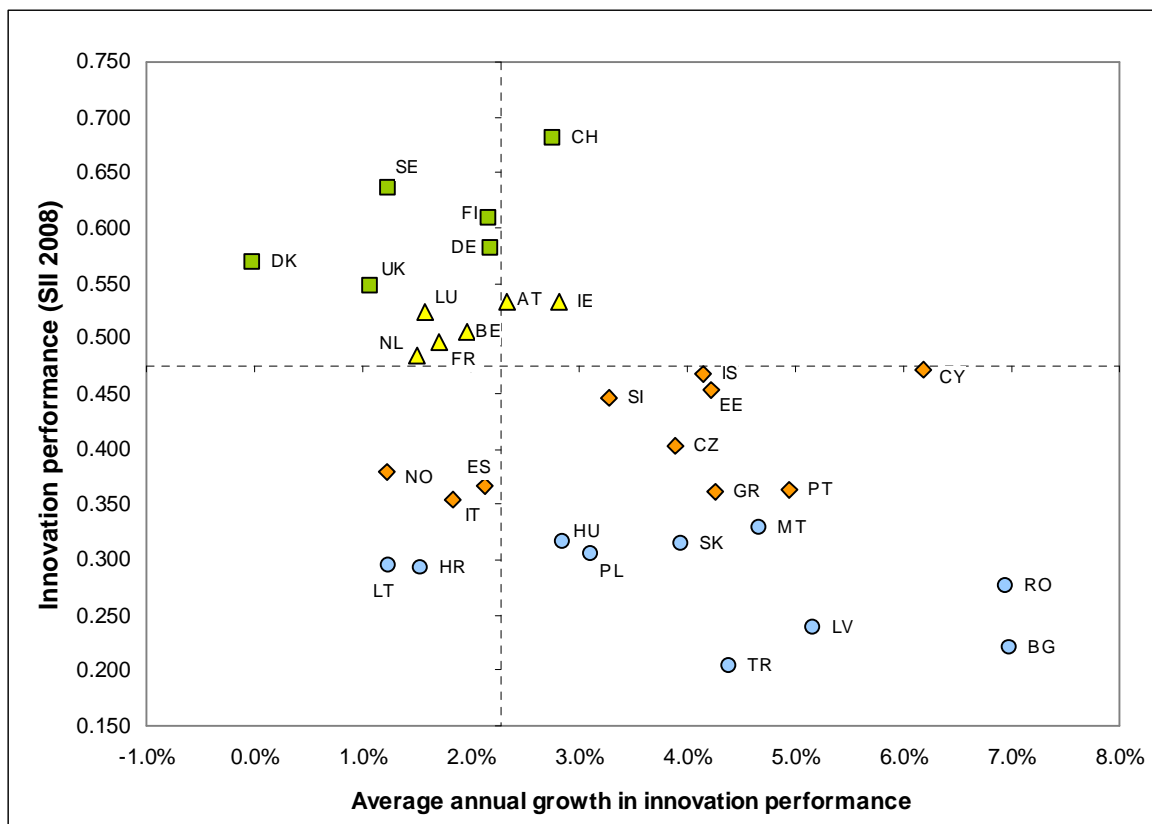
"Creativity is a crucial component of our capacity to innovate. And innovation is a key factor not just to become more competitive but also to improve our quality of life and the sustainability of our development"⁷⁸. Considering this fundamental function and in the frame of the European Year of Creativity and Innovation, there are several ongoing activities undertaken by the European Commission that relate to the measurement of creativity and innovation at national, regional and individual levels⁷⁹.

1.1 Innovation and creativity of nations and regions

Concerning innovation, the European Innovation Scoreboard⁸⁰ (EIS) provides a comparative benchmarking of national innovation performance across the European Union and Croatia, Turkey, Iceland, Norway and Switzerland. On the basis of the 29 EIS indicators (see Ann IV.1), countries can be classified into four clusters:

- **Innovation leaders** with innovation performance well above the EU average and all other countries: Denmark, Finland, Germany, Sweden, Switzerland and the UK;
- **Innovation followers** with innovation performance below those of the innovation leaders but above that of the EU average: Austria, Belgium, France, Ireland, Luxembourg and the Netherlands;
- **Moderate innovators** with innovation performance below the EU27 where the first 4 countries show a better performance than the last 6 countries: Cyprus, Czech Republic, Estonia, Greece, Iceland, Italy, Norway, Portugal, Slovenia and Spain;
- **Catching up countries** with performance well below the EU average⁸¹: Bulgaria, Croatia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Turkey.

Chart IV.1.1: Convergence in innovation performance



Source: European Commission
Additional note: see Table Ann. IV.2

All countries with the exception of Denmark have improved their innovation performance in the last five years. Most of the countries below the EU average

are improving their performance at higher rates than the EU average growth in the last five years, except in the case of Spain, Italy, Norway, Croatia and

Lithuania. Those performing above the EU average, generally progress slower than the EU average and only in this latter group Austria, Iceland and Switzerland show higher rates than the EU in the last five years.

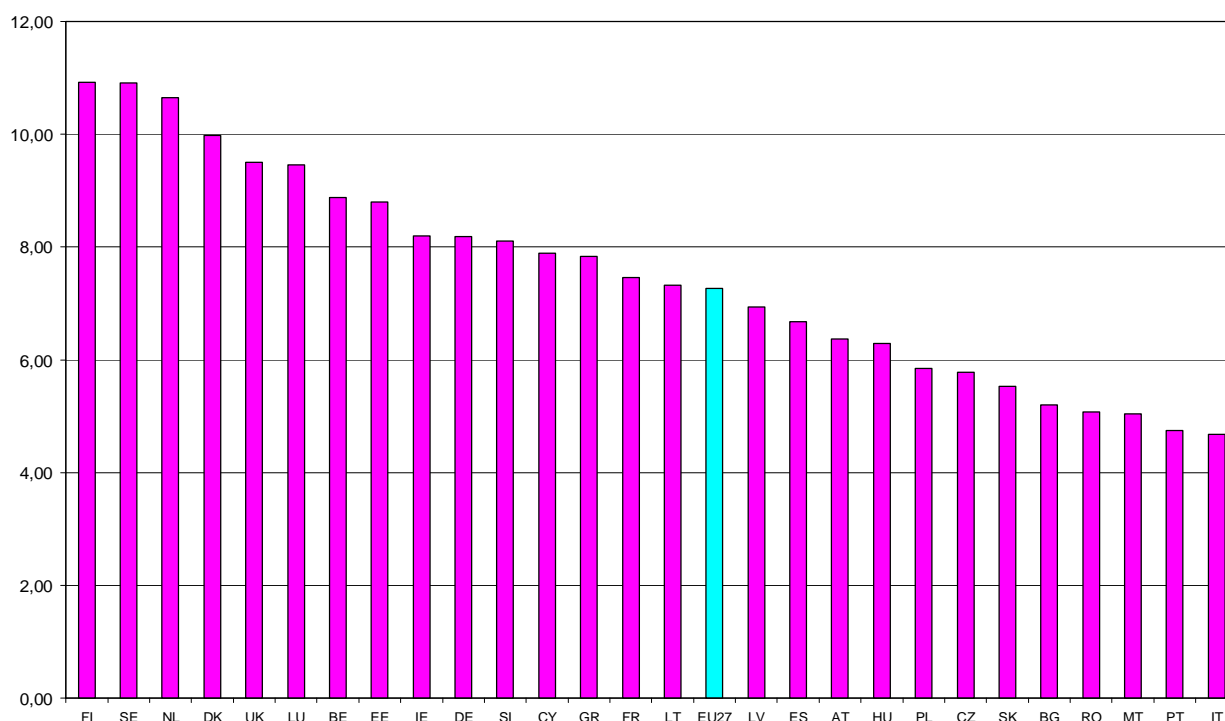
Indicators on innovation are pointers of the capacity of countries to transform their creative capacities into innovative results. However, the relationship between creativity and innovation is complex. Many factors are involved for creativity and innovation to appear covering institutional, economical, human and social resources dimensions⁸².

There is a need of an “enabling environment” conducive to creativity for innovation to appear. For example, it is likely that cultural activities⁸³ play a

role in enhancing creativity and innovation and creative industries and the “creative class” are catalysts for change and innovation⁸⁴. The creative class⁸⁵ is defined as share of the population doing creative work. It is based on the ISCO definition of occupations. (See Table Ann IV.5).

The core creative class is concentrated in and close to the capital regions, in Benelux and Nordic countries, Ireland and the United Kingdom. In these areas - often large cities - the share of foreign-born graduates and broadband access is also higher. Evidence at European regional level thus confirms that creative occupations are associated with areas where there are high levels of skills and a heterogeneous and tolerant environment.

Chart IV.1.2: Core Creative Class employment – national level



Source: European Commission

1.2 Measuring creativity skills and competences

Education and training are core tools to help people to develop their talent and creativity. Analysis at the national level using the EIS data has shown that creative education is associated with higher levels of innovation: “(...) policies aimed at improving levels of educational attainment and policies aimed at improving creative thinking in education will, after a number of years, have a positive effect on a society’s innovative performance”⁸⁶.

The previous indicators on innovation and creativity at national and regional levels could be regarded as indicators of the environment where creativity flourishes. Some of them (such as creative class

index) are proxies for creative people, but it is clear that precise measures of an individual’s creativity do not exist. In order to better understand the relationship between the environment that fosters creativity, people’s creativity and innovation, it is necessary to have information on the actual levels of people’s creativity.

There is a need of individual level measures that will permit clearer understanding of the role of creativity in innovation and economic growth. In particular, it would be necessary to assess if students after compulsory levels are leaving schools with the adequate levels of creative capacities, creativity cut across the eight key competences adopted by the Council as one aspect to prepare students for

lifelong learning. It is, thus, important to look into possible ways of assessing creativity in students. The conference: "Can creativity be measured?" organised by the Commission aimed at starting the process of identifying possible ways of achieving this goal⁸⁷. The measurement of creativity would require several different techniques capturing aspects of diverse nature, involving contextual information, attitudinal aspects, personality traits as well as cognitive aspects.

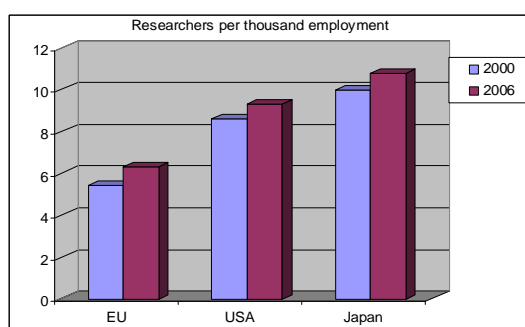
2. Graduates in Mathematics, Science and Technology

European benchmark
The total number of graduates in Mathematics, Science and Technology in the European Union should increase by at least 15% by 2010.⁸⁸

Science and technology are vital to the knowledge-based and increasingly digital economy. The education of an adequate supply of science specialists is also important in the light of the goal set by the Barcelona European Council of increasing overall investment on research and development (R&D) to 3% of GDP by 2010 (European Council, 2002b).

The EU has today still slightly fewer researchers on the labour market than the US and is lagging behind both the US and Japan when it comes to the number of researchers as a proportion of the total labour force (see Chart IV.2.1).

Chart IV.2.1: Researchers per thousand total employment, 2000 and 2006



Data source: Eurostat, OECD

2.1 Evolution of the number of MST students

The number of tertiary MST students has increased by about 16% since 2000, or on average by 2.1% per year. Growth has been particularly strong in Malta, Cyprus and Romania.

For some countries, however, the number of MST students stagnated or even declined. The latter was the case in Austria (partly a result of the introduction of tuition fees in 2001/02), Ireland, Belgium, Spain, Bulgaria and Sweden (Table IV.2.1).

Growth in the number of students has been slower than growth in the number of graduates since an increasing share of students takes several degrees (Bologna effect). In the EU, MST students accounted in 2007 for nearly a quarter of the total student population, some 4.6 million students (2007) compared to 2.8 million in the US and 750 000 in Japan (Source Eurostat (UOE)).

Table IV.2.1: Number of MST students (ISCED level 5A, 5B and 6), 2000-2007

	Number of tertiary MST students (in 1000)			Ø Growth per year
	2000	2006	2007	2000-07
EU-27	4000e	4514	4638	2.1
Belgium	74.6	68.8	62.9	-2.4
Bulgaria	64.5	63.2	64.3	-0.1
Czech Republic	74.5	77.4	83.2	1.6
Denmark	38.3	41.5	43.6	1.9
Germany	587.2	708.2	701.2	2.6
Estonia	11.4	15.3	15.8	4.8
Ireland	45.3	41.0	40.6	-1.6
Greece	:	93.6	184.5	:
Spain	525.1	522.5	499.8	-0.7
France	:	522.5	549.4	:
Italy	433.2	475.8	477.6	1.4
Cyprus	1.8	3.9	4.2	12.5
Latvia	15.1	20.0	20.2	4.2
Lithuania	33.4	48.0	48.1	5.4
Luxembourg	0.4	0.6	:	6.3
Hungary	65.7	77.6	79.2	2.7
Malta	0.7	1.4	1.8	13.6
Netherlands	80.8	85.3	85.2	0.8
Austria	73.9	61.2	64.4	-1.9
Poland	285.2	477.3	473.1	7.5
Portugal	102.2	107.4	108.5	0.9
Romania	124.2	191.3	217.0	8.3
Slovenia	19.7	24.2	25.8	4.0
Slovakia	38.1	50.3	53.6	5.0
Finland	97.9	115.4	113.3	2.1
Sweden	106.0	109.8	105.4	-0.1
United Kingdom	477.4	510.5	515.2	1.1
Croatia	:	32.4	32.9	:
MK *	12.0	12.4	14.1	2.4
Turkey	301	488.2	506.3	7.7
Iceland	1.7	2.4	2.5	5.5
Liechtenstein	:	0.16	0.2	:
Norway	26.9	33.5	34.1	3.4

Data source: Eurostat (UOE)

Annual growth per year represents geometric mean.

*MK= Former Yugoslav Republic of Macedonia

Additional notes:

Number of students means the total number of full-time and part-time students. Austria: Break in time series in 2003; before 2003 Austria reported students studying more than one field in each of the fields in which they were enrolled, leading to double-counting; since 2003 students have been allocated to only one field

2.2 Evolution of the number of MST graduates

With a growth of over 33% in the number of MST graduates in the period 2000-2007, the EU has already progressed with more than twice the rate of the EU benchmark for 2010 in the field.

After strong growth in the beginning of the period, however, the increase decelerated somewhat after 2005.

Taking 2000 as the base (when there were 686 000 graduates), the target growth of 15% implies an

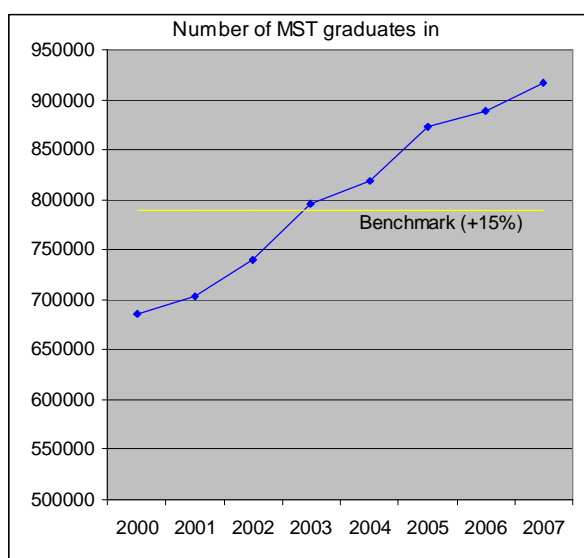
absolute increase of some 100 000 graduates by 2010.

However, an increase of some 230 000 MST graduates has been achieved with a total of 917 000 graduates in 2007 (chart IV.2.2).

In the period 2000-2007 Portugal, Slovakia and Poland reported the highest annual growth rates (>12%), followed by Italy, the Czech Republic and Romania (>10%).

Despite the general positive trend, Ireland, Sweden and Lithuania showed a considerable decrease in numbers in 2007 by 5% or more.

Chart IV.2.2: Number of graduates in Mathematics, Science and Technology (ISCED 5 and 6), 2000-2007



Data source: Eurostat (UOE)

While the EU progressed faster than both the US and Japan (in Japan the number of graduates has decreased since 2000), growth is particularly strong in emerging economies like China, where it has more than quadrupled since 2000 to reach nearly 2 million in 2006⁸⁹ (Chart IV.2.3).

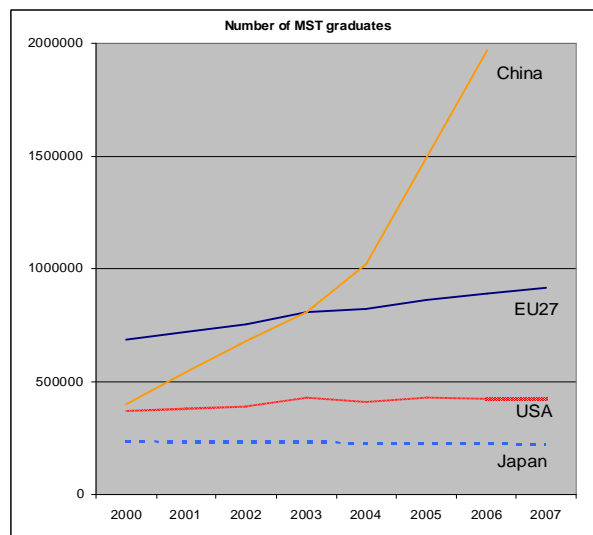
The availability of a large pool of MST graduates in low-wage countries will have a growing impact on high-technology industries worldwide and increasingly affects the comparative advantage (relative abundance of highly skilled workers) of developed countries.

The average number of graduates in Mathematics, Science and Technology in the EU was 10.2 per 1000 inhabitants aged 20-29 in 2000 and 13.4 in 2007. Related to a one-year age cohort, this implies that about 13% of young people take a degree in MST although some double counting is taking place (about 15%).

France, Ireland, Finland, Portugal and Lithuania have a relatively high number of MST graduates, with over 18 per 1000, whereas Hungary, Malta, Cyprus and Greece have below 8 per 1000.

The significant growth in numbers of MST graduates that has been achieved since 2000 in the EU might not continue in the coming years.

Chart IV.2.3: Total number of graduates in Mathematics, Science and Technology – international comparison of trends 2000-2007

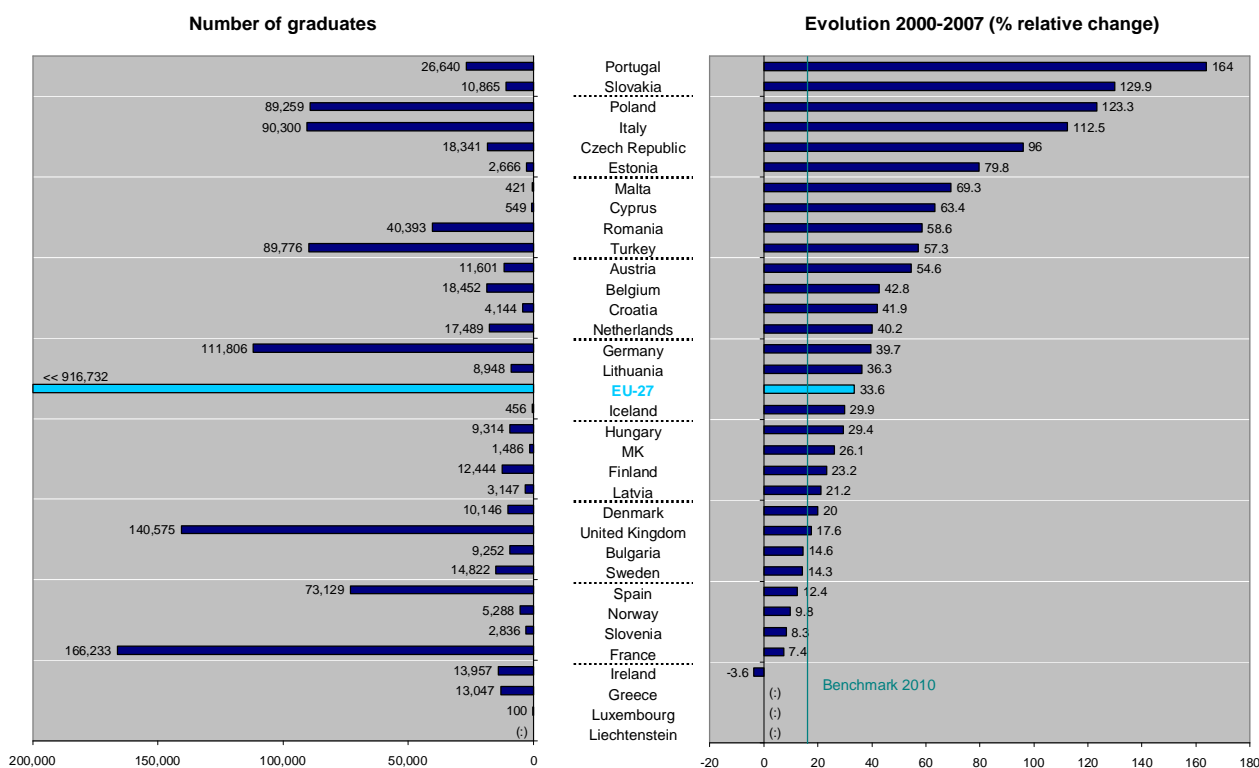


Data source: Eurostat and Statistical Bureau of China

Long-term demographic trends, especially the strong decline in birth rates in the new Central and Eastern European countries after 1989, might also pose the risk of stagnation or decline in the number of MST students and graduates after 2010, despite the increase in higher education participation rates.

In 2007, growth in the number of MST graduates had already slowed to 3.1%, while growth in student numbers amounted to 2.7%. A further deceleration in coming years is likely.

Chart IV.2.4: Graduates in Mathematics, Science and Technology



Source: DG EAC, calculations based on Eurostat (UOE) data, LU: data represent results for the year 2000

Additional notes : See also Table Ann IV.6

Evolution 2000-2007: for Croatia, Italy, Latvia, Malta, Poland, Romania, United Kingdom result extrapolated from growth rate for years with valid data
MK= former Yugoslav Republic of Macedonia

2.3 Growth in number of graduates by field and educational levels

Table IV.2.2: Number of graduates by field(EU 27)

ISCED fields	Graduates (1000)		Growth (in %)
	2000	2007	2000-07
Life sciences (42)	91.6	96.1	4.9
Physical science (44)	86.9	83.1	-4.4
Mathematics, statistics (46)	37.5	47.8	27.5
Computing (48)	83.9	149.5	78.2
Engineering (52)	264.4	313.6	18.6
Manufacturing (54)	32.0	47.6	48.9
Architecture, building (58)	88.8	120.7	35.9

Data source: Eurostat; in the case of physical science and computing, no data are available for Romania. Includes estimates for Greece for 2000 and Ireland for 2007.

Growth since 2000 has been very strong in computing (nearly 80%), while engineering, manufacturing, mathematics and architecture showed medium level growth rates. Growth was slow in life sciences. In physical science there has been even a slight decline in the number of graduates since 2000 (Table IV.2.2; see also Tables Ann.IV.7 and Ann IV.11).

However, it has to be taken into account that computing has also some of the elements taught in physical science and in mathematics. The lower growth or decline in these fields can partly be

attributed to a shift to informatics. There is also a trend to new interdisciplinary studies that are difficult to classify but which impact on the growth of certain fields.

2.4 The growth in number of MST graduates by type of programme

The graduates from academic programmes requiring an ISCED level 5A second degree grew strongly between 2000 and 2007, partly a result of the Bologna process, while the number of new PhDs increased only moderately (see Table IV.2.3)

Table IV.2.3: Growth in the number of MST graduates by type of programme

ISCED field	Graduates (in 1000)		Growth (in %)
	2000	2007	2000-2007
Academic programmes, all first degrees (5A)	460.4	564.5	22.6
Academic programmes, second degree (5A)	60.0	153.5	155.8
Occupation-oriented programmes, first qualification (5B)	131.3	146.2	11.3
Occupation-oriented programmes, second qualification (5B)	2.1	0.5	-73.9
Second stage leading to an advanced research qualification (6)	35.7	45.3	29.1

Source: Eurostat (UOE), Note: PHD/Doctorate in 2007 represented over 96% of all ISCED 6 degrees

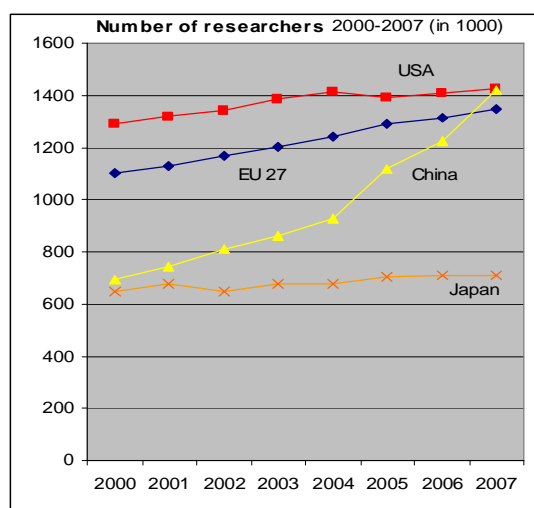
2.5 MST graduates and researchers on the labour market

In 2007 about 45 000 or 5% of MST graduates in the EU were PhD graduates (ISCED level 6), compared with 22 400 in the US (5.3%) and only 6 500 in Japan (2.9%). In the EU, this represents an increase of almost 30% compared to 2000 (Table IV.2.3). These are graduates with research training; some of them could be expected to find positions as researchers on the labour market.

The increase in MST graduates and the relatively high number of PhD level graduates has, however, not been reflected in sufficient employment of researchers in many Member States. Partly as a result of a lack of science jobs, a high share of graduates opt for non-science and non-engineering career. Some of these graduates furthermore choose to take up positions outside the EU (European Commission, 2005b, p.12).

It is important to create conditions conducive to a thriving research environment in Europe and to avoid a loss of European MST graduates to other sectors of the economy and other parts of the world. Nevertheless an upward trend in the EU as regards the number of researchers can be observed. The number of researchers (full time equivalents) in the EU increased in the period 2000-2007 by 22.5% or 250 000 (Table IV.2.4).

Chart IV.2.4: Trend in the number of researchers



Source: Eurostat (UOE)

Despite the high number of new MST PhDs produced by the EU, the EU (1.36 million researchers (2007) - full time equivalent - see Chart IV.2.5). has still slightly fewer researchers on the labour market than the US (1.43 million), in absolute terms but as a proportion of the total labour force. In 2007, China has overtaken the EU in absolute terms too with 1.42 million researchers. Japan, although with a smaller total number of researchers (0.71 million, 2006) has a much higher proportion of researchers in employment per 1000 employed and counts 10.8 researchers per 1000 against 6.3

researchers per 1000 in the EU (Source: Eurostat , OECD)

Table IV.2.4: Number of Researchers

	Number of researchers (in 1000 full time equivalents)			Average annual growth since 2000	Researchers per 1000 of total employment	
	2000	2006	2007		2000	2006
EU-27	1106.8	1331.2	1355.7	2.9	5.4	6.3
BE	30.5	34.9	35.9	2.4	7.8 (05)	
BG	9.5	10.3	11.2	2.4	3.4	3.3
CZ	13.9	26.3	27.9	10.5	2.9	5.3
DK	:	28.8	29.6	2.4	:	10.2
DE	257.9	279.5	284.3	1.4	7.4 (05)	
EE	2.7	3.5	3.7	4.8	4.7	5.6
IE	8.5	12.2	:	6.1	5.9 (05)	
EL	:	19.9	20.8	3.1	4.5 (05)	
ES	76.7	115.8	122.6	6.9	5.9	
FR	172.1	211.1	211.1	3.0	7.4	8.2 (05)
IT	66.1	88.4	:	5.0	3.2	3.7
CY	0.3	0.7	0.8	14.8	1.0	2.0
LV	3.8	4.0	4.2	1.5	4.1	3.8
LT	7.8	8.0	8.5	1.3	5.5	5.1
LU	1.6	2.1	2.2	4.1	:	11.5(05)
HU	14.4	17.5	17.4	2.7	3.8	4.2
MT	:	0.5	0.5	3.7	:	3.4
NL	42.1	47.3	44.1	0.7	5.0 (05)	
AT	:	29.2	31.4	5.4	:	:
PL	55.2	59.6	:	1.3	3.8	4.2
PT	16.7	24.6	28.0	7.6	3.3	4.1 (05)
RO	20.5	20.5	18.8	-1.2	1.9	2.5
SI	4.3	5.9	6.3	5.4	4.8	5.9
SK	10.0	11.8	12.4	3.1	4.7	5.1
FI	:	40.4	39.0	-1.7	:	17.0
SE	:	55.7	:	3.9	:	12.7(05)
UK	:	176.2	175.5	1.1	:	:
HR	:	5.7	6.1	-6.5	:	3.6
MK*	:	:	:	:	:	:
TR	23.1	42.7	49.7	1.6	1.1	2.0
IS	:	2.4	2.2	3.8	:	13.5(05)
LI	:	:	:	:	:	:
NO	:	24.5	24.5	3.4	:	9.5 (05)

Source: DG EAC, based on Eurostat and OECD data, (05)/ * = 2005 data

*MK= Former Yugoslav Republic of Macedonia

The number of researchers represents full time equivalents, total number of researchers for the EU for 2007 (headcount): 2.016 million

3. Entrepreneurship

Entrepreneurship is an important area that refers to an individual's ability to turn ideas into action. It is related to creativity, innovation and risk taking, as well as the ability to plan and manage projects in order to achieve objectives. Entrepreneurship is one of the eight key competences for lifelong learning included in the recommendation of the European parliament and the Council⁹⁰. The European Commission is committed to promoting entrepreneurship through education at all levels. However there is a lack of internationally comparable data in the field.

The Eurobarometer report from 2007 on entrepreneurial mindsets shows that in the US more people prefer to be self employed than in the EU (61% compared to 45%).

The initiative “Small Business Act” (SBA)⁹¹ for Europe aims to create favourable conditions for the growth and sustainable competitiveness of European small and medium-sized enterprises (SMEs). Community and national policies should take better account of the role of SMEs in economic growth and job creation.

In the 7th Framework Programme for Research and Technological Development, the Commission proposes a series of measures stimulating the cooperation between academic and private sectors. The Marie Curie Industry-Academia Partnerships and Pathways action aims to boost skills exchange between the commercial and non-commercial partners, including in particular SMEs. The main objective of the Marie Curie Initial Training Networks is to train young people who embark on a research career and to improve their research skills, including those relating to technology transfer and entrepreneurship.

The Commission promotes a business culture through networking of enterprises and exchanges of experience. Member States are encouraged to take measures in the fields of education, training and taxation to support entrepreneurs.

The Commission underlines that people in Europe need to see that self employment is a potentially attractive career option.

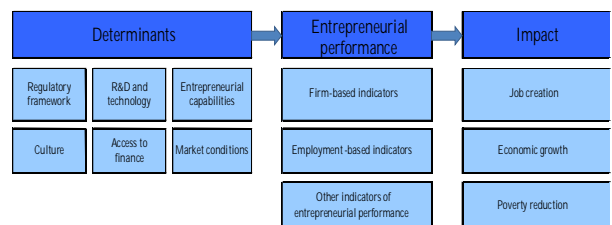
It is further stressed that *“the education system, and in particular the school curricula, do not focus enough on entrepreneurship and do not provide the basic skills which entrepreneurs need. Children can learn to appreciate entrepreneurship from the beginning of their education”*.⁹²

Member States where entrepreneurship is well established in the curricula are still a small minority. Entrepreneurship is a recognised objective of the education systems and embedded explicitly in national framework curricula in Spain, Finland, Ireland, Cyprus, Poland and the UK but implementing means (teacher training, teaching materials) still needs to improve.⁹³

The primary purpose of entrepreneurship education at university is to develop entrepreneurial capacities and mindsets. The teaching of entrepreneurship has yet to be sufficiently integrated into university curricula - indeed it is necessary to make entrepreneurship education accessible to all students as innovative business ideas may arise from technical, scientific or creative studies. The Commission (Directorate General Enterprise and industry) published in 2008 a survey on the offer of entrepreneurship programmes in Higher Education. The survey shows that more than half of the student population in Europe does not have access to entrepreneurship education. For instance only 1/4 of specialized institutions (excluding business schools) and 1/3 of multidisciplinary institutions without a business school offer this type of programmes.⁹⁴

The OECD-Eurostat Entrepreneurship Indicators Programme (EIP) aims to build a knowledge base measuring the rates at which new firms are created or close down, studying factors which allow enterprises to grow and assessing the impact of small businesses on jobs, turnover and trade. It has provided a framework for indicators on entrepreneurship (see Chart IV.3.1).

Chart IV.3.1: Framework for indicators on entrepreneurship

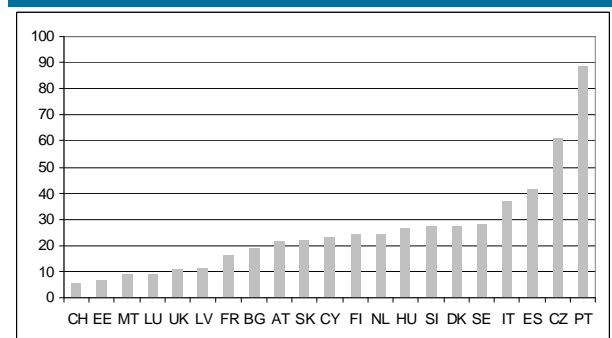


Source: M. Schmiemann (2009)⁹⁵

Initial findings cover 15 European countries, the US, Canada and New Zealand. The results show that in 2005 the number of new businesses as a proportion of all companies – the “birth rate” - was highest in Romania, Estonia, Lithuania and the Slovak Republic. Strong growth and economic restructuring related to European Union adhesion is likely to have been the key factor⁹⁶.

Chart IV.3.2 shows the density of enterprise “birth rate”, defined as the number of new enterprises divided by the total number of enterprises (in 10 000) in 2005 in the participating EU countries. This shows the amount of new enterprises created in relation to the total number of companies in a country. Southern European countries show a high proportion of new starts, together with the Czech Republic.

Chart IV.3.2: Density of enterprise “birth rate”



Source: Eurostat and OECD