OECD WORK ON NANOTECHNOLOGY SKILLS AND EDUCATION

Nanoscale Science and Engineering Education – the Next Steps
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Richard Scott, Science and Technology Policy Division

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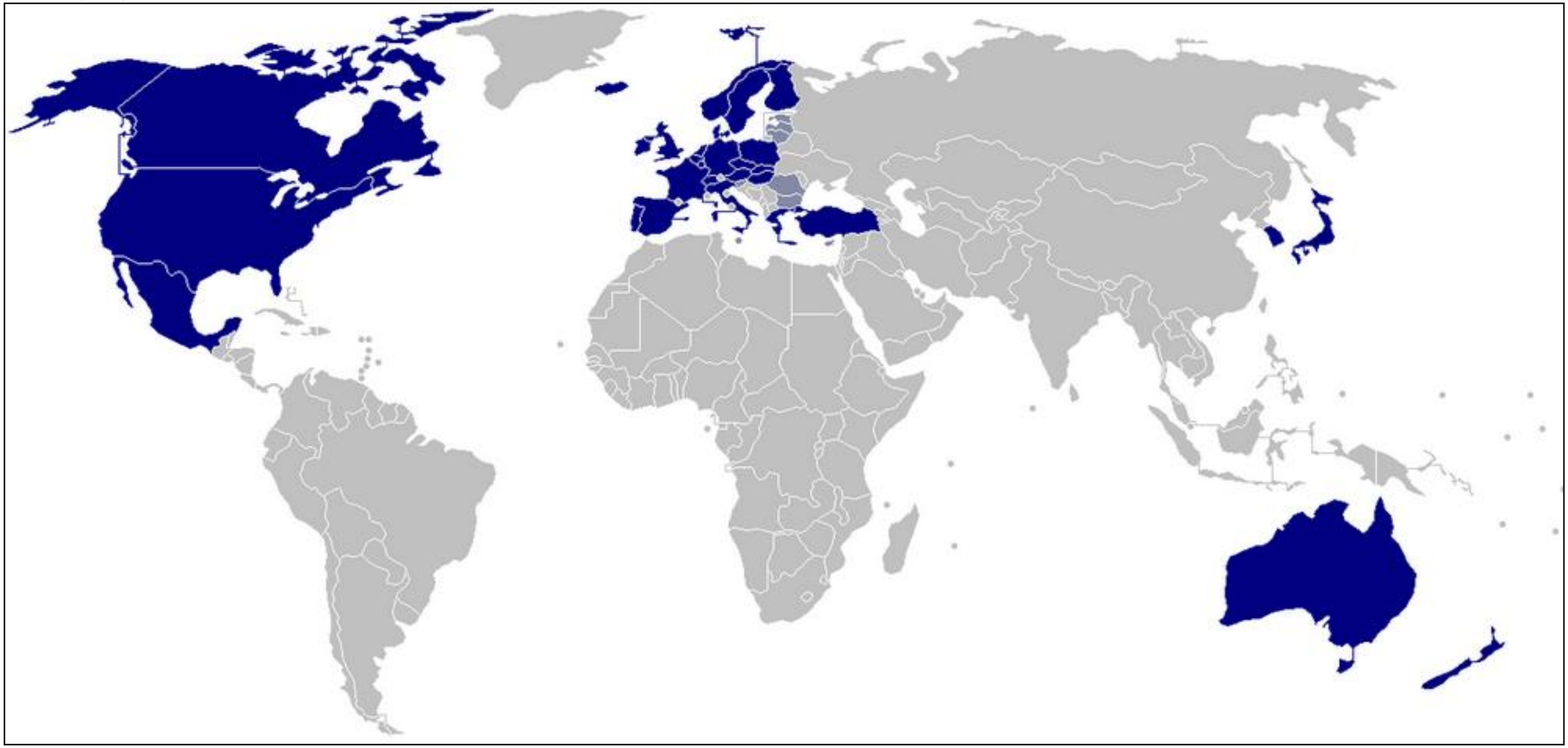
BETTER POLICIES FOR BETTER LIVES

Structure of the presentation

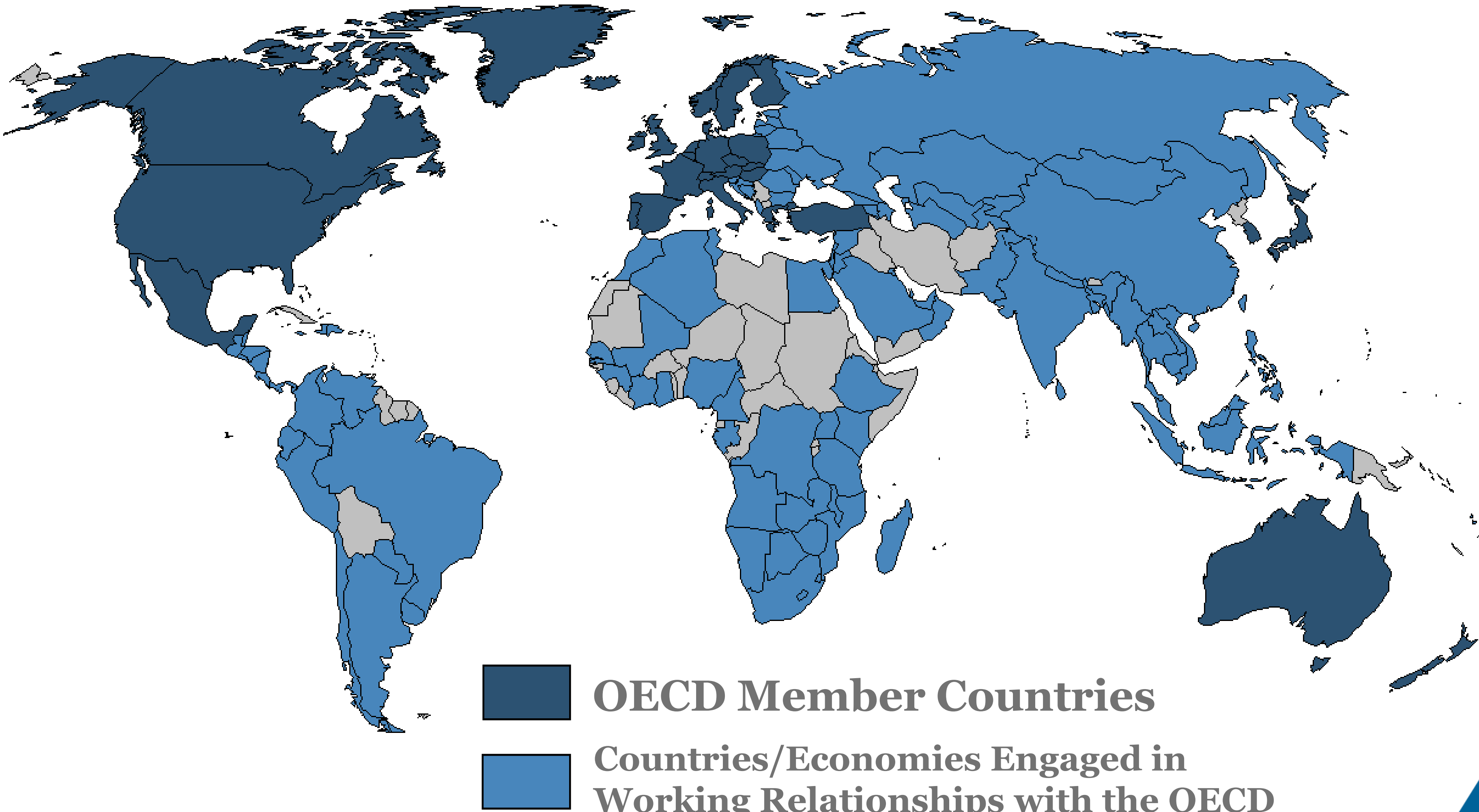
- Role of the OECD and its work on nanotechnology
- Summary of project *Skills and Education for Nanotechnology in an Increasingly Multidisciplinary Environment*
- Connecting to other work on skills and education for innovation
- Questions/discussion

Organisation for Economic Co-operation and Development



- 34 Member countries, plus links with those outside
- "Better Policies for Better Lives"
- Peer learning, best practice, comparable data collection, publications

Global perspective



Committee on Scientific and Technological Policy (CSTP)

Committee on Science and Technological Policy

- Exchange information, best practices and evaluation on science and technology policy to best encourage economic growth

Working parties:

- Technology and innovation policy
- Statistics and indicators
- Biotechnology
- Nanotechnology →

OECD Working Party on Nanotechnology (WPN)

- Nanotechnology = nanoscale science, engineering and technology
- Will become part of new group on Bio-, Nano- and Converging Technologies (BNCT) in 2015

OECD Working Party on Nanotechnology

- Examples of work areas:
  - Statistics and indicators
  - Business environments
  - Economic impacts
  - Regulatory frameworks
  - Risk governance
  - Public engagement
  - Nanotechnology and water
  - International co-operation, etc

Elsewhere……OECD Working Party on Manufactured Nanomaterials

- Safety of manufactured nanomaterials
- Harmonised process for risk assessment

Skills and Education for Nanotechnology in an Increasingly Multidisciplinary Environment

- Short survey (completed 2014) to provide snapshot of
  - OECD country approaches to develop skills and education for nanotechnology;
  - how these policies were being implemented and;
  - examples of country activity.
- Focus solely on national initiatives (central governments and their agencies)
- 11 responses received: Chile, Finland, France, Germany, Korea, the Netherlands, Norway, South Africa, Spain, Sweden, Turkey, plus additional desk research

5 areas of examination

1. Needs assessments
2. Role of industry
3. Monitoring and Evaluation
4. Availability of nanotechnology education and training
5. Country Profiles

Some countries have undertake a needs assessment of skills for nanotechnology

	Q1b. Has an assessment of skills/education need been made in your country?	
	Yes	No
Chile		x
Finland	x	
France	x	
Germany	x	
Korea	x	
Netherlands		x
Norway		x
South Africa		x
Spain		x
Sweden	x	
Turkey		x
TOTAL	5	6

- Examples:
  - Korea's annual manpower status survey of 250 companies (since 2009). Provides a quantitative assessment of the number of experts required in this field.
  - Germany developed quantitative measures based on a survey of nanotechnology companies

Industry plays a role in most countries

	Q2c. Does industry play a role in skills and education for nanotechnology?	
	Yes	No
Chile		x
Finland	x	
France	x	
Germany	x	
Korea	x	
Netherlands	x	
Norway	x	
South Africa		x
Spain	x	
Sweden	x	
Turkey	x	
TOTAL	9	2

- However, industry is also commonly involved at an earlier stage, e.g. Spain - ‘industrial PhDs’
- Norway – industry representatives sit on Research Council for Norway boards that , e.g. make funding decisions and issue PhDs
- Can be more ad hoc too – individual firms and individual universities – government role is more facilitation/incentives (not a given)

Little evidence of monitoring and evaluation of policies on skills & education for nanotechnology

	Q3a. Has monitoring and evaluation of policies been undertaken?	
	Yes	No
Chile		x
Finland		x
France	x	
Germany		x
Korea		x
Netherlands		x
Norway	x	
South Africa		x
Spain		x
Sweden		x
Turkey		x
TOTAL	2	9

- Monitoring and evaluation was not identified as being a regular activity.
- However, examples have been noted by France in relation to the assessment of institutes covering nanotechnology
- Formal evaluation of a nanotechnology programme in the case of Norway and its NANOMAT (PhD) programme.

Education level and nanoscale specialisation

Educational tier	Nano-relevant	Nano-focused	Nano-specific
Primary	10		
Lower secondary	10		
Upper secondary	10	1	
University e.g. B.Sc.	10	10	4
Advanced University e.g. MSc or PhD	10	10	10
Vocational training			7

Number of countries (out of 10)

- Nano-relevant education and training (e.g. within a broader science curriculum) takes place at the school level;
- Nano-focused education and training first becomes available at undergraduate level, except in the case of Korea;
- There is a mix of approaches to nano-specific education as four countries (Germany, Korea, Norway and Sweden) offer this at undergraduate level and six (Finland, France, the Netherlands, South Africa, Spain and Turkey) begin at postgraduate level.

Other findings from country profiles

- Germany – collection on nanotechnology education courses at the postgraduate level are available on the Federal Ministry of Education and Research website
- Korea has written skills and education for technology into legislation. Part of the Comprehensive Nanotechnology Development Plan – currently in Phase 3. Six regional technical schools focusing on practical nanotechnology programmes
- Netherlands – NanoNextNL is a consortium of firms, universities and institutes. Professional learning opportunities for researchers (e.g. risk analysis)

Possible Next Steps

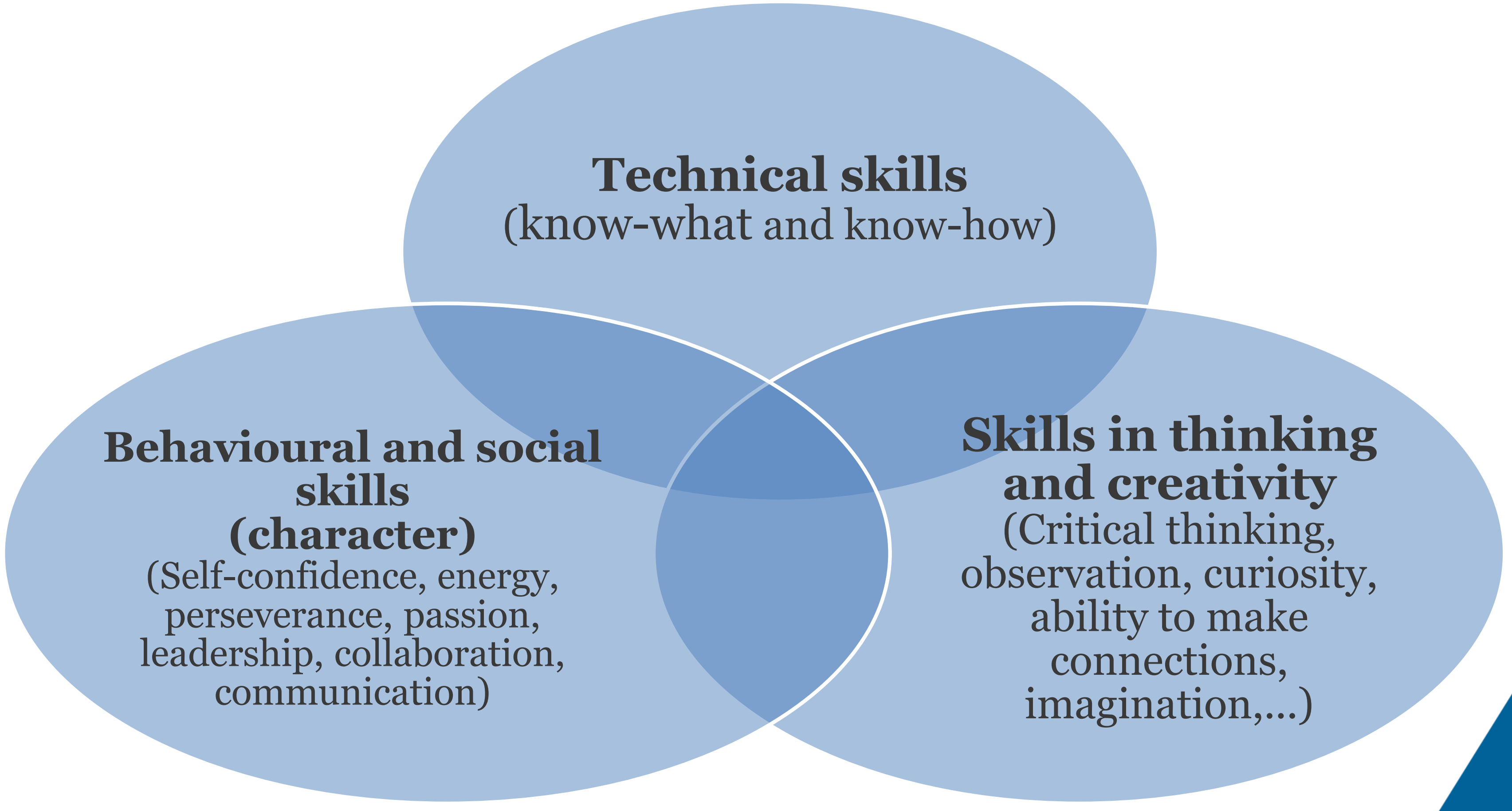
– Skills and Education included in the draft BNCT work programme for discussion.

– Could broaden further work:

- More actors – scope to examine requirements and actions among industry, research institutes, enforcement agencies and regional/state government
- More technology areas
- Step-back – the place of skills and education (e.g. STEM) in innovation.

Other OECD activities related to nanoscale science and engineering

- Work on **skills for innovation**



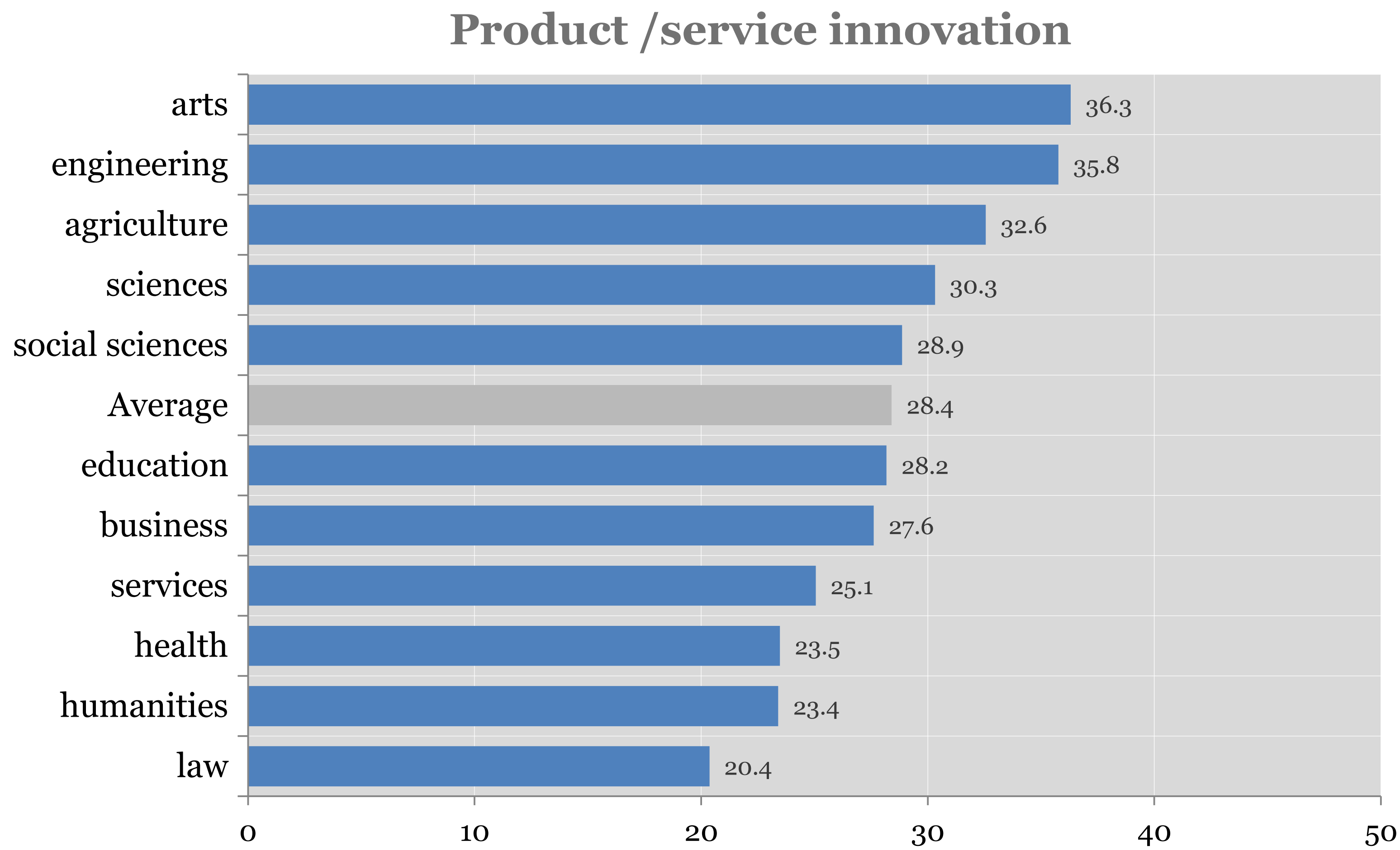
Possible implications

- Skills shortfall arguments need more nuance
  - Which skills are hardest for firms or PhD programmes or firms to instil?

- Possible barriers for different skills:
  - Assessment systems – generally poorly aligned with developing non-technical skills in OECD countries, especially at K-12 level → poor incentives
  - Curriculum development (technical skills)

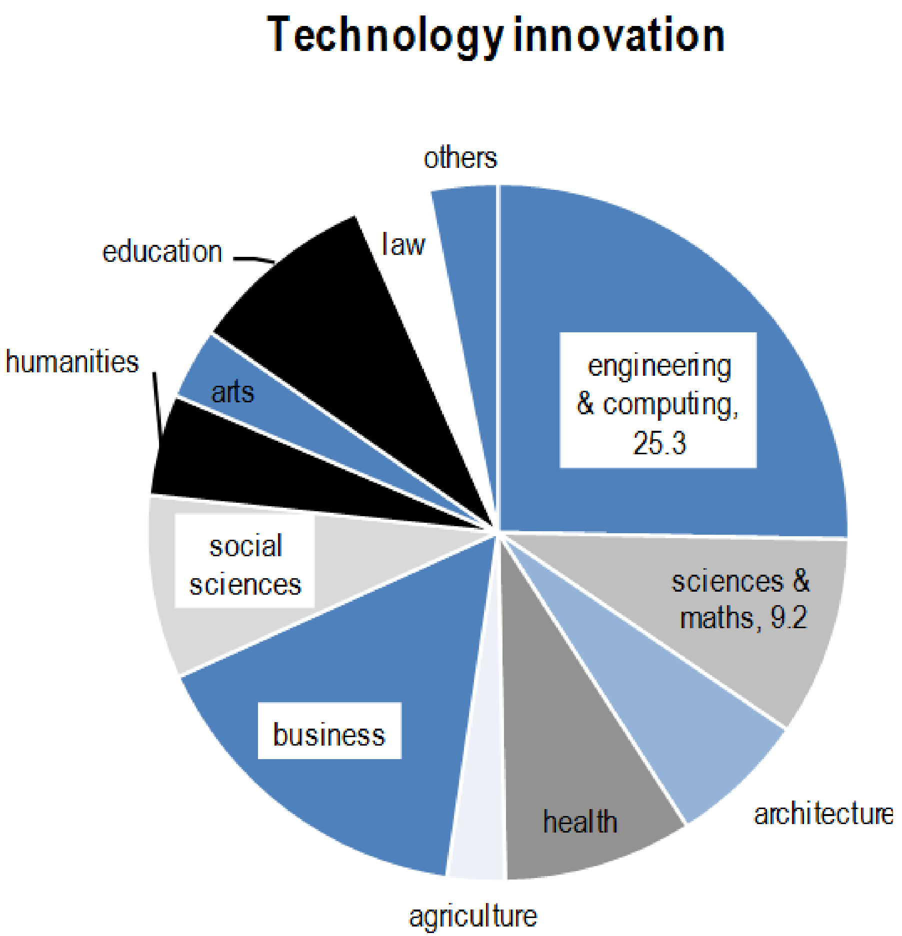
Innovation uses a variety of skills

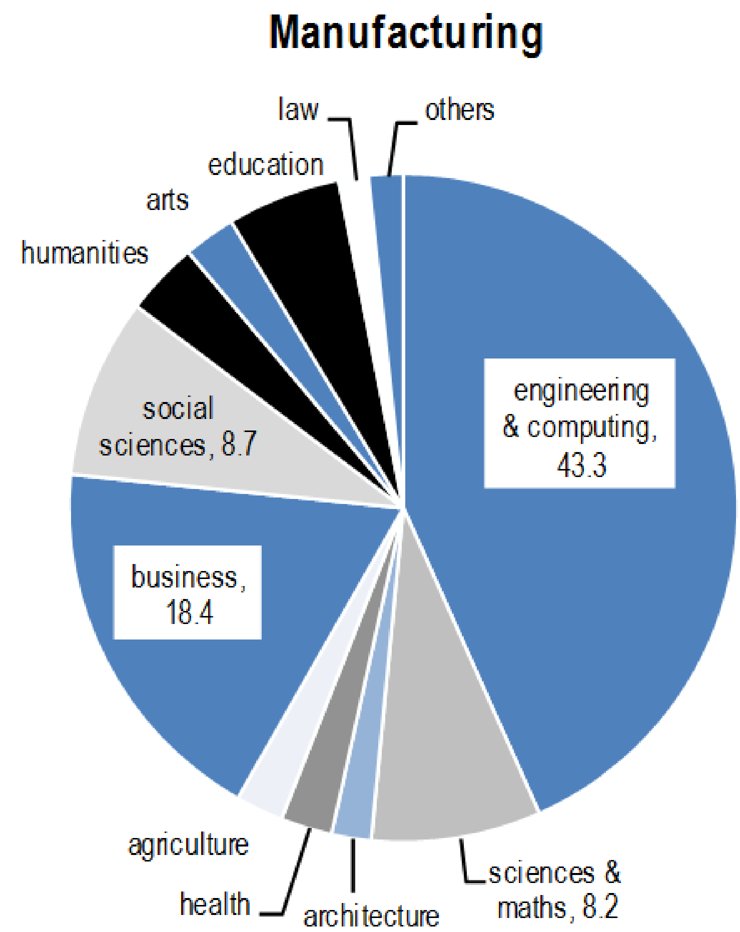
What percentage of university graduates of a given field have a highly innovative job?



Source: OECD, based on REFLEX and HEGESCO data

Varying picture when you look by type or sector of innovation

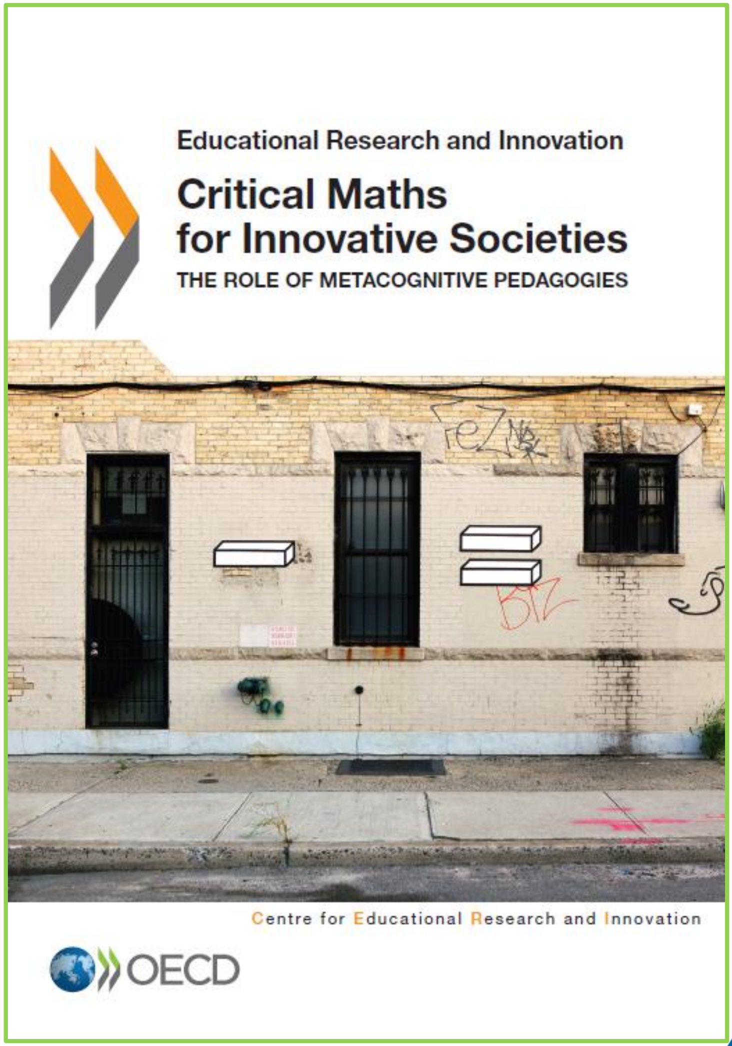




Source: OECD analysis of REFLEX/HEGESCO databases

OECD work on teaching STEM for broad skills

- Maths in secondary school – evidence of metacognitive strategies shows promising potential to increase interest, curiosity, while improving test scores of the lowest performing pupils
- In higher education, problem-based learning also strongly associated with better ability to apply one's knowledge. Most evidence comes from medicine, but some for engineering too



Importance of the technical workforce in innovation

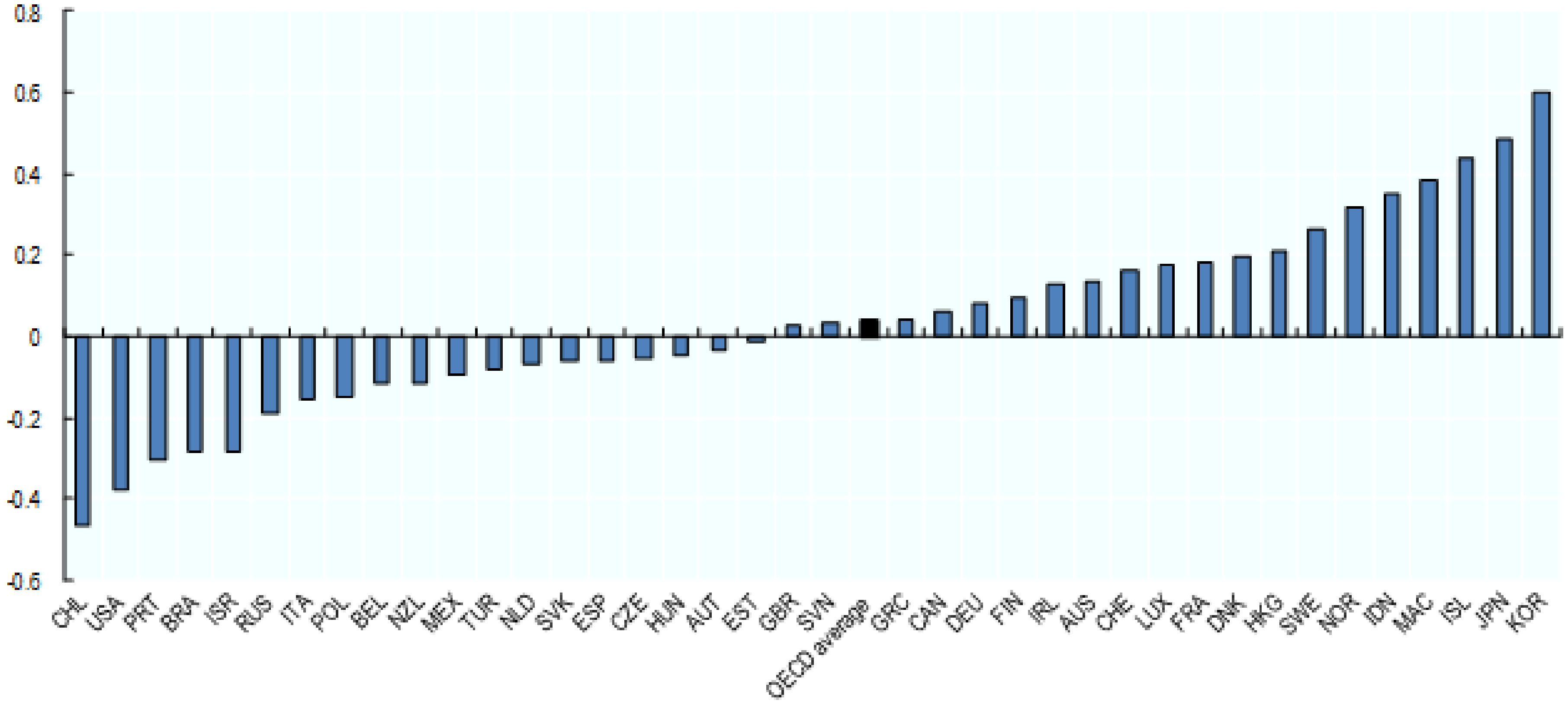
'Technical' workforce. Evidence suggests that non-university educated technical workers contribute to a large proportion of incremental innovation – e.g. in areas of instrumentation

Type of innovation	Radical	Incremental
Product	1. R&D personnel (conception) 2. Engineers (implementation)	1. Engineers (implementation) 2. R&D personnel (conception)
Process	1. Engineers (conception) 2. Technicians (implementation)	1. Technicians (implementation) 2. Engineers (conception)

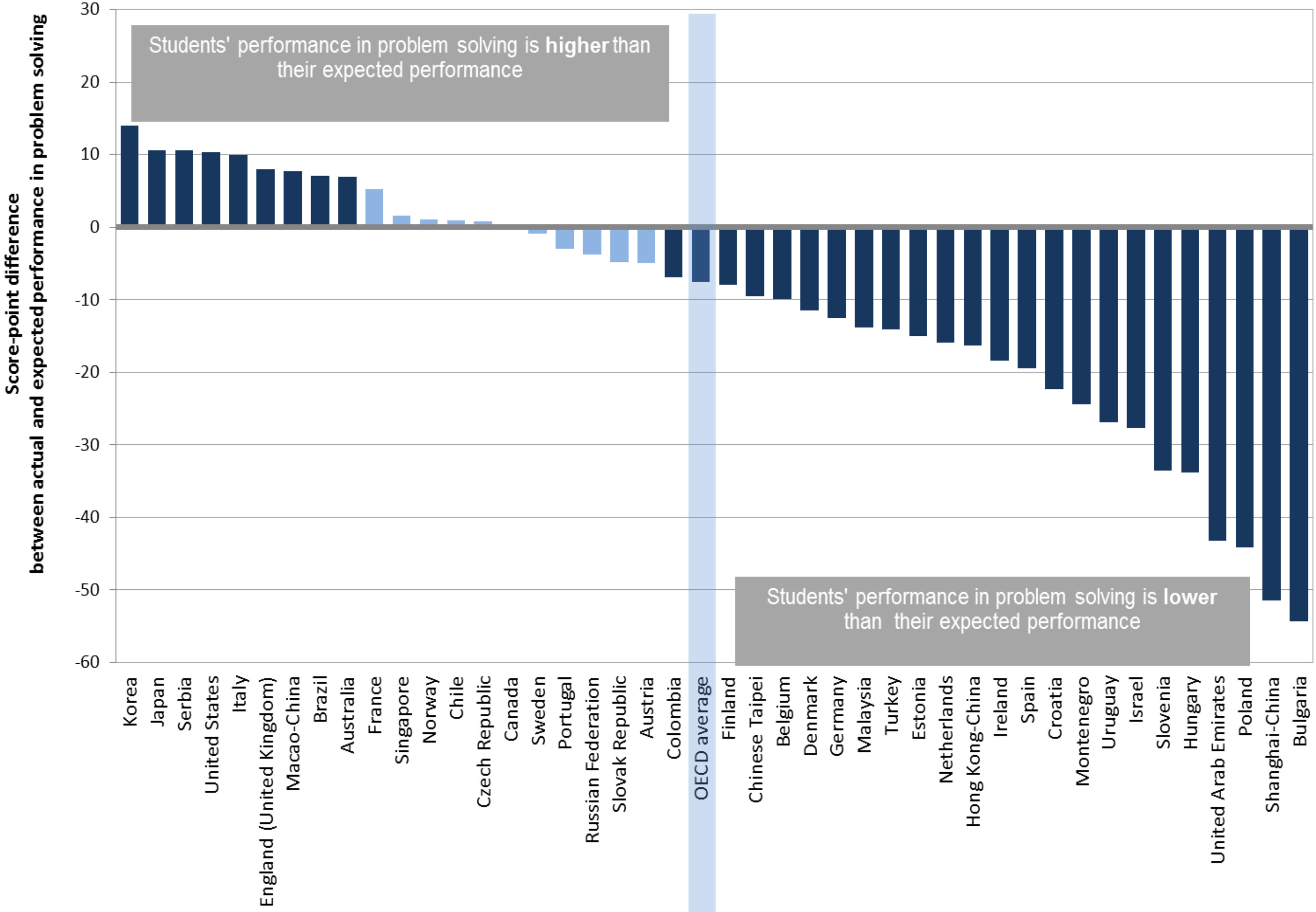
Source: Huiban and Bouhsina (1998), "Innovation and the quality of labour factor: An empirical investigation in the French food industry", *Small Business Economics*, Vol. 10, pp. 389-400.

Implications for interest in STEM too

Figure 2.14.2 Correlation of average test scores and average interest in science at the school level, OECD, Key Partner and non-member countries, 2006



Source: PISA 2006


Score-point difference
between actual and expected performance in problem solving
Students' performance in problem solving is higher than their expected performance
Students' performance in problem solving is lower than their expected performance
30
20
10
0
-10
-20
-30
-40
-50
-60
Korea
Japan
Serbia
United States
Italy
England (United Kingdom)
Macao-China
Brazil
Australia
France
Singapore
Norway
Chile
Czech Republic
Canada
Sweden
Portugal
Russian Federation
Slovak Republic
Austria
Colombia
OECD average
Finland
Chinese Taipei
Belgium
Denmark
Germany
Malaysia
Turkey
Estonia
Netherlands
Hong Kong-China
Ireland
Spain
Croatia
Montenegro
Uruguay
Israel
Slovenia
Hungary
United Arab Emirates
Poland
Shanghai-China
Bulgaria

Thank you!

richard.scott@oecd.org

http://www.oecd.org/sti/nano/

http://www.oecd.org/sti/sci-tech/

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