EDUCATION FOR INNOVATION: CURRICULUM, PEDAGOGY, ASSESSMENT

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Skills and education for innovation
« 21st Century Skills »
skills for innovation
Skills for innovation

- Is innovation hampered by a lack of qualified personnel?
- What skills/qualifications foster innovation in the economy?
- Has innovation led to a change in the level and type of education demanded?
- Are certain uses of workforce skills associated with more innovation?
Diversity of qualifications for innovation across sectors (example: Australia)

Mining
- Engineering: 32%
- Scientific: 18%
- Marketing: 14%
- Information technology: 16%
- Product management: 4%
- General business: 16%

Electricity, Water, Gas
- Engineering: 27%
- Scientific: 24%
- Marketing: 7%
- Information technology: 19%
- Product management: 14%
- General business: 9%

Finance and insurance
- Engineering: 21%
- Scientific: 24%
- Marketing: 24%
- Information technology: 17%
- General business: 21%
Fields of study of highly innovative professionals (%), selected sectors

Source: OECD, based on REFLEX and HEGESCO data
What share of graduates of a given field have a highly innovative job?

<table>
<thead>
<tr>
<th>Field</th>
<th>Product /service innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>arts</td>
<td>36.3</td>
</tr>
<tr>
<td>engineering</td>
<td>35.8</td>
</tr>
<tr>
<td>agriculture</td>
<td>32.6</td>
</tr>
<tr>
<td>sciences</td>
<td>30.3</td>
</tr>
<tr>
<td>social sciences</td>
<td>28.9</td>
</tr>
<tr>
<td>Average</td>
<td>28.4</td>
</tr>
<tr>
<td>education</td>
<td>28.2</td>
</tr>
<tr>
<td>business</td>
<td>27.6</td>
</tr>
<tr>
<td>services</td>
<td>25.1</td>
</tr>
<tr>
<td>health</td>
<td>23.5</td>
</tr>
<tr>
<td>humanities</td>
<td>23.4</td>
</tr>
<tr>
<td>law</td>
<td>20.4</td>
</tr>
</tbody>
</table>

Source: OECD, based on REFLEX and HEGESCO data
What share of graduates of a given field have a highly innovative job?

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What share of graduates of a given field have a highly innovative job?

### Knowledge / Method Innovation

<table>
<thead>
<tr>
<th>Field</th>
<th>Innovation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sciences</td>
<td>46.7</td>
</tr>
<tr>
<td>Education</td>
<td>41.8</td>
</tr>
<tr>
<td>Engineering</td>
<td>41.2</td>
</tr>
<tr>
<td>Agriculture</td>
<td>39.5</td>
</tr>
<tr>
<td>Average</td>
<td>38.3</td>
</tr>
<tr>
<td>Arts</td>
<td>38.1</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>37.7</td>
</tr>
<tr>
<td>Health</td>
<td>36.8</td>
</tr>
<tr>
<td>Humanities</td>
<td>36.0</td>
</tr>
<tr>
<td>Business</td>
<td>35.1</td>
</tr>
<tr>
<td>Services</td>
<td>32.7</td>
</tr>
<tr>
<td>Law</td>
<td>30.4</td>
</tr>
</tbody>
</table>

Source: OECD, based on REFLEX and HEGESCO data
individual skills for innovation
Critical skills for the most innovative jobs (according to tertiary-educated workers)

<table>
<thead>
<tr>
<th>Skill</th>
<th>Likelihood (odds ratios)</th>
</tr>
</thead>
<tbody>
<tr>
<td>come with new ideas/solutions</td>
<td>2.97</td>
</tr>
<tr>
<td>acquire new knowledge</td>
<td>2.44</td>
</tr>
<tr>
<td>willingness to question ideas</td>
<td>2.34</td>
</tr>
<tr>
<td>alertness to opportunities</td>
<td>2.24</td>
</tr>
<tr>
<td>present ideas in audience</td>
<td>2.18</td>
</tr>
<tr>
<td>analytical thinking</td>
<td>2.15</td>
</tr>
<tr>
<td>master of your own field</td>
<td>2.11</td>
</tr>
<tr>
<td>coordinate activities</td>
<td>2.05</td>
</tr>
<tr>
<td>write and speak a foreign language</td>
<td>2.02</td>
</tr>
<tr>
<td>use computers and internet</td>
<td>2.00</td>
</tr>
<tr>
<td>make your meaning clear</td>
<td>1.99</td>
</tr>
<tr>
<td>use time efficiently</td>
<td>1.98</td>
</tr>
<tr>
<td>mobilize capacities of others</td>
<td>1.97</td>
</tr>
<tr>
<td>work productively with others</td>
<td>1.95</td>
</tr>
<tr>
<td>coordinate activities</td>
<td>1.94</td>
</tr>
<tr>
<td>write reports or documents</td>
<td>1.81</td>
</tr>
<tr>
<td>perform under pressure</td>
<td>1.76</td>
</tr>
<tr>
<td>knowledge of other fields</td>
<td>1.76</td>
</tr>
<tr>
<td>negotiate</td>
<td>1.76</td>
</tr>
<tr>
<td>assert your authority</td>
<td>1.56</td>
</tr>
<tr>
<td>assert your authority</td>
<td></td>
</tr>
<tr>
<td>work productively with others</td>
<td></td>
</tr>
<tr>
<td>coordinate activities</td>
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<tr>
<td>assert your authority</td>
<td></td>
</tr>
</tbody>
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Source: OECD, based on REFLEX and HEGESCO data
What individual skills should education systems foster?

**Technical skills**
(know-what and know-how)

**Skills in thinking and creativity**
(Critical thinking, observation, curiosity, ability to make connections, imagination,...)

**Behavioural and social skills (character)**
(Self-confidence, energy, perseverance, passion, leadership, collaboration, communication)
Technical skills

• What skills?
  – Know-what (content, technical vocabulary)
  – Know-how (procedural knowledge, problem solving, )

• What subjects? Any
  – Foundational skills: domestic language (reading and writing), arithmetics
  – History, maths, science, IT, history, foreign languages, civic education, humanities, social sciences, technical fields, sports, etc.
Skills in thinking and creativity

- Critical thinking
  - Challenging assumptions
  - Arguing and assessing arguments
  - Dealing with uncertainty
  - Problem finding (rather than problem solving)

- Creativity
  - Imagining, generating ideas, playing with possibilities
  - Making connections, exploring
  - Daring to be different, original
• **Behavioural and social skills (character)**

  - **Behavioural skills**
    - Self-confidence and humility
    - Energy, passion
    - Persistence, resilience
  
  - **Social skills**
    - Collaboration (listening, sharing, giving/receiving feedback)
    - Communication (presentation, arguing, empathy)
    - Leadership (inspire, mobilise capacity of others)
Some comments on these skill categories

- They overlap and may reinforce each other

But

- They are different and cannot be reduced to a single skill (or measure)

- They are domain-specific
  - Skills are generally domain-specific: one is creative in a field, one knows how to behave/communicate in a specific context, one has problem-solving skills in a field, one has content knowledge in a field

- They can become « domain-generic »
  - A skills becomes « domain-generic » when one has gained it in a number of domains or settings, so that it becomes a « habit of mind » (a disposition or a stabilised skill) that one can apply to new fields
science education for innovation
Do education systems foster simultaneously all sets of skills for innovation?
Do countries foster simultaneously technical and behavioural skills? Not necessarily

Example: Science scores and interest in science are not always fostered simultaneously.

Source: OECD, based on PISA 2006
## Robustness

Partial correlation coefficients between science interest and science score:

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial correlation</td>
<td>-0.74</td>
<td>-0.71</td>
<td>-0.66</td>
<td>-0.69</td>
<td>-0.74</td>
<td>-0.56</td>
</tr>
</tbody>
</table>

**Controls:**

- **GDP p/c**
  - X
  - X
  - X

- **Luxembourg**
  - X
  - X

- **Self-concept (mean)**
  - X
  - X

- **Self-efficacy (mean)**
  - X
  - X

- **Culture (Hofstede 4-dim)**
  - X
  - X

**N**

|   | 34 | 34 | 33 | 34 | 32 | 31 |
### The Test-Score/Interest Paradox

**within-school** correlation of individual interest and scores

**between-school** correlation of average interest and scores

Source: OECD, based on PISA 2006
Do countries foster simultaneously technical and behavioural skills? Not necessarily

Example: Science scores and interest in science are not always fostered simultaneously

Source: OECD, based on PISA 2006
Science education for innovation

• Are some pedagogies more effective in fostering simultaneously all sets of skills for innovation?
Teaching indicators in PISA 2006 based on 4 clusters of activities:

- **Interaction**
  - Collaboration and participatory exchanges

- **Hands-on**
  - Guided activities around lab experiments

- **Application**
  - Drawing connections between school science and the outside world

- **Investigation**
  - Autonomous student inquiries
Pedagogies for innovation skills

Science score

<table>
<thead>
<tr>
<th></th>
<th>application</th>
<th>hands-on</th>
<th>interaction</th>
<th>investigation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-1</td>
<td>4</td>
<td>-2</td>
<td>-10</td>
</tr>
<tr>
<td></td>
<td>-2</td>
<td>8</td>
<td>-2</td>
<td>-10</td>
</tr>
</tbody>
</table>

Interest in Science Topics

<table>
<thead>
<tr>
<th></th>
<th>application</th>
<th>hands-on</th>
<th>interaction</th>
<th>investigation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>3</td>
<td>6</td>
<td>-2</td>
</tr>
<tr>
<td></td>
<td>-2</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
</tr>
</tbody>
</table>

The graphs show the changes in science scores and interest in science topics for different pedagogical approaches.
Pedagogies for innovation skills

**Science Enjoyment**

- Application: 26
- Hands-on: 1
- Interaction: 11
- Investigation: 2

**Science Self-Efficacy**

- Application: 15
- Hands-on: 4
- Interaction: 5
- Investigation: 4
Science education for innovation

Other ongoing work:

- Cooperative and metacognitive practices in math education
- Project-based and ICT-based pedagogies in science
- The role of informal science programmes
arts education for innovation
Arts education for innovation

• What is the impact of arts education on the different sets of skills for innovation?
Art for Art’s Sake? The impact of arts education (OECD, forthcoming 2013)

- A report based on a meta-analysis of empirical studies since 1950

- Languages covered: English, Finnish, French, German, Italian, Japanese, Korean, Spanish

- Arts education: music, visual arts, theatre, dance – and « multi-arts »

- Skills covered:
  - Academic non-arts skills (verbal, maths, spatial)
  - Skills in thinking and creativity (creativity, problem solving)
  - Behavioural and social skills (self-confidence, emotion regulation, empathy, perspective taking, motivation)
Multi-arts education and non-arts academic skills

An association…

United States: SAT scores of students taking following subjects in high school

<table>
<thead>
<tr>
<th>Subject</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drama</td>
<td>503</td>
</tr>
<tr>
<td>Music History/Theory/Appreciation</td>
<td>503</td>
</tr>
<tr>
<td>Drama Appreciation</td>
<td>491</td>
</tr>
<tr>
<td>Music Performance</td>
<td>497</td>
</tr>
<tr>
<td>Studio Art/Design</td>
<td>495</td>
</tr>
<tr>
<td>Art History/Appreciation</td>
<td>489</td>
</tr>
<tr>
<td>Dance</td>
<td>474</td>
</tr>
<tr>
<td>No Arts</td>
<td>465</td>
</tr>
</tbody>
</table>
Multi-arts education and subject-based skills

…but no causality

![Composite, Verbal, Math bar chart](image)
Strengthening verbal skills through the use of classroom drama

A clear causal link
Empathy / Perspective taking

Sample Item from “Reading the Mind in the Eyes” Test
Some causal findings

- **Music**: IQ, academic performance, word decoding, phonological skills (and possibly foreign language learning and visual-spatial reasoning)

- **Theatre**: verbal skills, empathy, perspective taking, emotional regulation

- **Visual arts**: geometrical reasoning, (scientific) observation
Arts education for innovation

- Most studies find a positive link between arts education and creativity, but the evidence cannot be generalised.

- Ethnographic evidence shows that visual arts education (at its best) promotes reflection and metacognition.

- Could other fields be inspired by arts education, e.g. project work while teachers give personal consultation or regular mid-project critiques?
assessing skills for innovation
Assessment and high stakes

• Assessment raises awareness of the desired learning outcomes (skills)

• Assessment allows one to diagnose problems, monitor progress, and improve teaching and learning

BUT

• High stake assessments can lead to narrowing of the curriculum and to teach/learn to tests that, by nature, cannot assess everything and are imperfect
Beyond the assessment of technical skills?

- Change high stake assessments to make them less predictable: use a variety of them, randomly?

- Develop (or use) assessments for other skills
  - Use panels of human assessors: costly, but allows to assess complex skills
  - Make goals explicit and try to develop language and criteria to monitor their progression

- Turn assessment into a meaningful learning activity
conclusions and open questions
Conclusions

- Need to develop *simultaneously* several sets of skills
- Curricula should not be too narrow – but pedagogy seems to matter more than what is taught
- Some pedagogies are better than others to develop all skill sets
- We need more balanced assessments if we want to take all skills seriously
Open questions

- What is the relevance of these questions to different Asian countries?
- How are the different sets of skills for innovation fostered in Asia – through which curricula, pedagogies and assessments?
- Is the agenda taken seriously only because (when) technical skills are well acquired?
How do we foster an innovation ecosystem in education?

Innovation in education

- Technology
- Research and Development
- System organisation
- School organisation
Stephan.Vincent-Lancrin@oecd.org

THANK YOU
www.oecd.org/edu/innovation