

Nanotechnology education for secondary schools and university students: The employers perspective

Albert Duschl, University of Salzburg

Sustainable Nanotechnology Conference
Venice, 10. March 2015



The problem

- Nanotechnology is by nature interdisciplinary, involving numerous scientific and technical disciplines
- Beyond nanotechnology, it is useful to have skills in physics, mathematics, materials sciences, biology, medicine, environmental sciences, business, law, communication, etc.
- Where would you find the experts for that?



NanoEIS CSA: Education meets jobs

- Nanotechnology is a KET that penetrates more and more industries. Accordingly, a job market develops.
- In response, universities have set up various study programs at bachelor, master and PhD level.
- Question: Do university education contents meet job market needs?



11 Partners, 3 years

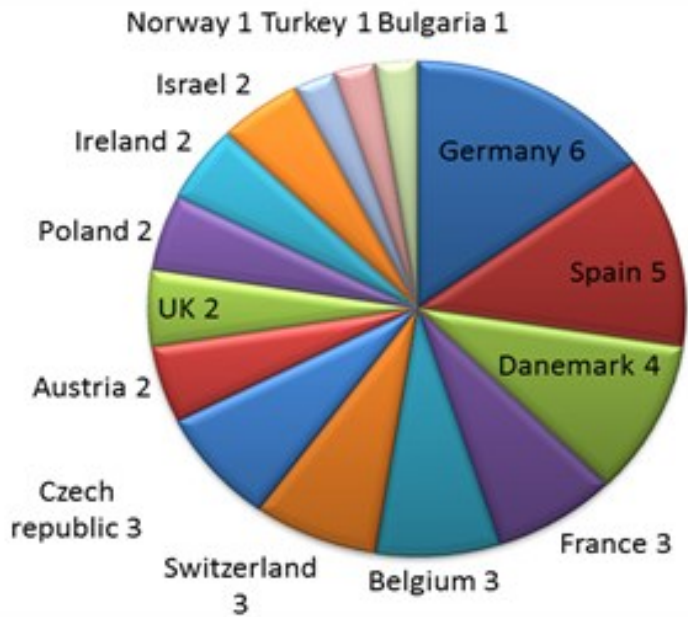


Industry needs

- Industrial employers report strong needs to recruit expertise in various nanotechnological areas. Both now and in 5 years, Health/Safety is topic number one. In 5 years, nanotechnology industry expects to recruit experts in 1) Health/Safety, 2) Regulation, 3) Environment.
RED FLAG: This is not at all coherent with present nano-study contents.



The university side

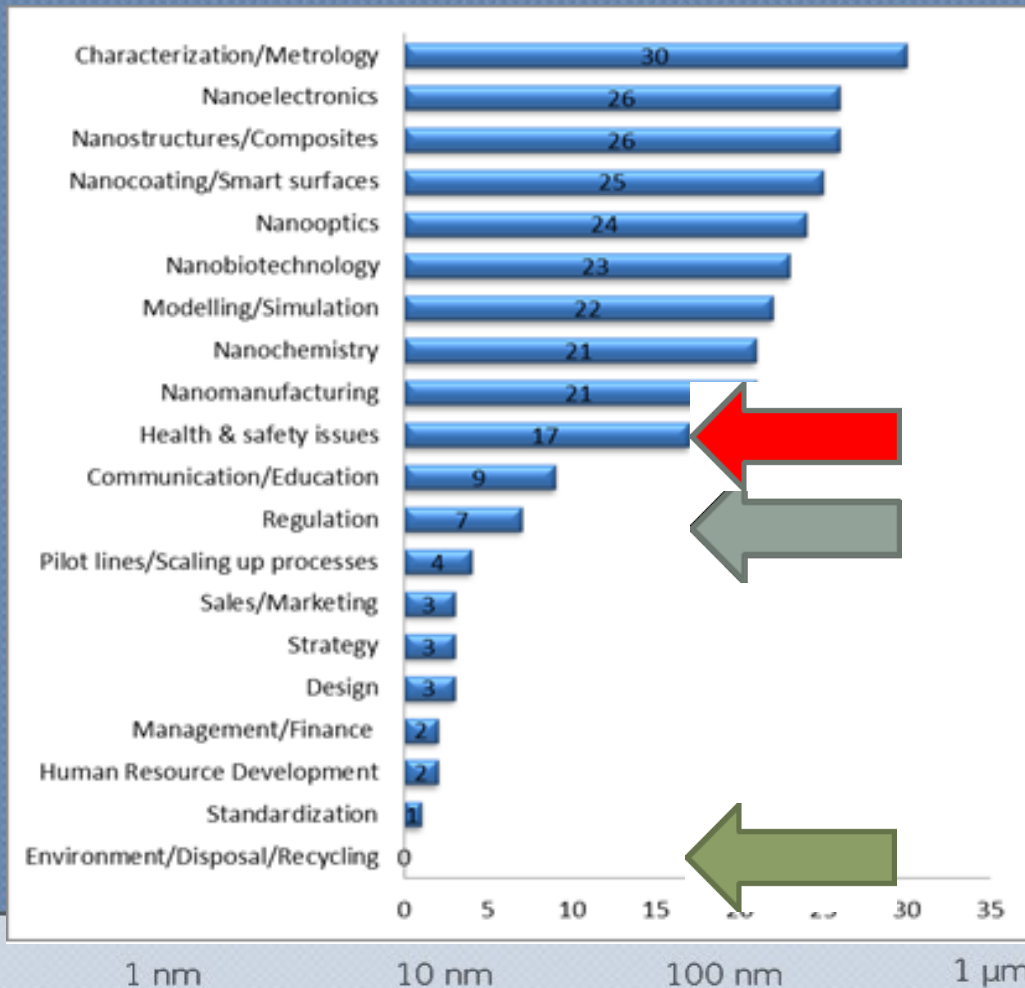


35 representative university curricula were studied:
10 BSc, 19 MSc, 6 PhD programs.

<http://www.nanoeis.eu/sites/nanoeis.eu/files/downloads/D32-corrected-public.pdf>



Do you teach?



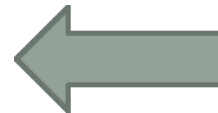
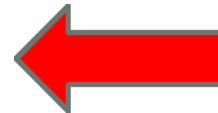
University teaching contents differ strongly from industry needs: The fields offered are the same in both studies!

<http://www.nanoeis.eu/sites/nanoeis.eu/files/downloads/D32-corrected-public.pdf>



Industry: Do you need?

SKILLS	NOW
Health and safety issues	31
Characterization techniques	26
Nanocoatings/smart surfaces	26
Nanochemistry	22
Regulation/standardization	20
Marketing and communication	18
Nanomanufacturing	16
Pilot lines/scaling up processes	14
Environment/disposal/recycling	14
Nanostructures/composites	13
Nanoelectronics	12
Metrology	12
Nanobiotechnology	10
Design	9
Modelling/simulation	8
Nanoptics	5
We don't need any now	2
Other*	1



http://www.nanoeis.eu/sites/default/files/downloads/NA_NOEIS%20D2.1%20Report%20on%20European%20industry%20needs.pdf

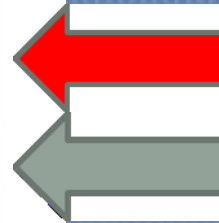
Fig. 3.11 Ranking of related skills/knowledge required by the companies NOW according to number of answers received (*knowledge about business)

nm 1 nm 10 nm 100 nm 1 μm 10 μm 100 μm 1 mm



Your (students) job market

SKILLS	5 YEARS TIME
Health and safety issues	26
Regulation/standardization	23
Environment/disposal/recycling	23
Nanochemistry	23
Nanocoatings/smart surfaces	20
Nanobiotechnology	18
Nanostructures/composites	17
Nanomanufacturing	17
Marketing and communication	15
Pilot lines/scaling up processes	14
Modelling/simulation	12
Metrology	12
Nanoelectronics	11
Characterization techniques	10
Design	9

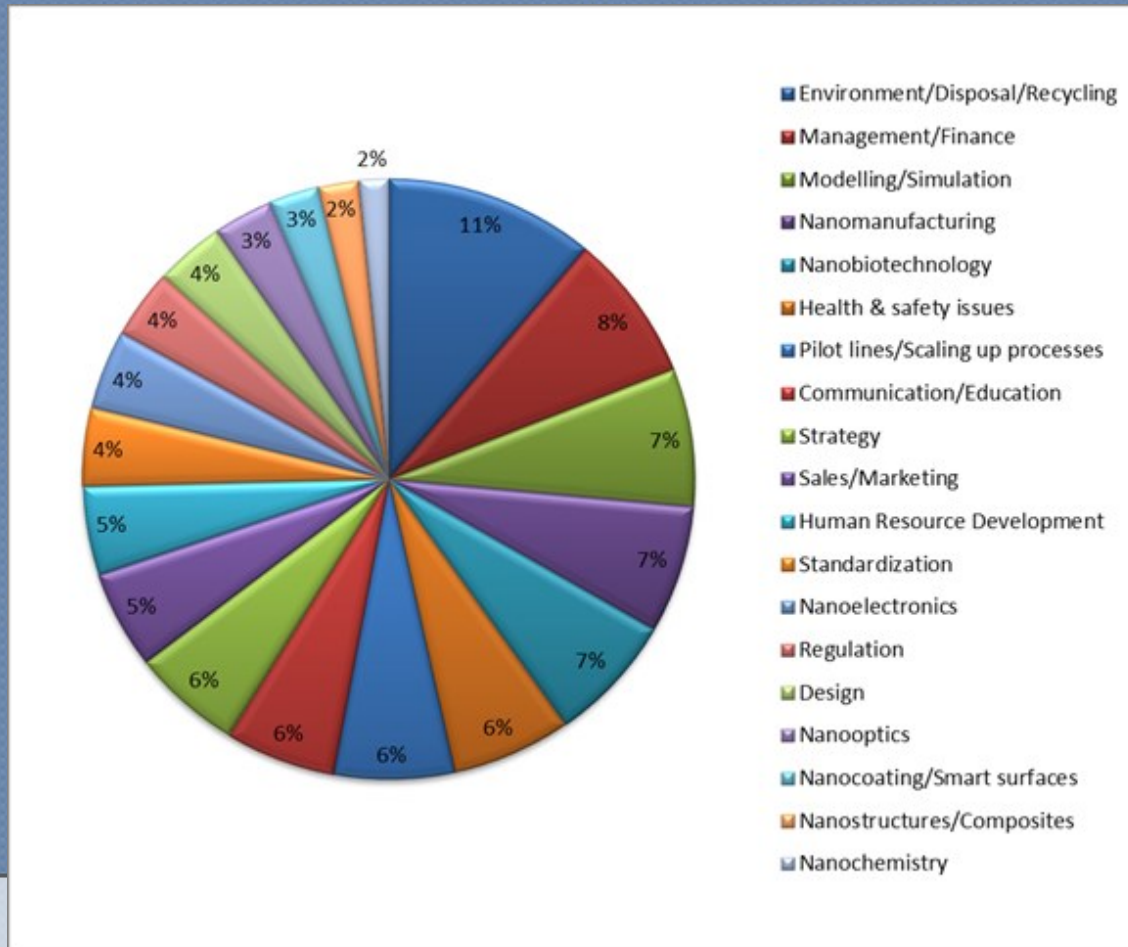


Nanotechnology industry
needs in 5 years:

<http://www.nanoeis.eu/sites/default/files/downloads/NANOEIS%20D2.1%20Report%20on%20European%20industry%20needs.pdf>



Students: What is missing in your study ... ☆



☆ ... but you think employers want from you?

<http://www.nanoeis.eu/sites/nanoeis.eu/files/downloads/D32-corrected-public.pdf>

nm

10 μm

100 μm

1 m



Other (social) employers

- NanoEIS identified three ,ecosystems' of employment:
- A) Dialogue & Communication (either stakeholder dialogue or public awareness raising and education – defined by target audiences; includes media)
- B) Regulation (Government, EU and international agencies)
- C) STI Promotion (Policy development, funding /coordinating research and facilitating innovation; *e.g.* REA, DASTI or FWF)

<http://www.nanoeis.eu/sites/default/files/downloads/NanoEIS%20DeliverableReporttotheremployersfinal.pdf>



The university side

- **Health and safety issues:** About half of the universities polled claim to develop health/safety issues to some extent in nanotechnology curricula.
- **Environmental/disposal/recycling issues:** Of the polled universities, zero reported to develop these skills.
- **Transfer into industry:** The single most important factor for smooth hiring of graduates by industry was **direct involvement of industry in teaching** (modules, industry courses etc.). This also goes for PhDs.

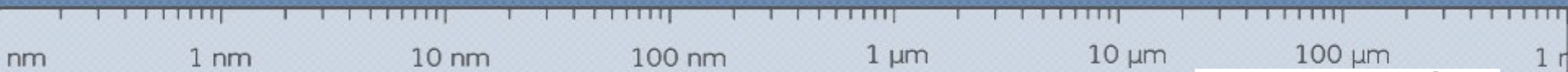
<http://www.nanoeis.eu/sites/nanoeis.eu/files/downloads/D32-corrected-public.pdf>

<http://www.nanoeis.eu/sites/nanoeis.eu/files/downloads/D33-corrected.pdf>



Suggestions

- There is a substantial job market where it is desired that people have better „**additional**“ **skills**, including safety, regulation, standardization, environment, etc.
- In **high schools** there are some islands of good practice but they are young and rare. Sustainability may be a problem when they are project-driven. Implement changes top-down?



Caveats

- The NanoEIS studies has not collected data on all available programs, due to restrictions of time and budget. It is thus a snapshot rather than a full picture.
- The project did, in line with the call, not include **universities of applied sciences** or **private training offers**, but focussed on secondary schools – universities – industries.
- There may be even other players which are important but were not covered.



Whom to ask?

- Answers, depending on whom we ask:
 - We **don't need** any nano-experts at all.
 - We need **skilled workers**, not academics.
 - We find **Bachelors** best to recruit.
 - We find **MA** best to recruit.
 - We find **PhD** best to recruit.
-
- The field is in development, employers are very different, and nobody knows the winning strategy.



Why safety?

- Health/safety was a surprising focus to find, but note that no nanosafety experts were involved in the industry survey.
- It is likely that the interest is for **technology experts** that have essential knowledge about safety. That would be in line with other expressed wishes, like regulation, environment, marketing.
- Technology studies may be well advised to consider the fit of their content to actual job duties (old hat, but still true).



Where to get safety experts?

- In case you really need an expert on safety, the EU projects on nanosafety play right now a critical role in training of experts with interdisciplinary skills.
- **H2020** can have a major impact in this respect, so bear in mind that even outside of MSC actions, training is a big issue: A lot of work is carried out by PhD students and postdocs.

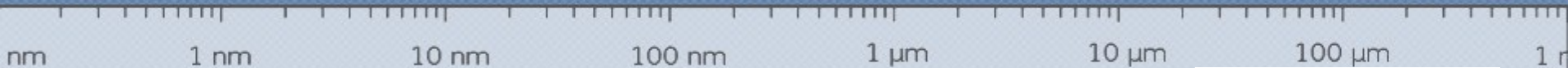


At the STEM

- We emphasize that **nanotechnology at secondary schools** offers a case study where many findings and conclusions can be translated to other STEM subjects.
- Nanotechnology is particularly interesting since it is so close to the **young users**★, but we think strategies considered here are relevant for raising interest in STEM subjects as a whole.

★ *Here is your cell phone, here is your cosmetics, here is your tennis racket, here is your pregnancy assay*

<http://www.nanoeis.eu/sites/nanoeis.eu/files/downloads/NanoEIS%20D3%201.pdf>





The team, with thanks to everybody for contributing to these results.

"The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 319054."

