Post-Bologna Process Undergraduate Chemistry Curricula in Europe

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The Bologna Declaration (1999)

The creation of a European Higher Education Area

1. Adoption of a system of easily readable and comparable degrees
2. Adoption of a system essentially based on two cycles
3. Establishment of a system of credits (ECTS)
4. Promotion of mobility
5. Promotion of European cooperation in quality assurance
6. Promotion of the European dimension in higher education

Major driving forces:
- Enhancement of the employability of the European graduate
- Enhancement of academic quality

KEYWORDS: comparability, recognition, mobility, quality, employability
Some achievements since 1999

• 95% of institutions have implemented the new degree structure (bachelor, master, doctorate)
• At the Bachelor level, widened access, student-centered learning and flexible learning paths
• Introduction of Master degree as a new, separate qualification
• Employability has moved to the forefront and poses concerns at the Bachelor level (continuation to Master level is ‘expected’)
• ECTS has developed as an accumulation and transfer system
• The EHEA exists (officially launched in March 2010) but much more work to do
Planned or realised (as of August 2009):

- 180 ECTS
- 240 ECTS
- VARIABLE
How to create two cycles from an existing 5-year programme

- **Temptation 1**
  - 3-year bachelor
  - 2-year master

- **Temptation 2**
  - 3-year bachelor

- **Requirement**
  - 3-year bachelor
  - 2-year master
The ‘Tuning Project’ was the HE institutions answer to the political decisions underlying the Bologna process.

It involved almost 150 HE institutions in 9 subject area groups; apart from chemistry, these are: physics, mathematics, history, earth sciences, business, education sciences, nursing, European studies.

For chemistry the work was carried out by the European Chemistry Thematic Network (ECTN)
ECTN is a network, established in 1996, with over 130 members from 29 countries; apart from universities these include nine national chemical societies (DE, FR, GB, IT, NL, CZ, SK, LT, SI).
Some relevant Tuning Themes

- Outcome-based programmes based on subject-specific and generic competences
- ECTS as a credit accumulation and transfer system
- Quality assurance

For chemistry this led to the Eurobachelor framework

Tuning USA at www.luminafoundation.org/our_work/tuning/
The Chemistry Eurobachelor - A framework for a European first-cycle degree in chemistry

Outcomes
Define which competences a programme seeks to develop, or what its graduates should be able to know, to understand, and to do
• Aid to transparency/comparability
• Aid to the development of better-defined degrees
• Aid to the development of systems of recognition
• Aid to employability
• Aid to mobility

Chemistry Eurobachelor - defined as a programme of 180 credits based on outcomes, but also applicable to institutions using 240 credits. Very flexible.

Endorsed by EuCheMS
Aspects considered in the Chemistry Eurobachelor

• Learning outcomes (adapted from QAA benchmarks–UK)
• Modularisation
• Credit distribution
• ECTS and student workload
• Mobility
• Methods of Teaching and Learning
• Assessment, Grading
• Quality Assurance
Credit distribution:

- At least 150 of the 180 credits should deal with chemistry, physics, biology or mathematics.
- The course should include EITHER a bachelor thesis of 15 ECTS credits OR an equivalent industrial placement.
Credit distribution:

Compulsory modules (total of \textit{at least} 90 credits):
- Organic chemistry
- Inorganic chemistry
- Physical chemistry
- Analytical chemistry
- Biological chemistry
- Physics, Mathematics

Semi-optimal modules (a \textit{minimum} of 3 modules - 15 credits) from:
- Biology
- Computational chemistry
- Chemical technology
- Macromolecular chemistry
- ....and others, depending on the institution
OUTCOMES

• Subject knowledge

• Abilities and Skills
  (a) Chemistry-related cognitive abilities and skills
  (b) Chemistry-related practical skills
  (c) Generic/Transferable skills
OUTCOMES - SUBJECT KNOWLEDGE

• The characteristic properties of elements and their compounds, including group relationships and trends within the Periodic Table
• The structural features of chemical elements and their compounds, including stereochemistry
• The properties of aliphatic, aromatic, heterocyclic and organometallic compounds
• The nature and behaviour of functional groups in organic molecules
• Major synthetic pathways in organic chemistry, involving functional group interconversions and carbon-carbon and carbon-heteroatom bond formation
• The relation between bulk properties and the properties of individual atoms and molecules, including macromolecules (both natural and man-made), polymers and other related materials
• The structure and reactivity of important classes of biomolecules and the chemistry of important biological processes.
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Abilities and skills
(a) Chemistry-related cognitive abilities and skills

• Ability to demonstrate knowledge and understanding of essential facts, concepts, principles, and theories relating to the defined subject knowledge
• Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of a familiar nature
• Skills in the evaluation, interpretation, and synthesis of chemical information and data
• Ability to recognise and implement good measurement science and practice
• Skills in presenting scientific material and arguments in writing and orally, to an informed audience
• Computational and data processing skills, relating to chemical information and data
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c) Generic Skills: These are the Key to Employability of the Bachelor!

- The capacity to apply knowledge in practice, in particular problem-solving competences, relating to both qualitative and quantitative information.
- Numeracy and calculation skills, including such aspects as error analysis, order-of-magnitude estimations, and correct use of units.
- Information-management competences, in relation to primary and secondary information sources, including information retrieval through on-line computer searches.
- Ability to analyse material and synthesise concepts.
- The capacity to adapt to new situations and to make decisions.
- Information-technology skills such as word-processing and spreadsheet use, data-logging and storage, subject-related use of the Internet.
- Skills in planning and time management.
- Interpersonal skills, relating to the ability to interact with other people and to engage in team-working.
- Communication competences, covering both written and oral communication, in one of the major European languages (English, German, Italian, French, Spanish) as well as in the language in which the degree course is taught.
- Study competences needed for continuing professional development. These will include in particular the ability to work autonomously.
- Ethical commitment
Generic competences and the Tuning project

- 7 disciplines (chemistry, physics, maths, geology, history, educational sciences, business studies)
- Questionnaire sent to employers (944), recent graduates (5183), academics (998)
- All EU Member States involved
- Give importance of each of 30 Generic competences, and rank the 5 most important
- Very strong agreement
  ✓ Between graduates and employers (less agreement with academics)
  ✓ Between disciplines
  ✓ Between countries
## Ranking of generic competences from Tuning project questionnaire for chemistry

<table>
<thead>
<tr>
<th>Graduates (612)</th>
<th>Employers (96)</th>
<th>Academics (102)</th>
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<tbody>
<tr>
<td>Capacity for analysis and synthesis</td>
<td>Capacity for applying knowledge in practice</td>
<td>Basic knowledge of field of study</td>
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<td>Problem solving</td>
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</tr>
<tr>
<td>Teamwork</td>
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<tr>
<td>Capacity to learn</td>
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<tr>
<td>Capacity for organisation and planning</td>
<td>Basic knowledge of field of study</td>
<td>Adaptability</td>
</tr>
<tr>
<td>Capacity for generating new ideas (Creativity)</td>
<td>Capacity for organisation and planning</td>
<td>Critical and self-critical abilities</td>
</tr>
<tr>
<td>Knowledge of a second language</td>
<td>Interpersonal skills</td>
<td>Interdisciplinarity</td>
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Quality Assurance: the “Eurobachelor Label”
Eurobachelor and Euromaster Labels

Run by an international “Label Committee” of ECTNA

- **First**: “Slimline” self-assessment procedure
- **Second**: One-day site visit by 1 national and 2 international experts
- **Third**: Award recommendation made by Label Committee

- **Final decision** taken by Administrative Council of ECTN Association

- National chemical societies play a vital role
- Accreditation agencies licensed to award Label (UK, DE, PL, IT)

- Valid for 5 years with simple renewal procedure

- 54 Eurobachelor Labels awarded (+ 25 Euromaster Labels) to programmes in 16 different countries.
Further information

• The EHEA  www.ehea.info
• Tuning project
  http://tuning.unideusto.org/tuningeu/
• The Bologna Process for US Eyes
  http://www.ihep.org/assets/files/EYESFINAL.pdf
• Tuning USA  http://www.luminafoundation.org/our_work/tuning/
• Chemistry Eurobachelor
  www.eurobachelor.eu
• Bologna process and chemical engineering
  www.eceen-assoc.cpe.fr