

# **EMPLOYABILITY OF THE CHEMISTRY FIRST CYCLE GRADUATES**

KURT BEGITT, PAVEL DRAŠAR  
Editors



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Prague and Frankfurt, 2009



Education and Culture

## Socrates

SOCRATES PROGRAMME / ERASMUS 3  
Chemistry Thematic Network / 230393- CP -1-2006-1- FR - ERASMUS - TNPP

The editors acknowledge the extremely valuable help with the English language to Terry Mitchell, Tony Smith, Ray Wallace, and Paul Yates and Radmila Řápková for typesetting.

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Typesetting and printing: Czech Chemical Society publishing office “Chemicke Listy”, 2009.

ISBN 978-80-86238-66-1



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**LIST OF AUTHORS:**

**AUFTERBECK-MARTIN MARGIT**, *IFOK GmbH Munich, München*  
**BEGITT KURT**, *German Chemical Society, Frankfurt am Main*  
**DRAŠAR PAVEL**, *Czech Chemical Society and ICT Prague*  
**FACCHETTI SERGIO**, *Consiglio Nazionale dei Chimici*  
**GROS LEO**, *Fresenius Fachhochschule, Idstein*  
**HEYLIN MICHAEL**, *C&EN Washington*  
**MITCHELL TERENCE N.**, *TU Dortmund*  
**WHEWELL RICHARD J.**, *University of Strathclyde, Glasgow*

# FOREWORD

## ECTN CONTRIBUTIONS TO THE EMPLOYABILITY OF UNIVERSITY GRADUATES IN CHEMISTRY

PAVEL DRAŠAR<sup>a</sup>, LEO GROS<sup>b</sup>, KURT BEGITT<sup>c</sup>

<sup>a</sup>Czech Chemical Society and ICT Prague, CZ-166 28 Prague;

<sup>b</sup>Fresenius Fachhochschule, Idstein, D-65510 Idstein; <sup>c</sup>German Chemical Society, D- 60444 Frankfurt am Main

<sup>a</sup>Pavel.Drasar@vscht.cz; <sup>b</sup>gros@hs-fresenius.de;

<sup>c</sup>K.Begitt@gdch.de

The ECTN Network is a community of partners, mainly universities and learned and professional societies, working together since 1996 and funded by the European Commission. Currently, today it is working under the fourth contract renewal within the Socrates framework (SOCRATES PROGRAMME / ERASMUS 3 :Chemistry Thematic Network / 230393-CP-1-2006-1-FR-ERASMUS-TNPP) which started in October 2006 as the ECTN4 “*Chemistry in the European Higher Education Area*” project of the European Commission, Directorate-General Education and Culture.

Thematic Networks are one of the main innovations of the Socrates-Erasmus programme. They provide a forum for the analysis and study of the state of development of education and training in Europe in order to encourage and improve its quality on a European dimension. Their philosophy has always been to emphasise the teaching dimension of university activity. The Thematic Networks have carried out two sets of basic tasks over the years: firstly “Mapping and enhancing education” (Describing, analysing and comparing existing teaching methods. Defining and experimenting with new teaching methods. Identifying the existing teaching material and placing this at the disposal of the members of the network with the aid of databases. Producing or updating, translating and disseminating new teaching material. Activities in the field of quality assurance.) And secondly “Facilitating European Cooperation” (Assessing the quality of European co-operation, identifying needs and obstacles and providing solutions. Developing tools for co-operation (the use of ECTS, new models of co-ordination, Europeanization strategies), promoting the production of European modules).

The current ECTN Thematic Network project aims to bring together all actors in the chemistry sector to enhance the employability of chemistry graduates at all levels, but particularly at the first cycle level; to enhance the professional/generic skills of doctoral level students; to report on and evaluate innovative teaching methods; to develop a European qualifications framework for the chemistry sector; to identify best practices in the creation of study programmes combining chemistry and chemical technology; to create an Internet-based test in biological chemistry; to develop links with other networks, for example through participation in the organisation of the archipelago of science and technical thematic networks and organising a joint summer school with a chemistry research network; to enhance the value of previous Leonardo and Socrates projects involving chemistry; to continue full participation as a core subject area in the Tuning project; and to enhance the public image of chemistry. The

project is targeted at all actors in higher education in chemistry in Europe (students, teachers, the chemical industry and workers in that industry, and professional organisations). Among the activities and outputs planned to achieve these objectives are

- A study of the employment of chemistry first cycle degree holders, with conclusions drawn for chemical education policies.
- A report on best practices on employability enhancement in chemistry programmes at all levels.

To cover all necessary activities within the field of Employability, ECTN, on the input from the 2006 Vienna ECTN General Assembly meeting, formed a working group (WG) which took over the work on employability. The WG was chaired by Pavel Drašar, Czech Chemical Society, Prague, CZ. WG Members were from 2007: Ashmore Tony, Begitt Kurt, Baselga Lorenzo Aguilar, Berdague Philippe, Beuduin Gerard, Braga Dario, Čopikova Jana, Čtrnáctová Hana, Drašar Pavel, Flemlr Vratislav, Frankowicz Marek, Fruhmann Philipp, Ganeur Sebastien, Gonzales Carmen, Gros Leo, Iwan Thonus, Jones Alan, Kober Viktor, Koeekhoven Jos, Kontro Anna, Kovala-Demertzi, Kretzer Melanie, Krumlová Irena, Marazza Rinaldo, Oskam Ad, Oszejca Marek, Pagani Raffaella, Palolucci Gino, Rauch Pavel, Rosa Alonso, Rui Marina, Sališová Marta, van Herk Alex, Veber Marjan, Vieillescazes Catty, Wallace Ray, Zajíček Jiří, Žurková Ludmila. It should be noted that many more colleagues took part in the work of the WG at meetings and seminars. The principal aim of the group (rationale) was: The WG should research into the employability of university graduates in chemistry. As the first and seemingly the most important task the WG decided to contribute to the mapping of the position of chemistry bachelors.

The WG had several meetings, in Frankfurt, February, 2007; Donostia, March 12, 2007; Frankfurt, June 10, 2007; Helsinki, May 15, 2008; Frankfurt/Brussels December 9-10, 2008. During the meetings the policy, ways of work, problems to be dealt with etc., were discussed and polished. In accord with the project Management Committee the WG agreed on the fact that the bachelor position and employability description, if it were to be taken seriously, must be supported by the work of an independent organisation in order to minimise the bias of academics from different countries and different universities within ECTN. In 2007 the German consultancy company IFOK<sup>∇</sup> was selected for collaboration, as it was known as a well internationally established partner in strategy and policy consulting. IFOK was asked to develop a pilot study on Acceptance of the Bachelor Degree in Chemistry: A Spotlight on the Bachelor of Chemistry and other Chemical Sciences. This study is a major part of this book.

The work on the chemistry bachelor employability study is not only very important for ECTN: it is also a topic which touches major players on the European job market, universities, large international companies as well as SMEs. In a situation

<sup>∇</sup> <http://www.ifok.de/>

where there were expected to be hundreds of thousands of open job positions for technically educated people in Europe, the job market could react either by employing foreign labour or in recognizing the new “bachelor” category of potential employees.

The change from a master-doctor scheme to bachelor-master-doctor goes hand in hand with a more or less political requirement of a future target in having  $\frac{1}{2}$  of the future European workforce with a university degree. To achieve this, it logically needed the category of bachelor, as with the classic master-doctor scheme this would be economically and even practically impossible. Such a large enhancement of the distribution of educational levels in European society goes hand in hand with fears of a more or less significant lowering of the quality of education (as no-one can expect that any political decision will change the natural distribution of human abilities, which the natural scientist expects to be symmetrically Gaussian). Universities within Europe faced this new situation from different angles. We saw on the one side an approach which condensed all the material from the 4- or 5-year study into a 3-year bachelor scheme. Another extreme was the formulation of courses with very limited demand, very often with the experimental experience of a student limiting to zero. As the requirement for bachelors is mainly from an industry very much oriented to practically oriented skills and competences, the above extreme approaches would not fit to the potential job market. The solution lies in stratification of the chemistry bachelor courses aiming some of them at general training and others as training which is fully professionally aware. The second will be much more valid if the course or the individual can be “labelled” by a quality label. Two major players in the European chemistry higher education area, the European Association for Chemical and Molecular Sciences (EuCheMS, formerly FECS)<sup>◊</sup> and ECTN<sup>±</sup> created, both on the input from the EU, set of quality labels that fit to the purpose of helping both, the human resources professionals to find qualified people, and the job-seekers to offer themselves to the job market.

The editors of this publication are very happy that the American Chemical Society agreed to let them reprint here an article from Chemical and Engineering News on a similar study carried out in the USA. It should be mentioned that similar articles are published in Chemical and Engineering News quite often and that they can serve very well as a source of relevant comparative information.

The quality labels now comprise a set of labels that deal with bachelor and master chemistry courses, the EuroLabels (Eurobachelor and Euromaster) and one which describes the professional status of a practicing chemist, the European Chemist (EurChem). During their still short existence the quality labels were recognized by EU authorities, EURASHE, and others as significant tools that can play vital role on the future job market of beginning as well as professional chemists.

We trust that this publication can help to provide a better understanding of the new realities in the European Higher Education Area as well as in the European job market.

*Frankfurt and Prague, February 2009*

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<sup>◊</sup> <http://www.euchems.org/>

<sup>±</sup> <http://www.ectn.net>



ACCEPTANCE OF THE  
BACHELOR DEGREE IN  
CHEMISTRY:

A SPOTLIGHT ON THE  
BACHELOR IN CHEMISTRY  
AND OTHER CHEMICAL  
SCIENCES

## ACCEPTANCE OF THE BACHELOR DEGREE IN CHEMISTRY: A SPOTLIGHT ON THE BACHELOR IN CHEMISTRY AND OTHER CHEMICAL SCIENCES

MARGIT AUFTERBECK-MARTIN

*IFOK GmbH Munich, D-81675 München  
email: margit.auftebeck@ifok.de*

### Executive Summary

#### Background

The introduction of the academic Bachelor's (first cycle) degree, as part of the so-called Bologna reforms, is an exemplary instance of a concerted effort on behalf of European higher education institutions (HEIs) supported by strong political will. Today **most institutions in the majority of European countries have implemented a two cycle degree system** complemented by a third, doctorate degree. Students today enrol in new courses and the first graduates are facing the labour market.

Following a phase of hesitation, **industry has largely accepted and welcomed the Bachelor's degree** and accommodates its holders in their respective recruitment systems. The Bachelor in chemical sciences, however, appears to play a special role. The proportions of Chemistry Bachelor graduates who actually enter the labour market and start employment are only very small. Thus in Germany for instance 95% of **Chemistry Bachelors remain in further education** and only enter the labour market after having completed a Master's or PhD degree. In countries that have a long tradition of two-cycle degree systems such as the United Kingdom or Ireland, the situation is different and more than half of the graduates opt for employment after the Bachelor's degree.

The question that arises is why employment of Chemistry Bachelor graduates is still so low:

- Will it simply **require more time** in order to take root in the employers' recruitment systems and cultures,
- does the educational outcome Chemistry Bachelor programmes **lack its matching job profile** on the employers' side / the job market or
- does the new academic degree **lack appreciation** with employers and students?

The present study investigates the acceptance of Chemistry Bachelors in industry. It draws from a **survey** on 18 employers of chemistry graduates of various sizes and industries from six European countries plus one institution of European administration. Data was collected by means of a questionnaire that human resources (HR) representatives of the companies were asked to fill in. In some cases, follow-up interviews were held in order to gather more detailed information.

#### Results

The survey reveals that employers' expectations of and experience with the Bachelor are positive in general. HR representatives acknowledge the degree as an academic grade

relevant to the job market. Those companies that actually have employed staff with a Bachelor in chemistry as their highest academic degree give positive testimonials and indicate that the degree has gained its distinctive place in the labour market. Those employers who have not yet had any experience see scope for this degree and appear to welcome applications from Chemistry Bachelor graduates. However, some of them have not received a single application by holders of this degree as yet since graduates choose to study on towards a further degree. Thus, the process of the degree taking root certainly does require more time, but care should be taken to avoid a deadlock in which both students and employers basically ignore the new early degree and its potential.

A look at employers' opinions on the educational outcome of a Chemistry Bachelor's degree reveals that it is not the level of scientific knowledge that is relevant for the acceptance of the degree. Instead, it is those **skills important for practical professional life, practical experience and personal maturity** enabling self-reliant behaviour that employers appreciate more. The design of the Chemistry Bachelor was intended to meet this demand exactly: graduates with a sound but not in-depth knowledge who during their studies have gained valuable insights into practical and professional life. Employers surveyed illustrated that the degree **does not lack its matching job profile**.

Communication on the contents and aims of the new degree appears to be sufficient in general. However, there is still room for improvement in this issue. Communication should focus less on informing what the new degree "contains" but **promote the advantages of the new degree** for employers, publish good examples and challenge existing prejudices against the degree. Quality labels accredited to individual Chemistry Bachelor programmes can play a vital role here. Employers accept the new degree, but they need to be helped and motivated to **actually appreciate it**.

#### Recommendations

Two types of recommendations can be derived on the basis of the study:

- **success factors** on how employers can make good use of the Chemistry Bachelor degree in their recruitment and HR development policies
- **recommendations on shaping debate and attitudes** to advance employability of Chemistry Bachelor graduates.

As for success factors in employing Chemistry Bachelor graduates, four recommendations are presented:

#### 1. The Chemistry Bachelor serves best as a component within modular HR development

In modular HR development policies, phases of work experience alternate with phases of further qualification. The Bachelor serves as a basic academic degree that allows early entry into working life. From there, employees subsequently qualify in further degrees, either full- or part- time, alongside their actual career. Furthermore, the bachelor can serve as an academic degree for employees with a vocational training background.

This concept of modular HR development corresponds to a current trend of spreading phases of academic qualifications over a lifetime's career rather than isolating education in an early phase of life prior to actual work experience.

**2. The Chemistry Bachelor can best be embedded in an HR development of permeable career paths.**

The flexibility involved in the Bachelor's degree (e.g. combining the degree with a degree in business studies) matches well the flexible and permeable career paths in today's professional reality. It may not qualify as such for in-depth research and development positions but it does for more general roles in industry that require a chemistry background, including marketing, finance, logistics and HR in respective industries.

**3. Chemistry Bachelor graduates are best appreciated in terms of their potential rather than their academic profile.**

The degree provides staff that bring a basic but sound knowledge in core chemistry fields and join an employer at an early stage in their career. Employers hire potential in Bachelor graduates that they can develop according to the company's individual requirements. Hiring potential may be more profitable and effective than the tedious search for the perfectly qualified candidate.

**4. Once employers start and recruit Chemistry Bachelor graduates, confidence will increase through positive feedback.**

Countries that have a tradition of Bachelor recruitment are way beyond scepticism towards the degree. Once there is a positive track record of successful careers and staffing based on the Chemistry Bachelor, the degree will take its place within continental European recruitment policies. This process needs however to be supported and accelerated by shaping debate and attitudes.

The study has revealed that the employability of Bachelor graduates in Europe today is at a **point of transition between general acceptance of the degree and actual recruitment**. This transition needs to be facilitated and accelerated by **shaping debate and attitudes**. While the process of optimizing the educational outcome of the Chemistry Bachelor and matching it to industrial demand should by all means be carried on, any attempt to improve the actual level of acceptance of the degree will necessarily need to address attitudes, behaviour and mindsets of students and employers. This process can only be an interactive one between HEIs and employers (or their representatives). It should include:

1. **Dialogue** between stakeholders to overcome sceptical sentiments by making the degree a common point of interest for both HEIs and employers.
2. **Communication** that promotes best employment practices and individual career success stories.
3. **Collaboration** to optimize the match between educational outcome and industrial demand.

*Introduction*

10 years ago, the Sorbonne declaration on the creation of a single and competitive European area of higher education marked the beginning of what was to become the greatest reform that higher education has undergone so far on a

European scale. In 1999, 32 European states agreed to co-ordinate their education policies (Bologna declaration, The Confederation of EU Rectors' Conferences and the Association of European Universities (1999)). In order to harmonise the degree systems in Europe, it was agreed to adopt a system of transparent and compatible degrees based on two main cycles of education, commonly (but not consistently<sup>1</sup>) referred to as Bachelor's and Master's degree. A further, third cycle would lead towards the PhD/doctorate degree<sup>2</sup>.

**Bologna Declaration signatories:**

Austria, Belgium (French community), Belgium (Flemish community), Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Swiss Confederation, United Kingdom.

It was thought that a comparability of degrees, combined with the establishment of a system of transferable credit points for academic achievements (European Credit Transfer System (ECTS)) and European co-operation in quality assurance, would promote the mobility of students, teachers and researchers. Institutions of higher education in participating countries have now widely introduced the new system. The first batches of students holding the "new" Bachelor have now graduated.

The Bachelor's degree, lasting for a minimum of three years, qualifies graduates not only for further studies leading towards the second cycle, Master degree and/or a PhD but is also aims to provide an early entry degree point for the job market. This study evaluates the fate of Bachelor graduates: how well equipped they are for and feel in their professional lives and what their professional perspectives are in the current job market. In view of demographic changes and an already palpable lack of "new blood" in the chemical industry, it is of the utmost importance that qualified junior staff be secured in the short-, medium- and long-term. This is only possible if Bachelor qualifications in Chemistry, Biochemistry, Pharmaceutical Science and Chemical Engineering (here collectively termed "chemical science") lead to the necessary employability and are recognised by potential employers.

This study is divided in three parts: The first part summarises existing data, observations and evaluations as to what extent and with which professional goals in mind Bachelors of chemistry actually leave education and enter the job market, and how they are received by employers. Data on these issues is extremely scarce and is only just appearing. The second part of the study will therefore collect data from employers and survey their attitudes and policies on Chemistry Bachelor's employability. The third part finally suggest recommendations on how the acceptance of the degree can be improved in the future by both higher education institutions and employers.

<sup>1</sup> In this study, we will use the term "Bachelor" as the generic term for first cycle degrees

<sup>2</sup> For a comprehensive list of Qualifications in chemistry see <http://www.euchems.org/Qualifications/index.asp>

## Part I: Analysis of Studies into “Bachelor Employability”

### The supply side: The Chemistry Bachelor’s degree as a strong currency in a competitive European employment area?

#### The current state of reform

Ten years after the Sorbonne declaration, educational reform towards a harmonised European education area has gone a very long way. Today, less than two years to the 2010 deadline for the realisation of reforms, most countries have successfully introduced and implemented a three cycle degree system at universities and other institutions of higher education. A study by the European University Association (Crosier et al. 2007) found that in Europe in 2007, 82% of the 900 higher education institutions (HEIs) surveyed reported that they had the three cycles in place. In 2003, these were only 53%. The report “Focus on the structure of higher education in Europe” (Eurydice 2004/05 and 2006/07) gives a detailed overview of the status quo and national trends in the Bologna process.

In 2007 the European Directorate General on Education and Culture published a report on the state of implementation of educational reform which specifically looked at national degree structures and curricular changes. The report gives concise descriptions of the history, individual features and the current state of curricular reform in 32 countries (EU 25, EEA/EFTA and candidate countries). The result reads as a dramatic effort on how to make individual HE systems compatible. The report also takes a step further and aims to detect the first and early impacts of the reforms. Indicators such as improvements in access to higher education, graduation, employability, mobility, quality, and cost effectiveness are investigated. In many cases, first results can be identified, even if the majority of countries note that it is still too early to draw conclusions. As for the impact on employability, it seems that only in some countries the first cycle actually does qualify graduates for immediate employment. Where this is the case, these are predominantly first cycle degrees from HEIs other than universities (e.g. universities of applied sciences or others). In the majority of countries it still seems to be the case that the first cycle is mainly the first step to the second cycle, often de facto not being directly employable<sup>3</sup>. Exceptions here are Italy, the United Kingdom and Ireland, the latter two being well accustomed to the Bachelor’s degree, looking back at a long history of experience with the three cycle system.

While the evaluative data on Bachelor acceptance in the labour market is scarce overall, it is even more so when we focus on the Bachelor’s degree in chemistry. The major – and supposedly only – Pan European study that looks specifically at chemical education in the European context is titled “Chemical Education for a Competitive and Dynamic Europe” (Cooke et al. 2005). The study gives detailed account of the

situation, systems and recognition of chemical education in 12 countries: Austria, Germany, the United Kingdom, Ireland, Spain, Finland, Poland, the Czech Republic, the Slovak Republic and, more briefly, Hungary, Romania and Bulgaria. It reveals the great amount of diversity that prevails between education systems in individual countries and puts particular focus on work experience offered during the courses. For a general survey of educational systems in the respective countries (see. Eurydice 2004/05).

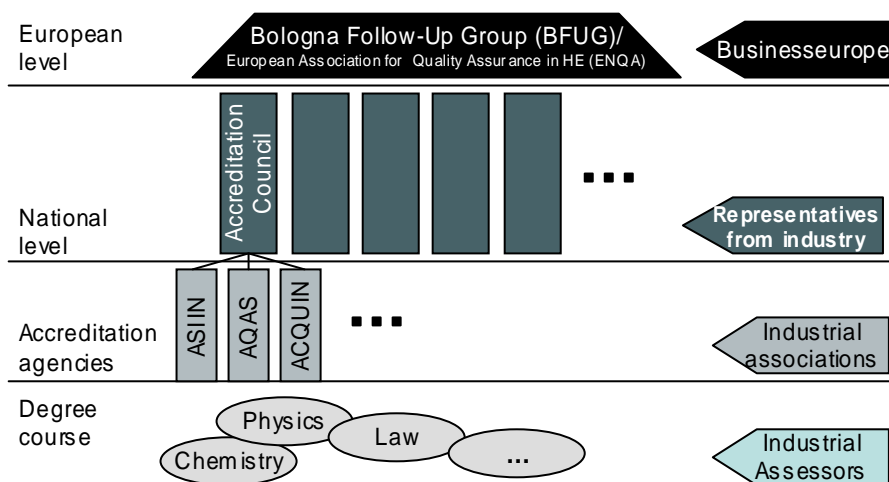
#### A Change in academic culture: Focussing on employability and relevant competences

The main motivation and driver behind the Bologna reforms is the goal to enhance the employability of graduates in a single European labour market. This concern is now widely spread amongst institutions of higher education: 67% of institutions consider the concern for employability of graduates as “very important” and further 32% as “important”. The 5% of institutions which in 2003 still considered the aspect of employability as “not important” has now shrunk to 1% (Crosier et al. 2007: 34). These numbers show that a change has taken place not only in structural and curricular form but also in academic culture. Institutions of higher education are no longer conceived as “a prestigious place that gives nobility education to the chosen few”, but rather as a place that delivers mass higher education for mass employment (Bachelor for Labour Market Project 2007). This cultural change must not be underestimated and considering that it is intrinsically more difficult and of longer duration for cultural change to take root than it is for structural change, the early timing of evaluation studies should be borne in mind.

Designing academic courses in order to convey labour market relevant competences means that universities need to open their gates to future employers in order to clarify employer demands from their future workforce. One area in which this collaboration between education and industry is currently implemented is in the area of quality assurance as part of the accreditation process for programmes. Figure 1 displays this collaboration.

Here, representatives from industry are involved at all levels: as auditors for individual degrees, as members of panels for accreditation agencies (technical committees, accreditation commission and boards (e.g. ASIIN), here also the industrial associations), participating at the national level in accreditation councils (e.g. British Accreditation Council, Deutscher Akkreditationsrat etc.) and at the European level, where representatives of the European Employers’ Association, BusinessEurope, sit on panels of the European accreditation association ENQA (European Association for Quality Assurance in Higher Education). At all these levels, employers have an opportunity to air their requirements for future graduates and actively shape the relevant courses at university. Submitting HEIs to accreditation processes and directly putting the employers’ needs first is a concept that is still fairly new to most European countries. The progress made during the past 10 years strongly backed by political will should not be underestimated.

<sup>3</sup> This is the case i.e. for Belgium while e.g. in Czech Republic the Bachelor is directly employable.



**Fig. 1: Involvement of employers in quality assurance of degree courses, based on Jäkel (2007)**

However, while employers generally feel that they are given enough opportunities to take part in the shaping of educational programmes (see chapter below); only 29% of interrogated institutions (Crosier 2007) responded that there is close involvement/cooperation with the industry on this matter. Further more, this number, when compared to 2003, is stable, showing no sign that the dialogue has improved. The Bachelor phenomenon is still new and surely “it will take time for the cultural change [towards close collaboration between IHE and employers] to take root” but there is a consensus from industry and HEIs that effort must be made, either by governments or by institutions, to involve employers in debate on the reforms (Crosier 2007). A comparative overview on partners from the world of work and professionals in the field concerned, associated in the process of external evaluation and/or accreditation, shows that in more than half (23 out of 43) of the countries (and regions / lingual communities within countries) surveyed there is no external evaluation or involvement of such partners (Eurydice 2004/5).

#### **Taking accreditation further: the EuroBachelor®**

For chemistry in particular, the idea of accreditation was taken even further by the introduction of the EuroBachelor®. This label aims to “provide a first cycle degree which will be recognised by other European institutions as being of a standard which will provide automatic right of access to chemistry Master programmes” (ECTN Association 2008). Based on those goals for a first cycle study programme as

defined by the Budapest Descriptors, the EuroBachelor® was developed as a result of the „Tuning project“<sup>4</sup>, a European project aimed to further facilitate transparency and recognition of degree profiles of European Education programmes. Today it is developed and maintained by the European Chemistry Thematic Network Association (ECTN-A).

The EuroBachelor® acknowledges that the degree shall “be relevant to the European labour market as an appropriate level of qualification” (Bologna declaration). However, it was originally conceived to first and foremost provide a degree that allows entry to further studies, i.e. a Master programme, not specifically aiming for employment straight after the first cycle. This definition was slightly shifted in subsequent discussions (e.g.: “The aim for the introduction of the EuroBachelor was to have an internationally recognised standard aiding mobility and employment at the end of the first cycle” (Barr 2006)) and the employability aspects stressed. This is reflected in the list of outcomes require to equip students with competences for their future work place. By the end of 2008, the EuroBachelor® label had been awarded (accredited) to 37 institutions and 3 consortia from 16 countries.

<sup>4</sup> The outcome of the tuning project is presently evaluated by the CoRe APL Tuning project, <http://www.core-project.eu/?file=methodology>. Accessed 2008 March 13.

The EuroBachelor<sup>®</sup> describes a list of clearly defined requisites outcomes that is defined in terms of subject knowledge and abilities and skills such as (ECTN 2007)

1. Chemistry-related cognitive abilities and competences, i.e. abilities and competences relating to intellectual tasks, including problem solving;
2. Chemistry-related practical skills, e.g. skills relating to the conduct of laboratory work;
3. Generic competences that may be developed in the context of chemistry and are of a general nature and applicable in many other contexts.

Thus, in order to deliver programmes that correspond to labour market needs, the EuroBachelor<sup>®</sup> is a quality label which covers courses with a very wide range of competences, including those transferable skills that are only indirectly connected to the subject of chemistry. The agreement on such an ambitious set of educational outcomes shows the effort of HEIs attempt at meeting the employers' demands.

### **Bachelor graduates and the labour market: Where do graduates go and how well equipped do they feel?**

One key indicator for the quality and recognition of the first cycle degree as a "fully fledged degree" in the world outside higher education certainly is the number of students who regard the degree as sufficient in order to enter the labour market and succeed in finding a job.

Country	Employment after Bachelor's degree	Employment plus further studies	Further studies
Germany <sup>5</sup>	4.4 %		95.0 %
France <sup>6</sup>	15.6 %		
Italy <sup>7</sup>	33.8%	11.1 %	40.6 %
Ireland <sup>8</sup>	46.0 %		46.0 %
United Kingdom <sup>9</sup>	46.0 %	6.7 %	34.5 %
Denmark <sup>10</sup>	8.2 %		91.8 %

**Table 1: Proportions of students entering employment with the Chemistry Bachelor as their final degree**

While this indicator is related to other variables, such as the dynamism and the difficulties of the demands arising from the labour market, we rate the maturity of the first cycle degree in

<sup>5</sup> Gesellschaft Deutscher Chemiker (2007) Chemiestudiengänge in Deutschland. Statistische Daten 2007. <http://www.gdch.de/ks/publikationen/statistik.htm>.

<sup>6</sup> Céreq. Enquête Génération 98. Exploitation Céreq.

<sup>7</sup> Bachelors in Chemistry and Pharmacology; AlmaLaurea Report IX, p 8.

<sup>8</sup> Higher Education Authority, Ireland: "What do Graduates do: 13, Numbers applying to "Ordinary Bachelor's degree".

<sup>9</sup> Prospects: What do Graduates do 2008, 12, Numbers applying to "First degree Chemistry holders".

<sup>10</sup> Employees in chemical industry in 2006 with Bachelor as highest level of qualification: 552, with higher cycle degrees, <http://www.statbank.dk/statbank5a/default.asp?w=1600>. Accessed 2008 March 13.

terms of the numbers of students who are content with the Bachelor as the final degree. Numbers here are scarce and vary to a great extent, particularly for degrees in chemistry.

Table 1 lists a selection of findings, giving the numbers of students who enter the labour market after graduation with the Chemistry Bachelor, those who carry on their further education part-time and those who remain in education, embarking on further studies. Note that information on the destinations of Chemistry Bachelor graduates in Europe is extremely scarce and that the number in Table 1 do not reveal whether the employment graduates find commensurate with their degree level. The figures may involve non-academic employment outside the field of chemistry for which many graduates may be over-qualified. Table 1 reveals that there is a great discrepancy between countries. On the one hand there are those which traditionally know and are well accustomed to a three-cycle degree system (e.g. UK, Ireland). Here, employers are experienced with first cycle graduates entering the job markets, the result being that more than a third of Bachelor graduates confidently look for employment. On the other hand there are those countries that have only just introduced a first cycle degree. Here the degree still needs to take root in employment culture, the result being that in fact all of the graduates prefer to carry on their studies until they feel equipped enough to enter working life. In Italy, 78,5% of science Bachelor graduates consider it as "almost an obligation" to continue higher education in order to access the labour market (AlmaLaurea 2007). While concrete numbers for the Netherlands are not yet available, it is reported that "The introduction of the Bachelor diploma is not leading to a significant flux towards industry" (EuCheMS 2007). Germany is probably one of the best illustrations for countries where the general acceptance of the Bachelor's degree still needs to be established with students, graduates and industry, with 95% of Chemistry Bachelors remaining in higher education for a higher degree. Finland was reported to show similar numbers.

A study on the destinations of Bachelor graduates in Germany (Hochschul-Informationssystem, HIS, 2005) sheds more light on how the situation is perceived by the students and how they view the reform. The study publishes the results of the first national survey carried out by interviews with graduates of all academic fields in 2004, specifying their fields of studies. Students of chemistry report that the aspect of practical work experience of a Bachelor's degree was their first reason for embarking on this course, particularly at Universities of Applied Sciences (Fachhochschulen). These students appreciated the link between theoretical insight and transferring that knowledge to practical work. When asked why they intend to opt for a further degree on top of the Bachelor, they mention that they do so in order to specialise in a particular field finally opting for a PhD (80%) (HIS 2005: 94). 69% of Chemistry Bachelors say they only have limited confidence in their professional prospects with their Bachelor's degree (HIS 2005: 94).

Looking at existing numbers from Germany as one example, both Bachelor and Master students rate generic competences and chemistry-related practical skills as the most important competences acquired during their study programmes (Briedis 2007). Interestingly, the ratings do not

vary significantly between Master and Bachelor students of chemistry. Competences in general business knowledge for example are rated as least important by both groups, with 21% of Bachelor students and only 14% of Master students rating them as important. After completion of their course, only 30% report that they had required social competences and only 1% reported competences in general business knowledge. More than 70% of students report that their studies were neither taught in a foreign language nor had their course a particular international perspective to it. The highest score for acquired competences is that of basic chemistry-related cognitive skills and competences, which 79% report to have acquired. As for work placements, the opportunity for practical insight was rated very highly. However, a lack of preparation and follow-ups of the industry placements was criticised.

Another call from industry that the Bachelor's degree manages to respond to is that for earlier graduation and tighter course schedules: Italian statistics of students following the reformed Bachelor courses (Cammelli 2007: 24) show that the vast majority in 2005 graduated within the prescribed time or with a maximum delay of one year. The average age of graduation (24.2 years) is found to be "very far from the 28 years that had long characterized Italian graduates until the eve of the reform". Class attendance, in comparison to usual class attendance in Italian universities prior to the reform, was also higher: 72% of first cycle graduates declared that they attended over 75% of prescribed classes.

#### **Involvement of employers as partners in higher education programmes**

An analysis of developments in Italian universities (Cammelli 2007) substantiates the general trend that internships and in-house company training experiences are on the rise, showing the universities' commitment and their growing collaboration with employers. 80 percent of training periods were carried out outside universities. 58% of graduates (of all fields) had in-house company training experience as an integral part of their education (a 2% increase). Italian statistics also manage to show quantitatively that internship/training experience is associated with a higher employment rate: the latest investigation on graduates' occupational situation (AlmaLaurea 2007) detected a 10% increase in employment rate between those who carried out an in-house company training during their studies and those who did not.

Industry is invited to get involved on all levels in order to shape the course layouts (cf. Fig. 1 above). However, only 29% of HEIs actually report a close involvement of professional associations and employers in the design of curricula (Crosier et al. 2007: 34). The lack of employers' awareness of reforms appears to be a key issue. Employers are reported to be on the whole unsure about what to expect from a university Bachelor's degree (Crosier et al. 2007: 35) and it is generally deplored that in some countries only little effort is made to involve employers in debate on reforms.

#### **The demand side: Taking the employers' perspective**

##### **What do employers want?**

In October 2004, BusinessEurope (then UNICE), the association of industrial and employers' confederations of Europe, welcomed the Bologna Process and expressed their willingness to support its goals (UNICE 2004). In particular, they considered that the credit point system would improve transparency, comparability and compatibility in order to facilitate student mobility, provide flexibility of study courses and allow for permeability between the different branches of (higher) education. Employers stated their expressed wish to intensify the cooperation between higher education institutions and enterprises in areas such as research but also quality assurance. In order to ensure a broad acceptance on the European labour market, they expressed their belief that it is necessary for business, as well as other social and economic partners, to become involved in managing the Bologna process. As for the employability of Bachelor graduates, UNICE specified that they should bring a broad professional basic knowledge coupled with a number of indispensable cross-disciplinary qualifications and competences (UNICE 2004: 3f). If business requirements are catered for, UNICE assured its confidence that the labour market will accept the new structure and its graduates.

Studies on the general acceptance of Bachelor graduates of all fields in industry show that the first cycle degree is generally accepted as a fully-fledged academic degree. Even in Germany, where this early entry point into the labour market is still a very recent concept in the labour market, interviews with 50 line managers from a wide range of sectors agreed that Bachelor graduate employees would in general not need a longer period of time to come to terms with the job requirements than their second cycle degree colleagues and would enjoy the same career opportunities (Stifterverband 2004). These interviewees valued in particular the broad range of educational outcome covered in first cycle degrees: covering not only generic and field-related competences and skills but also practical work experience and international perspectives.

As for the acceptance of Chemistry Bachelors in chemical and related industries, the importance of professional skills is reflected in a recent survey by the World Chemical Engineering Council (2004) in 63 countries. This report comes to the conclusion that, in the future, fewer highly specialised chemical engineers will be needed for research. Instead, industry will have a greater demand in graduates who will bring a sound basis of scientific knowledge but, on top of that, a broad spectrum of professional skills. The study shows that the academic world lags behind the needs of the work place which are for soft skills and marketing/business orientation. One could hope that the Bachelor's degree will fill these needs. However as we will see below the extent to which employers recognise the Bachelor's degree varies to a large degree in different European countries.

##### **Who do employers recruit?**

Depending on the structure of traditional systems in higher education, the introduction of the Bachelor's degree involved different levels of change in individual countries.

Thus, the higher education system in the United Kingdom and Ireland always knew a three-cycle system and employers had a clear understanding and expectation of which competences Bachelor graduates would bring. In countries like France or Germany, however, the reform was much more drastic since the idea of a first, undergraduate degree was an entirely new concept to industry. Exceptions are big multinational companies with a tradition in international recruitment who have employed bachelor graduates from other countries such as the United Kingdom in the past. In Germany, the new degree was clearly welcomed by industry as an option for early access to the labour market. Thus, in 2004 the Institut der Deutschen Wirtschaft, a private economic research institute, observed that, for all subjects in general, in two-thirds of companies, graduates with a Bachelor's degree qualification had the same chances of career progression as graduates with traditional German qualifications (Konegen-Grenier 2004). As for Chemistry Bachelors, however, companies gave less positive statements: out of nine international companies based in Germany, five said they did not recruit Bachelors, the other four showed a rather cautious attitude towards the new degree (Bundesagentur für Arbeit 2004: 36). This picture reflects the greater insecurity that prevailed in 2004.

In documents published in 2004 ("Bachelors Welcome"), 2006 ("More Bachelors welcome") and 2008 ("Bachelors Welcome – MINT Nachwuchs sichern!") German industry expressed their explicit support for the Bachelor's degree. The 2008 document focuses in particular on bachelors from science and technology subjects since the country is facing a shortage of qualified staff in these areas. These documents can be regarded as milestones towards the acceptance of this degree in the job market. According to the results of a recent survey on German Bachelors in general, only five per cent of companies surveyed would not employ graduates with a Bachelor qualification.<sup>11</sup> More than half the companies would employ a graduate with a Bachelors qualification and could see them in leading executive positions (IP 2004). As for chemistry, many of the above mentioned companies have adapted their recruitment perspective: BASF today for example offers a number of entry levels for Bachelor graduates, such as technical, laboratory and analytical specialist and sales engineer (Meyer 2007). However, statistics for Germany still show that 100% of Chemistry Bachelor graduates go on for further studies and do not enter the job market. These numbers would be expected to decrease if the job market held attractive opportunities for graduates with Bachelor's degrees and students were more confident in finding suitable positions and career perspectives in the labour market.

There appears to be certain scepticism in the chemical sector as to the employability of graduates with a Bachelor's degree. Many companies in the sector fear having to provide a high level of (additional) training in order to equip the

generally still quite young graduates with the necessary competencies (Diergardt 2007). Reliable studies into whether and, if so, to what extent this is the case are not yet available. The ambivalence on the employers' side appears to remain that while they embraced the reform, they do not seem to live up to it in recruitment reality. In order to understand this situation, we need to distinguish two aspects to the Bachelor's degree:

Aside from its European scale of comparability, the concept of the Bachelor's degree has two aspects to it that are labour market relevant: First it provides a basic degree that allows young graduates early access to the labour market and second its curricula are designed to cover not only the education in cognitive abilities and skills in a particular subject but also the teaching of practical skills and generic competences. It is important to differentiate between these two aspects since the latter appears to be greeted more favourably by the employers' side than the former.

As for the early entry into the job market, the Chemistry Bachelor takes a somewhat special role as compared to Bachelor's degrees in other subject. In most countries, the typical job entry for academically trained chemists is after the Master's degree or, as in Germany, even after the PhD. As a senior manager of a large German chemical company puts it: "we were promised by HEIs that the Master would deliver what we were used to find in "Diplom"-graduates<sup>12</sup> before the reform. The Bachelor is more of a by-product half-way there. We never actually asked for it". Similarly, another study observes that "Industry shows reluctance in giving away a proven "educational product" such as the [German] Fachhochschule "Diplom" guaranteeing good employability for holders of degrees in technical fields such as chemistry" (Cooke et al. 2005: 101). However, no studies appear available so far that specifically investigate the attitudes of employers on Chemistry Bachelor graduates during the actual recruitment process by means of reliable data. Therefore, the second part of this study will conduct relevant interviews and compare case studies. The aim is to examine whether the Bachelor's degree in chemistry simply lacks promotion or whether it indeed lacks job matching profiles in the labour market.

<sup>11</sup> Survey conducted by the Institut für Personalwirtschaft (IP, Institute for Human Resources) on behalf of the Industrie- und Handelskammer (IHK, Chamber of Industry and Commerce), the Handwerkskammer (HWK, akin to a chamber of artisans' guilds) and the Vereinigung der Unternehmensverbände in Berlin und Brandenburg (UVB, the Federation of Business Associations in Berlin and Brandenburg).

<sup>12</sup> "Diplom" refers to the former academic degree in Germany prior to the implementation of the Bologna reform. It used to be awarded after four or five years of study time

## Part II: Case Studies

### Study Design

In order to find out why acceptance of Chemistry Bachelor graduates is still low, case studies were carried out for 18 companies in six European countries plus one institution of European administration (the European Patent Office). Some of the selected companies recruit Europe-wide; others focus predominantly on the national level. The studies draw from a questionnaire that human resources (HR) representatives were asked to fill in and in some cases comment on during a telephone interview. The aim was to gather information on

1. Employers' attitudes towards the Bachelor's degree
2. Industry's expectations on and experience with the Bachelor's degree
3. Best Practices
4. Examples of how employers can make best use of the degree from the perspective of recruitment and human resources development
5. Shortcomings and scope for improvement
6. Identifying where the Bachelor's degree does not deliver the outcome required by employers and how the situation could be improved.

Participants in the study were assured that information they provided would be dealt with confidentially.

The individual case studies were evaluated and interpreted. On the basis of this, recommendations were made on how to improve the acceptance of the Bachelor's degree.

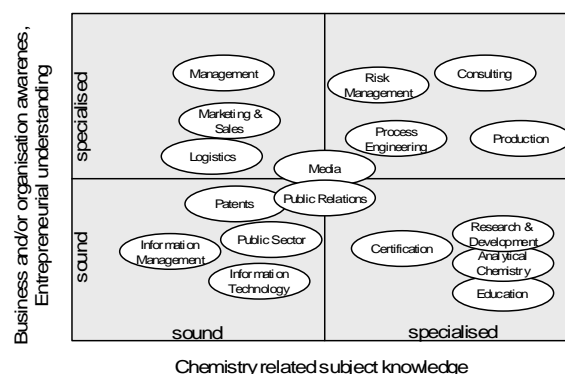
### Professional fields for chemistry graduates

The labour market for chemistry graduates has undergone strong diversification during the recent and this trend is ongoing. While there used to be typical job profiles for chemistry graduates, there is now a wide variety of potential industries, positions and career paths available to them.

Chemicals and related industries	Other industries and sectors
Pharmaceutical industry	Health & Safety
Food industry	Public Sector
Cosmetics industry	Non Governmental Organisations
Power generation industry	Educational Sector
Polymer industry	Law firms
Biotechnology industry	Insurance industry
Automotives industry	Consulting
Printing industry	Media
Agricultural industry	Defence industry
...	...

**Table 2: The broad field for employment for chemistry graduates**

Table 2 gives a list of various industries that would employ graduates in chemistry. Note that this list serves as an illustration and does not claim to be exhaustive<sup>14</sup>.



**Fig. 2: Aspects of employability: Allocating sectorial job profiles to profiles of required educational outcomes**

Potential employers of chemistry graduates can be big multinational chemical and related companies but also small and medium sized enterprises (SMEs) or start-up companies such as biotech companies. Chemistry graduates, however, also find employment in the public sector, in Non-Governmental Organisations (NGOs) and in the service sector such as law firms, insurance industry, and consultancies. Graduates gifted with an entrepreneurial spirit and mind may also consider starting their own business.

Considering this wide occupational range and with numerous possible types of employers in mind it is fair to conclude that the prospects for Chemistry Bachelors are highly diverse and involve a broad spectrum of job profiles. As a result, the requirements in terms of educational outcomes of degree courses are just as diverse, and this impacts on the employability of Bachelor degree graduates.

Figure 2 is an attempt to assort the fields for employment alongside two axes related to employability:

- (1) requirements on business and/or organisational awareness
- (2) the level of chemistry related knowledge.

### Accounting for European diversity: Selection of countries

Academic and industrial traditions and cultures differ highly within Europe and it would be beyond the scope of the present study to aim to cover this diversity. Instead, countries were selected for the study to represent specific situations in industry, labour market and systems of higher education. These countries are the Czech Republic, France, Finland, Germany, the Netherlands and the United Kingdom.

Germany was chosen as a representative of those countries in which Chemistry Bachelor students have not properly entered the labour market as of yet. The Bologna

<sup>14</sup> For occupational destinations of chemistry graduates see e.g. [www.chemengworld.org](http://www.chemengworld.org)

reforms led to drastic institutional reforms. From an industrial perspective, Germany has the greatest turnover rate in the chemical industry in Europe (BAVC/IdW 2004), with a large demand for skilled chemistry staff today and a projected shortage in supply in the future.

France is in a similar position to Germany. It is the second best performer in turnaround of the chemical industry and here also, the Bologna reforms involved drastic structural and cultural change.

The Netherlands were selected as another country with a strong chemical industry that has also shown to be a swift implementer of the Bologna reforms.

Finland represents a country in which reforms have been swiftly implemented but where chemistry bachelors so far have not entered the labour market as yet.

The Czech Republic was included in the study as a representative of smaller and also Eastern European countries. It is a good performer in future indicators of increase in science and technology (MINT-) graduates<sup>15</sup>, Bologna reforms were implemented in this country with great rigour.

The United Kingdom was included in the study as a representative of an educational system that is well acquainted with the Bachelor's degree. The strong chemical and related industries in the country have learned to incorporate the degree in recruitment policies and it was expected that companies in the UK would deliver good practices to learn from.

### Selected Employers

The present study is a spotlight on the situation of Chemistry Bachelor graduates entering the labour market. It would be beyond its scope to try to cover the entire spectrum of possible employment prospects for graduates. However, in order to convey the fullest picture of the situation of graduates' employability, the selection of employers for case studies was aimed at covering multiple aspects. Table 3 describes participating employers, representing a range of occupational set-ups. The questionnaire was aimed not only at focussing on the "classic" job profiles for chemistry students i.e. careers in technical and research positions but also to analyse other job profiles for which employers consider Bachelors of chemistry qualified, such as working for the European Patent Office.<sup>16</sup>

Please note that the selection of employers does by no means claim to be representative. A representative sample that would deliver quantitative results would have to cover many more employers and countries. However, the time span of this project was a limiting factor.

### Questionnaire design

The questionnaire that employers were asked to fill in was divided in four parts:

1. Information on company staffing profile
2. Recruitment policies and human resources development
3. Experience with and/or expectations in Bachelor programmes and degrees
4. Collaboration of the company with Institutions of Higher Education (HEI)
5. Expectations of / Requirements for Bachelor recruits

### Results

#### Employing Chemistry Bachelors: Status Quo

Table 3 describes well the current situation of Chemistry Bachelors in Europe: about half of the participating companies report no staff holding a Bachelor as their highest academic degree or only very marginal numbers of up to 2%. In only five cases are the numbers of Bachelors more significant being greater than 10% of the workforce. The sample of companies therefore provides a good illustration of the European labour market reality for Chemistry Bachelor graduates.

The fact that the other companies mentioned do not employ these graduates is not necessarily linked to a lack of acceptance of the degree. On the contrary: many were found to be in favour of this qualification but simply have not received any applications so far.

Those companies who do employ graduates with a Bachelor in chemical sciences have their respective reasons: the United Kingdom looks back on a long history of Bachelor's degree recruitment and thus today shows the percentages of Bachelor graduates in staff that other European countries aim for. The Netherlands as well as Czech Republic are eager implementers of the new degrees system (Eurydice 2006/2007); a Czech employer participating in the study even run their own university with Bachelor programmes that are tailored to the company's needs.

<sup>15</sup> MINT subjects are: maths, engineering, science and technology students.

<sup>16</sup> A total of 45 companies was approached and invited to participate in this study. Many companies did not feel confident to give statements on the Chemistry Bachelor since they have up to now never employed them, and would not comment on this degree in general. Despite repeated follow up invitations by phone only several questionnaires were returned completed.

	Nationality of company seat	Industry	Type of employer	No. of Staff	% of staff holding Chemistry Bachelors as highest degree
1	Germany / Worldwide	Chemicals	Multinational company	95.000 (2006)	0
2	France / Worldwide	Cosmetics	Multinational company	66.000/7.000 <sup>17</sup>	1.5
3	Germany / Worldwide	Homecare/ Cosmetics/ Adhesives	Multinational company	55.000 ww	n.s.
4	Germany/ Worldwide	Chemicals	Multinational company	40.000 ww/ 27.000 <sup>18</sup>	0-1
5	The Netherlands	Chemicals, fertilizers, plastics and metals	Dutch branch of Multinational company	31.000 ww/ 3.000	16.6
6	Czech Republic	Automotive	Subsidiary of Multinational Company	23.500	1
7	Germany	Pharmaceuticals & Chemicals	Multinational Company	10.000	> 0.5
8	Europe	European Patent Office	Administration department	6.500	0
9	Czech Republic	Petrochemistry	Subsidiary of Multinational Company	6.000/ 2.100 <sup>19</sup>	2.5
10	UK / Worldwide	Chemicals	Europe branch of Multinational Company	4000	10-15
11	Finland	Polyolefins	Multinational company	950	no record
12	Finland	Adhesives and Cleaning Agents	SME	300	0
13	The Netherlands	Chemicals	Dutch branch of Multinational Company	250	10.4
14	Germany	Diagnostic Systems	SME	180	0
15	UK	Distributor/supplier of bulk/packaged chemicals	SME	80	7.5
16	Germany	Distributor for Analytical Instruments	SME	40	0
17	UK	Laboratory services: analytical chemistry, environmental testing and ecotoxicology	SME	36	14
18	UK	pharmaceutical, fine chemical and materials analysis	SME	4	25

**Table 3: Profiles of participating companies**

<sup>17</sup> The HR representative interviewed was responsible for 7 000 employees and could only provide numbers for these.

<sup>18</sup> 27 000 Employees in Germany.

<sup>19</sup> The HR representative interviewed was responsible for 2 100 employees and could only provide numbers for these.

The HR recruitment in the French company could be characterised as particularly open and flexible and it will be shown below that this employer has already become adept at making good use of the new degree in their employment system.

The fact that so few companies in Europe have actually recruited Chemistry Bachelors<sup>20</sup> so far was indeed the main challenge when recruiting informants for the present study. Many employers did not feel confident enough to comment on this issue due to a lack of experience. Others showed certain suspiciousness towards the topic; because of the prevailing uncertainty as to how the Bachelor will take root in human resources recruitment and development, many company representatives would not participate. Only very few informants of the 45 companies approached saw an opportunity in this questionnaire to position themselves as a good practice example and “prime mover” on how to make best use of the degree. Thus, the French company pro-actively stated that they “particularly appreciate the personal competences of [Bachelor] graduates (not only their technical know-how) as being very able in communication, analysis, project management, intellectual curiosity etc.” A German employer summarised the current reality for most European companies in the following manner: “We are interested in Chemistry Bachelors and offer them appropriate entry positions, but so far we haven’t seen a single one of them – Germany is still waiting for them. Our experience so far: able graduates move on to the Master, the bad ones are neither wanted by industry nor by the university.”

This situation is deplorable since it may result in a grid-lock: if employers do not comment due to lack of experience and the uncertain situation, the debate on the issue will not deliver good practice examples from those who have actually tried. Once role models of successful careers based on the Chemistry Bachelor can be communicated, it can be hoped that the ice will break and both students and employers will be motivated to embark on Chemistry Bachelor careers. An advancement that would certainly help in this situation is the targeted publicity of quality labels for bachelor programmes. Certified labels would improve the confidence employers have in the new degree and the variation involved.

### **Chemistry Bachelors in Labour Market Reality: Recruitment policies and Career perspectives**

All companies but three accept the Chemistry Bachelor as a fully fledged academic degree that is relevant to the job market. Some add that since they have not had a single application of a Chemistry Bachelor they only do so theoretically.

Being asked whether they offered specific entry positions to Chemistry Bachelor graduates, some companies pointed out which these were in particular:

- corporate R&D and applied research (development chemist, research chemist, applications chemist, lab technician, pilot plant, chemical analysis etc.) assistant medical/biological/chemical technicians, technical managers (lower managerial positions) etc.,
- operational fields (chemistry experts in e.g. production, plant engineering, process engineering, technology),
- commercial fields (chemistry experts in e.g. sales management, marketing, distribution, logistics, controlling, accounting etc.).

The survey thus confirms our initial hypothesis from above: Chemistry Bachelor graduates should aim for broader perspectives for employability and not target positions in research and development only. Indeed there is a high demand for such graduates in non-technical career strands as we will see below.

Employers have by and large not changed their recruitment policies since the new Bachelor programmes have been introduced. Some intend to do so once they have gathered experience with employing Bachelor graduates, others have not changed their policy but have adapted job descriptions and evaluations. What they appreciate most about the new degree is the European quality standard, the internationalisation of degrees and an increase in internship experiences in business during the study period. On the whole, they feel confident that the degree will eventually find its specific place in existing recruitment policies.

German companies in particular however see a problem in that Chemistry Bachelor graduates compete with candidates with vocational training background (such as assistant medical technicians and similar positions). This clash was even held to be one of the most problematic issues involved. A need was identified for institutions of higher education to specify the profiling of Chemistry Bachelors against these vocational professions. A Czech company on the other hand confirms that a Bachelor graduate will have a better chance to get a job than secondary education school leavers.

Career path perspectives that are offered to Chemistry Bachelors once they have entered the job market vary widely. While some employers describe career paths that remain in the technical discipline, others stress the flexibility that is available to some young employees. It is important to bear in mind that some employers commented on this only hypothetically since they so far lack actual experience in the recruitment and development of Chemistry Bachelor staff. Many employers stress that the individual career path depends much more on the graduate’s personality and further qualifications in different fields than on the question of whether he or she holds a bachelor’s or a master’s degree. Bachelors enter the company on a less specified level than Masters do and their career paths tend to be more varied. As an example, a German SME illustrates that they employ chemistry academics with higher, i.e. Master’s and PhD, degrees for positions that involve technical and innovative research. However, for the management of products, which in their case require explanation and knowledge of the needs of customers from the chemical industries, they would welcome Bachelor graduates. Here the depth of scientific know-how is less important than

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<sup>20</sup> Note that “Chemistry Bachelors” in the following is used as shorthand for graduates with a Bachelor’s (first cycle) degree in chemistry as their highest academic degree.

additional experience in sales and communications techniques, marketing or even programming skills. A French company stressed how the permeability of the careers system offers interesting career perspectives to Bachelor graduates: “if a [Chemistry Bachelor] is capable of and interested in working in Marketing, Finance, Logistics or Human Resources this can be possible”. A UK company reports that 60% of employees in sales have a chemistry degree. German employers stress the potential academic development opportunities for employees with a Bachelor. These employers encourage their staff to enrol in extra-occupational studies; Chemistry Bachelors are welcomed to enter the company and then, successively, acquire a Master’s or higher degree while at the same time gathering job experience from within the company.

The majority of companies confirm that Bachelor graduates face the same career perspectives as Master’s graduates do, one stressing that they look more at personal competences than study titles. One employer admits that Master graduates may experience faster position advance and broader career opportunities than Bachelor’s graduates do. A Czech employer states that the degree may not be sufficient for promotion to higher managerial positions.

A central argument from the early days of the introduction of the Bachelor’s degree was to provide the labour market with young graduates. In many European Member States students would previously not hold an academic degree that is relevant to the labour market before they had reached their late twenties.

In Germany, for example, the former “Diplom” would be reached at an average of 27.9 years of age. Today the Bachelor is awarded at an average age of 25.8; for chemistry the average age lies even lower at 2.4, years (Destatis 2007: 13).

However, no employer interviewed during this study actually confirms the age of an applicant as an important argument for employment, at least not under the age of 45. Equal opportunities legislation in individual countries even prohibits the age factor to be used as an argument for or against employment.

However, companies surveyed do concede that hiring at a young age enables the employer to shape individuals and employ at relatively low wages. The age factor may count indirectly in favour of candidates in terms of the time it took to graduate since it reflects a student’s general eagerness, goal-orientation and ambitiousness. However, none of these arguments are related to the general length of study programmes.

In general, the companies interviewed do not think that the degree of acceptance of Bachelor graduates is related to the size of the company. However, they do see great potential for Chemistry Bachelors in SMEs, where less specialisation and more general competences may be required. This is particularly the case when an applicant has combined different study programmes, such as a Bachelor in chemistry and a Master in business studies. When asked which other industries may have an interest in Chemistry Bachelor graduates, participants name all areas that require a clear idea on the needs of chemistry clients but no in-depth scientific knowledge. Consulting was mentioned as one other industry.

Only three of the company representatives surveyed say they do not feel sufficiently informed about what to expect from an applicant holding a Chemistry Bachelor’s degree. Most claim that they know what is generally being taught during a Chemistry Bachelor programme. SMEs show a tendency to be slightly less informed since they lack the resources for HR specialists to be continually informed of new developments. Similarly, two company HR specialists feel less informed since they only very rarely hire Chemistry Bachelors.

It has to be taken into consideration, however, that there may be an inherent bias towards affirmative answers in this study. Indeed, some of the companies who would not participate in the survey may not have felt confident enough to comment on the Bachelor degree exactly because they did not feel well informed. However, most companies confirm that the information available is sufficient and easily accessible.

There is however another level of information that appears to be underdeveloped: Some big multinationals realise that the new degree is not yet sufficiently promoted and championed for with students and employers likewise. Many specifically commit themselves to bringing the topic of Bachelor’s degree forward by means of communications and taking an active role in public debate. One company concedes that there is a need for good examples and explanations to challenge existing preconceived ideas about the degree. Only five employers state that they know of a few pioneer good examples of chemistry bachelors in the labour market.

#### **What’s in it for the employers? Views and attitudes on what to expect from the Chemistry Bachelor**

Two thirds of the company representatives confirm that the Chemistry Bachelor’s degree meets the current demands from industry. They particularly praise the effort of HEIs to combine academic studies with practical insights, most importantly by means of making internships and placements compulsory elements of the study programme. Another advantage is the incorporation of generic skills as well as personal skills and in particular language skills. Another bonus of the new degree system is that it allows the combination with other study fields. A combination of the Chemistry Bachelor with degrees in other fields such as business studies was regarded as an attractive qualification for corporate careers.

One motivation for harmonising the European degree system was to promote mobility in a single European labour market by means of degrees that are mutually compatible. However, there appears to be no consensus between employers surveyed on whether or not the Bachelor’s degree necessarily or actually promotes mobility of students and employees on an international level. Some employers confirm this and add that the trend towards mobility exists regardless of the new degree, but that the new system promotes the trend. Others deny the correlation of the new system with mobility. One reason suggested was that the aim to teach language skills during Bachelor programmes is laudable but the level at which these are taught is far from sufficient. Another argument is that the bachelor may well promote mobility of students but this does not necessarily imply an increase in job mobility during working life.

Most company representatives agree that the new system delivers increased transparency in the qualifications of job applicants. One stresses the fact that with the new system, “international candidates can be selected on a more level playing field, avoiding possible favouritism from candidates who went to universities one knows of personally”. However, the diversity involved in the new system may allow new dimensions of flexibility but it also challenges comparability and puts great demands on the documentation of study programmes. The diploma supplement, which is an appendix to a degree diploma, describing an individual degree by means of standardised European terminology, is much appreciated by employers in this context. It allows the understanding and classification of degrees, particularly of applicants from abroad. One reply indicates that the new system does not increase transparency as much as it should, as all degrees at the end of the day are awarded by independent academic institutions, so one can never be completely comfortable that one degree is equal to another. One might argue that accreditation requirements should serve as one instrument to ensure that the quality of degrees are equal. Again, this is a point of scepticism on the employers’ side where quality labels can play a crucial role to change their attitudes.

A number of employers argue that the Chemistry Bachelor may have some potential in terms of recruitment, but that it, at the same time, competes with other, non-academic, entry levels to their company. This applies particularly to German employers, who state that in fact this is the biggest issue at stake in terms of acceptance of Chemistry Bachelors. Other employers argue again that each applicant is employed and developed according to his or her own merits and competences so that this clash does not pose a problem. The majority of employers confirm that chemistry bachelor graduates have better chances of getting a job than applicants with a vocational training background.

Employers mainly agree that the Bachelor supplies the market with younger graduates. While some appreciate that candidates are now available sooner, others argue that they are still immature when entering the job market. In general, they stress that they do not look for the younger graduates but for those who are better prepared for a role in business by their competences and personalities. However, one employer concedes that shorter study may indicate a greater dynamism to start a job.

A frequent argument from critical voices towards the new system is that Bachelor graduates may have higher requirements of internal training for the employer. This argument was confirmed by four employers; a third pointed out that it very much depends on whether a candidate was introduced to entrepreneurial/corporate thinking during his or her studies – and that this in turn often depends on individual professors. The majority of employers deny the demand for more internal training for Bachelors. They point out that internal training is tailored to the individual person and the individual position or profession rather than the degree he or she holds. A different viewpoint is that employers may want to employ Bachelor graduates simply because they are more easy to shape according to the company’s needs and values. The fact that two companies replied they were not sure on this matter

suggests that clarification is needed. From what we saw above, there will not be one conclusive answer to this issue since different companies pursue different approaches to HR development. However, communicating good practices on Bachelors and internal training can shed light into this matter and certainly challenge existing preconceptions.

#### **Collaboration with Institution of Higher Education (HEI) pays off**

All companies surveyed regard collaboration with Institutions of Higher Education (HEI) as a worthwhile investment. All but one confidently confirm that they keep up-to-date with the changing world of higher education. They do so in a number of ways, such as campus visits, forum presentations, meetings with professors, interviews with students, student initiatives and company comments on study plans of collaborating universities. Another approach that was mentioned was internal training to staff on new developments in higher education. All but three (SME) companies confirmed that they are in regular contact with HEIs. Furthermore, most companies offer internships for chemistry students, with the exception of two global companies and one SME, the latter planning to do so in the future. In Germany, universities of applied sciences (Fachhochschulen, e.g. Hochschule Fresenius) often are in close collaboration with employers. Another example of direct collaboration is that of a Czech company with ICT Prague. The contents of entire courses may be coordinated with what employers report as industry requirements and representatives of companies engage in teaching at these institutions. Such close collaboration appears to be good practice to produce Chemistry Bachelor outcomes that are directly relevant for the market.

It was not certain whether trade/industrial associations support companies by holding regular meetings with HEIs; four companies reported their trade associations did so; five did not, seven state that they could engage more. The activities of the representing bodies thus appears to be either insufficient or simply not well documented and communicated.

One SME reported that they make particular use of their associations in order to support cooperation and advocacy with HEIs. A group of German SMEs have even founded a local society (“Analytik Management Zirkel”) for this purpose; this collaborates with the Fresenius University of Applied Sciences (FH Fresenius). By means of such a society, SMEs can collaborate with HEIs despite their often limited resources for such activities. Only one company confirmed that they are actually involved in the accreditation process of university programmes. It appears from the interviews that the possibility of playing an active role in this could be better communicated to companies.

There appears to be some demand for explanatory courses on the Chemistry Bachelor for company executives and HR personnel. However, one global company stressed that this would best be done by improving the general level of communication. Executives tend to be interested in individual high potential candidates, not necessarily in educational structures. Recruiters on a more operational level, however, should be well informed and for these, such information courses might be useful. The vast majority of company

representatives however felt sufficiently aware of the contents of a Chemistry Bachelor degree.

Companies agree that collaboration with HEIs on the whole is a worthwhile investment for employers. However, it needs to be focussed on the right activities, such as getting students closer to business, offering experiences such as internships, projects, testimonials, alumni presenting, career entry and career development opportunities.

#### **Required competencies and where employers think these are gained**

The last part of the questionnaire contained a list of competences which fell into three categories (see appendix):

1. Chemistry related knowledge and skills (e.g. basic knowledge on facts and methods in core chemistry areas).
2. Generic competences (e.g. creativity and flexibility in applying knowledge/methods).
3. Personal skills (e.g. presentation and communication skills in a foreign language).

Participants were asked to rank these competences according to the importance they attach to them (ranging from xxx for most important to x for important). In a second step, they indicated at which stages in higher education and practical work they thought this competence is acquired. Four options were given: competence is:

- a. more likely to be provided by the Bachelor's degree,
- b. more likely to be provided by the Master's degree,
- c. cannot be taught but will be acquired during placements/internships,
- d. cannot be taught but will be acquired during a lifetime's career.

Figure 3 displays the results of the two-step question. The ranking of competences according to importance is illustrated by only showing the number of times that a competence was categorised as "most important", expressed as a percentage of the total number of mentions as "most important". The colour coding of the bars indicates the second step of the question: where the competences are most likely to be acquired.

The results show that there is a strong agreement that the most important chemistry-related competence for employment is a basic knowledge on facts and methods in core chemistry. Only two company representatives rated expert knowledge as the most important competence (note that multiple ranking of

highest importance was possible). Obviously, this question was posed at a very general level – undoubtedly there are positions where expert knowledge is crucial for employment, particularly in research and development. However, employers appear to agree on basic knowledge as the most important requirement. This general opinion confirms the idea behind the concept of the Chemistry Bachelor degree in general: providing a basic degree that teaches the fundamental knowledge of chemistry.

As for generic competences, the three competences mentioned most often as the most important are

- the ability to think chemistry in contexts,
- creativity and flexibility in applying knowledge and methods, and
- the ability to work with people from outside chemistry.

Conceivably, neither of these competences is linked with the length or depth of study, the main feature that distinguishes the Bachelor's from the Master's degree. Rather, they are subject to a general orientation of a study programme towards practical applicability in a corporate world. Some Bachelor programmes already address this and are geared towards enabling their students to transfer their knowledge to real-life business situations.

The personal skill most often mentioned as most important is the ability to work autonomously and take responsibility. This skill may be linked to the maturity of a candidate, which was rated in the above as a possible disadvantage of the young Bachelor graduates and indeed the master marginally excels over the bachelor in this point. However, teaching these skills, if at all possible in an HEI environment, is more likely to be connected to individual teaching methods that involve self-reliant behaviour rather than mere length of study. The two other personal skills rated as most important are the ability to work with others as a team and independent learning skills. As for the former, the bachelor is only surpassed by internships as the place to acquire this skill and as for the latter; the bachelor is regarded to be the most likely place of acquisition.

## Most important competences

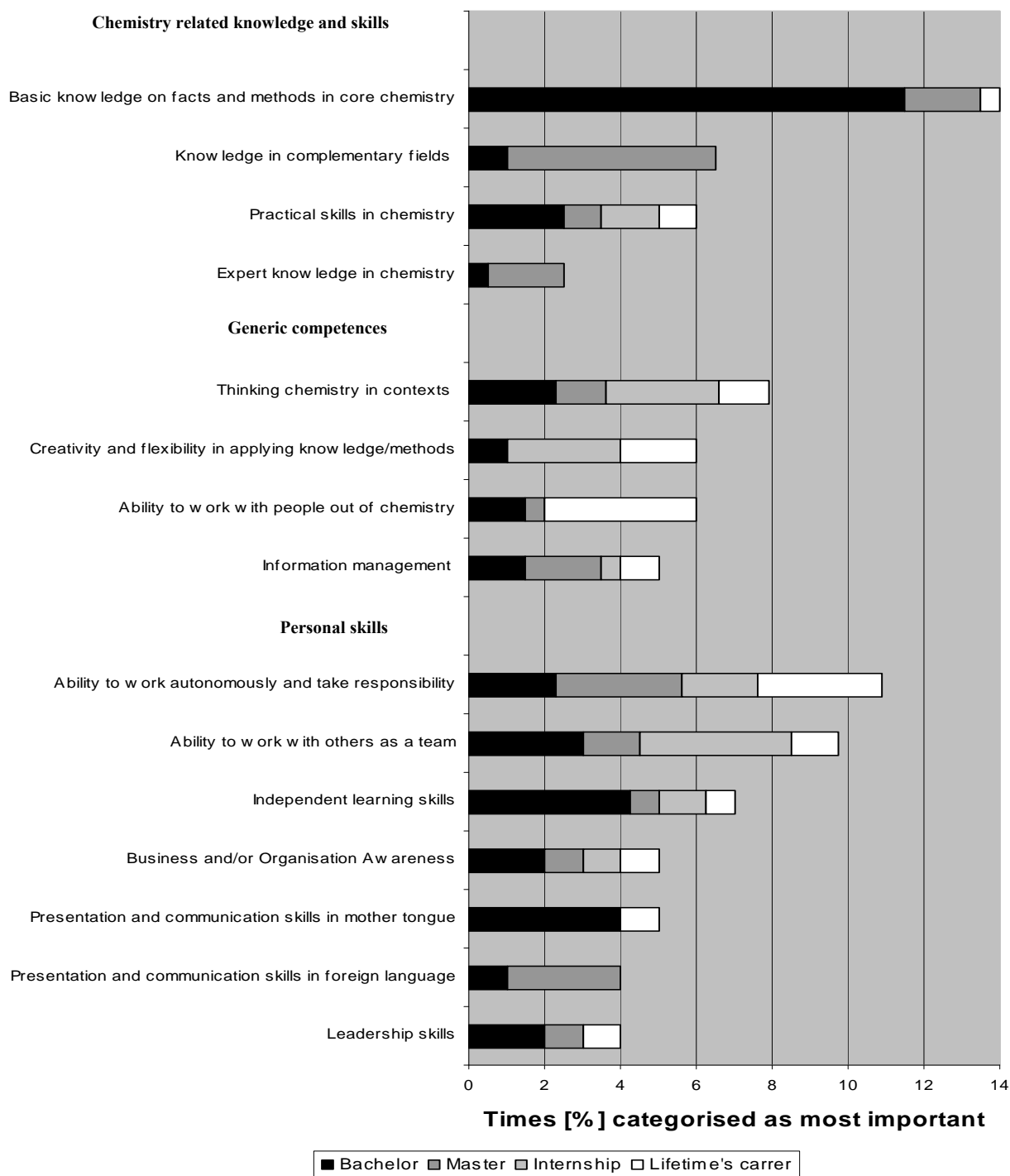


Fig. 3: Competences rated as most important and where they are likely to be acquired

Looking at how these most important competences match with where in life they are likely to be acquired, figure 3 indicates a strong match with the Chemistry Bachelor programme. The majority of HR managers consider the Bachelor to deliver most of those competences which are rated as most important. This is a very positive testimonial by HR staff for this degree. Furthermore, the questionnaire reveals that it is in fact not so much the Master's degree that the Bachelor competes with as to where skills are required; only 5 out of 15 competences were reported to be very important and more likely to be acquired by the Master than by the Bachelor. These are knowledge of complementary fields outside chemistry, expert knowledge of chemistry, information management, the ability to work autonomously and take responsibility, and presentation and communication skills in a foreign language.

All other competences that were not considered to be sufficiently covered by the Bachelor were held to be acquired during placements or through a lifetime's career, not by a Master's programme. Thus, the Bachelor appears to compete less with the Master than with practical work experience. Practical experience, in turn, is a strong element in the profile of Chemistry Bachelor programmes.

To conclude, the company representatives rate the bachelor and its qualifications positively in general. Judging from these findings, it appears that it is not due to the contents of Chemistry Bachelor programmes that the degree has not gained sufficient acceptance by students and employers as yet.

### Conclusions

The current study shows that employers' expectations of and experience with the Bachelor are positive in general<sup>21</sup>. All but three employers acknowledge the degree as an academic qualification relevant to the job market. The efforts of HEIs to collaborate with industry during the introduction of this degree appear to have largely paid-off. Those employers who actually have employed staff with a Bachelor in chemistry as their highest academic degree give positive testimonials and indicate that the degree has gained its distinctive place in the labour market.

Those employers who have not yet had any experience see scope for this degree and appear to welcome applications from Chemistry Bachelor graduates. The general consensus is that the degree meets current demands of the industry labour market. All but UK-based employers state that it is still early in the process to review it and that it is likely that the degree will require more time to become established. However, and particularly if we interpret the high number of companies who did not contribute to the study as having a lack of confidence or interest, it cannot be left to time alone for the Bachelor to become established. Instead, the degree needs to be actively

championed by education, industry and politicians as well as by means of active promotion and marketing.

A closer look at employers' opinions on the outcome of a Chemistry Bachelor's degree reveals that it is less the in-depth scientific knowledge that is relevant for the acceptance of the degree; instead, it is those skills important for practical professional life, practical experience and personal maturity enabling self-reliant behaviour that employers appreciate most. Interestingly, the Bachelor appears to compete less with the set of competences and skills acquired during a Master's degree but more with experiences that can only be made during placements/internships or indeed throughout a lifetime's career. The Chemistry Bachelor already covers a large proportion of those competences that were rated as most important. A strong asset of the Chemistry Bachelor's degree indeed is its focus on skills that are transferable and applicable in industry. There is still room for improvement on the part of the design of Chemistry Bachelor curricula. However, there might also be scope for a change in the attitudes of employers towards an understanding that tailoring competencies of employees within the company, rather than in higher education institutions prior to employment may be more profitable than the tedious and often ineffective search for "the ideally qualified" candidate between graduates.

Communication on the contents of the new degree appears to be sufficient in general. Most employers feel informed about the degree and do have a notion of what is being taught during the course, despite the great variation involved. The new degree does facilitate pan-European comparability of degrees. However, there is still room for improvement and quality labels are of vital importance here. Communication should focus less on informing what the new degree "contains" but promote the advantages of the new degree for the employers, publish good examples and challenge existing prejudices against the degree.

### Part III: Recommendations

## Success factors for making most of the Chemistry Bachelors

The aim of the study is not only to take account of the present state of acceptance of the Bachelor's degree, but also to find out how industry can make most of the degree in order to improve the general employability of graduates. The following describes four approaches of companies that either have successfully embedded the Chemistry Bachelor in their recruitment systems or that show in their pro-active behaviour that welcoming future Bachelors is more to them than paying lip service.

<sup>21</sup> Note that there may be an inherent bias in the study; those companies who do not agree with the Bachelor course may have not participated in the study. However, in the phone calls with those companies who did not contribute no strong opposition was apparent.



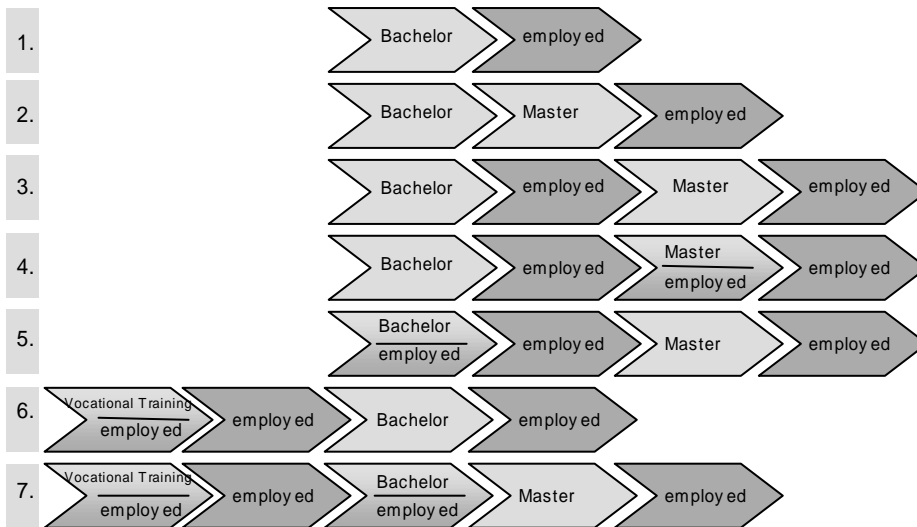
**Companies successfully employ Chemistry Bachelors where**

<b>HR de- velopment is modular</b>	<p>Bachelor serves as a basic degree for entry positions, from there, phases of work experience in employment alternate with phases of further qualification, either full-time or part-time</p> <p>Bachelor can also serve as an academic degree for further qualification for staff with a vocational training background</p>
<b>Career paths are permeable</b>	<p>Flexible degree structures matches flexible and permeable career-paths in a broad field of professions</p> <p>Approach helps to deal with demographic change, longer working lives and international recruitment in times of domestic shortage of skills</p>
<b>Employers shape staff according to their needs</b>	<p>Hiring at a level of little professional specialisation/profile</p> <p>Qualifying and shaping employees according to the company's needs.</p> <p>Frequent with SME employers</p>
<b>A tradition of Bachelor employment prevails</b>	<p>A Tradition of Bachelor recruitment will eventually build on cases of successful employment and careers, triggering positive feedback</p> <p>Bachelor degree is regarded no less and no more than a prerequisite for first screening in recruitment</p>

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**Fig. 4: Four success factors for making most of Chemistry Bachelor graduates**

**Bachelor as a component of modular HR development**



**Fig. 5: Embedding the Bachelor's degree flexibly in a system of modular HR development**

### **Bachelor is a suitable component within modular HR development**

A good way to embed the (chemistry) Bachelor in recruitment policies is by regarding it as a component of modular HR development. Figure 5 is based on an actual recruitment and development policy by one of the companies surveyed. Each arrow describes a phase in careers development either devoted to further education (vocational training, Bachelor's and Master's degree, illustrated by light colour of the arrow) or during which the individual is employed (dark arrows). This scheme describes how the degrees can suitably and flexibly be incorporated into individual careers. The Bachelor degree can be used as:

1. a basic academic degree for early access into the labour market,
2. a basic degree followed by a Master's degree before entering the labour market,
3. a basic degree that allows early employment and later addition of a Master's degree,
4. a basic degree that allows early employment and later addition of a Master's degree through part-time study during employment,
5. a degree that can be taken part-time while already working,
6. a degree that can be taken part time, building on vocational training and experience in employment, either through full-time studies during a sabbatical, or
7. part-time studies while being employed.

Thus, the bachelor serves as a component of clear and flexible career paths within a modular and lifelong system of HR development (based on Meyer 2007).

A general trend in human resources development can be ascertained that transfers education and qualification from a restricted phase of isolated learning at HEIs in youth towards lifelong learning during the employment period. The general idea is that a sound base of knowledge and key competences is acquired in a relatively short but efficiently used phase at HEIs prior to entering the job market. More specialised knowledge is then acquired during a lifetime's career in subsequent part-time qualifications. The advantage of this approach, in which the British system has a long tradition, is that employees know and appreciate the relevance of what they learned already during, not after the degree courses. Hence they have an opportunity to transfer their knowledge directly into professional life and thus tailor it to their actual professional needs. The advantage for the employer is that staff, who in many European countries will in future continue to work beyond the age of over 65, will be active, stimulated and up-to-date with cutting-edge expertise. This new trend differs from the "old continental" system in which staff would acquire a professional profile at HEIs and subsequently draw from knowledge that was acquired decades ago. The Bachelor degree in this system provides the basic level of knowledge for entry positions and thus follows this trend. Thus, the combination of a basic Bachelor's degree that is followed by further qualification on a part-time basis accompanying career and work experience, opens a whole new dimension of options for human resources development to

employers. As one HR specialist puts it: "The Bachelor is just the right background for entry positions and we take our staff individually from there". Employers today are only starting to exploit this trend and gain experience. Therefore it is too early as yet to evaluate the impacts of the new approach at this stage. Embedding the Bachelor in a modular qualifications system also allows employers to use it as a component that follows vocational training, thus offering a basic academic qualification as an incentive for non-academic staff. Two of the companies surveyed offer the chemistry Bachelor in this way to supplement their employee's education. This approach is one means of avoiding a potential competition between the Bachelor's degree and vocational training, but only if the Bachelor's degree involves additional qualifications that are not already taught during vocational training. The question remains why, if this system is open to chemistry students, so few Chemistry Bachelor graduates actually embark on such a programme. Judging from the outcome of this study, it may be the case that the flexibility of a modular, part-time education system may as yet not be matched with the same flexibility on the graduates' side. At least in Germany, it still is a widely held expectation to finish (academic) education first and then, subsequently, enter the job market. The greatest advances in a professional career are still achieved at early stage in working life and these dynamics contradict the perceived benefits of subsequent qualification throughout a lifetime. Much needs to be done to change students' perceptions, and communication and dialogue appear to be the right approach.

### **Bachelor is suitable degree for permeable career paths and opens a broad range of professional fields**

This study has generated a number of examples for international recruitment that utilise the flexibility involved in the Bachelor's degree since it matches flexible and permeable career paths in the company. In instances of successful employment of Chemistry Bachelors, career paths are considered in the broadest sense, not only along the technical strands of careers such as research and development. Graduates that have used the flexibility offered by the Bachelor's degree to acquire generic and personal skills and maybe also combined the course with a non-technical degree, such as business studies; find themselves encouraged by employers to embark on a broader career. This could take them into operational and commercial fields where personal competences in communication, analysis, project management and general curiosity are required to match a sound knowledge in chemistry. Examples for these are Marketing, Finance, Logistics and Human Resources.

Candidates for this type of company are those well prepared for a general role in business and industry rather than those who have a restricted perspective of research careers. Employers in this study describe that an ideal candidate would bring a sound knowledge of core chemical areas mixed with a personality that is communicative, curious and open to broad perspectives of career development that may involve transferring chemical know-how to a wide range of other fields. However, it should not be underestimated that innovative corporate research and development does require

more specialised knowledge, and this is where the Masters and Ph.D. in chemistry will always retain their advantage. Companies taking this broad approach to HR development manage to accommodate:

- flexible and wide career perspectives that enable a company to recruit widely from a range of degrees. This will bring future advantages to employers in times of demographic change and shortage of skilled personnel. The general idea is to reduce the level of specification at entry level and instead allow for subsequent specification as part of HR development,
- careers perspectives for staff that remain challenging and motivating even when staff in the future are likely to work beyond the age of 65,
- an international perspective on recruitment.

This system can deal with academic degrees that involve variation from country to country since the actual shaping of staff occurs not before but after entering employment, within the company.

Again, the concept of flexible career paths and a broad approach towards what the Chemistry Bachelor qualifies for may require promotion to students. There appears to be a demand to communicate the broad scope of professions that are available to Chemistry Bachelor graduates, not only within the chemical industry but also beyond the obvious industries and positions. Table 2 and figure 2 show the broad professional fields that are open to chemistry graduates. One would recommend that HEIs and associations such as chemical societies communicate the wide range of opportunities both in professional fields and through further qualification open to Chemistry Bachelor graduates.

#### **Employers “shaping” staff according to their needs**

Large and global companies often develop their staff along well defined career paths that result from a range of positions with functions and responsibilities that are clearly set out. Careers at small and medium sized businesses tend to differ in that they involve much more flexibility and more generalist approaches to individual positions. Entrepreneurial attitude, thinking and behaviour is important for each individual employee in an SME and not, as sometimes can be observed in large companies, left to a set of people in charge of a company’s strategy. As a result, SMEs have a demand for staff who have acquired a sound knowledge of core chemistry facts and methods but can also think chemistry in particularly broad terms. This includes areas such as sales and product management, where the level of expert knowledge is less important than skills such as sales techniques, marketing, business, programming etc. SMEs in particular look for young graduates to join their company who may not have acquired a strong specialist profile yet but come motivated and eager to learn so that the employer can “shape” them according to their needs. Chemistry Bachelors would conceivably meet these demands and could be suitable candidates for SMEs in particular. SME employers who were asked in this study look for staff who remain with them over a long period of time or

even a lifetime career. They often dread the short retention times that are frequent in big companies.

In order to increase the acceptance for the Chemistry Bachelor, it seems that investment in in-house qualifications may be profitable. The search for the perfect candidate may be more costly and less effective than hiring potential and developing it by means of subsequent qualification and further study tailored to the company’s needs.

#### **Establishing a tradition of Bachelor employment**

In Anglo-Saxon recruitment policies, the Bachelor’s degree has long found its clear place and HR specialists consulted for this study appear to be way beyond scepticism of the degree.

This is the situation that should prevail at the end of the cultural change that continental European employers and students are still experiencing. However, this change can only be accomplished once Chemistry Bachelors have actually been employed and a tradition of Bachelor recruitment has been established. Subsequently, one would expect a chain of positive feedback, where best practices of Chemistry Bachelor recruitment would promote the degree by itself.

Experienced recruiters of Bachelor graduates regard the degree as a prerequisite for a first screening of candidates for both technical and non-technical positions. However, once recruitment gets to the level of selection, it is the professional competences and personal skills that become more important. Behind this approach lies the belief that candidates holding a Chemistry Bachelor’s degree have proved their intellectual ability to master basic and complex matters in chemistry and have acquired a sound knowledge in core chemistry areas. In order to master the challenges in the corporate world, however, a candidate will have to resort to his or her professional competences and personal skills. Ideally, a candidate who was taught these during his or her studies will have a competitive advantage. Internships and work experience may play a larger role here than the mastering of specific scientific methods and skills, which can always be conveyed during internal training focussed on those methods which are really required in working life.

Again, British companies see the Bachelor as an entry degree offering a wide range of positions and perspectives for development. These include positions such as development chemist, research chemist and application chemist but also commercial sales and marketing positions. Bachelor graduates are reported in some cases to undertake the same career pathways as Master graduates do. There is scope to develop from the Bachelor’s degree onwards. The fact that it is a basic degree does not mean that the graduate will have to remain in a low position and that subsequent career steps would be denied.

#### *Shaping debate and attitudes*

This study has shown that in general the Chemistry Bachelor’s degree is considered by employers to be a degree that is relevant to and potentially delivering the outcome required by the job market. The fact that in many European countries hardly any Chemistry Bachelor graduates have

entered the labour market yet can to some extent be explained by the time the degree needs to take root in recruitment systems and employment cultures but also career perceptions of graduates.

However, the process of accepting Bachelors in theory to actually employing them cannot be left to time only. Compared to Bachelors in other subjects and industries, the employment market for Chemistry Bachelors seems to be developing particularly slowly. Conservative attitudes appear to be more persistent here than in other subjects. A reason for the low level of acceptance may lie less in the quality of output from the study programmes than in the attitudes and beliefs of both employers and students described above. Obviously, it appears easier to use the new system as a variation of the old (e.g. Germany treat the new Master's degree as the equivalent of the old Diploma and ignore the Bachelor's degree) than discover the new options involved in the Bachelor and adapt recruitment strategies accordingly.

The process of optimising study programmes for Chemistry Bachelors should by all means be carried out in order to match educational outcome to industry demands. It is however clear now that much has been achieved here and that it can no longer be left to optimising the quality of the outcome of degrees to convince employers of their value. Any attempt to improve the actual level of acceptance of the degree in students and employers will necessarily need to address attitudes, behaviour and mentalities in students and employers.

The process from acceptance to employment can only be an interactive one between HEIs and employers. It should include three approaches: dialogue, communication and collaboration.

### Dialogue

The development and introduction of the Chemistry Bachelor (and other degrees in the new system) has deliberately been designed as an interactive process between institutions of higher education and industry from the very start. Future employers of graduates were approached to participate and express their demands of educational output, and their requirements on competences and skills were to a considerable degree accounted for in the design of Chemistry Bachelor programmes. The purpose of the accreditation process is not only to ensure a certain level of quality in study programmes but also to involve industry. Many companies are taking active roles in the debate on Bachelor's degrees on both national and European levels. The advantages employers take from this engagement include influencing the contents of the Chemistry Bachelor's degree but also shaping debate on all levels: political, educational and industrial. HEIs profit from industry's input by gaining insights into what is really needed in order to supply the labour market with appropriately skilled staff. Dialogue and participation can however only be fruitful if a number of rules are obeyed. Thus it should be open to any willing participant. In the past it seems that only a small selection of employers participated in the shaping of the Bachelor degree. More companies should be invited and motivated to take part. This could be achieved e.g. *via* industrial associations. Furthermore, the results of the dialogue should be made transparent, focussed and culminate in actual

recommendations for action by both employers and HEIs. Only by this can the dialogue be effective and thus motivate employers to participate.

### Communication

Results of the present study suggest that there is a good knowledge from the side of employers (HR specialists) on what the Bachelor of chemistry contains and what (roughly) is being taught. Only one informant stated that there is a demand for courses for management/executives on the Bachelor. The market situation suggests that employers seeking information on Chemistry Bachelor courses find it is in ample supply.

What however is missing or what there is too little of is the communication of best practices from real (not hypothetical) professional life on how employers actually do make best use of Chemistry Bachelor staff. Likewise examples on how graduates actually do have a good career based on the Chemistry Bachelor are still scarce. Instances of these success stories may be hard to find in countries such as Germany where they are rare as yet, but there are good examples in other countries such as the United Kingdom and Ireland which could be used and translated into other countries. A suitable method for communication here would be portraits of successful careers that would serve as role models to promote the Chemistry Bachelor and overcome existing preconceptions in employers and students.

### Collaboration

There are a number of exemplary cases of collaboration between employers and HEI and employers and accreditation bodies. Collaboration mainly serves to match what industry needs in the output of Bachelor courses with what is being taught at HEIs. This matching would ideally be a continuous process over time.

All informants in this study agree that collaboration is a good investment and a win-win situation for both sides. However, it appears that in actual collaboration projects it often boils down to the same employers engaging more than others. This may be down to individual motivations but also to limited resources for such engagement, particularly for SMEs. The study revealed one instance where a group of German SMEs jointly collaborate with an HEI together. This is certainly one approach that could be copied. Forms of collaboration between employers and HEIs include:

- Employers offering placements/internships to students.
- HEIs opening committees on study programme design to representatives of employers in order to match educational outcome to industrial demand.
- Company representatives teaching at HEIs and delivering education that is relevant to real professional life.

In order to motivate employers for such collaboration, the benefit to companies needs to be clearly communicated. It appears that many employers regard such collaboration as an instance of corporate social responsibility when indeed it is an

investment in the provision of suitable staff that is highly profitable.

## Appendix

### Questionnaire

Thank you for taking the time to share your views and experience with the recruitment of Chemistry Bachelor graduates in your organisation. Please answer the questions by ticking the appropriate boxes and specify your answers, if possible and time allowing, where indicated.

#### 1. Your Company

Question	Please specify
How many staff do you currently employ	
What percentage of staff in your company hold an academic degree?	
How many of your staff hold a Chemistry Bachelor as the highest level of higher education?	

#### 2. Recruitment policies and human resources development

Question	Applies	Does not apply	Please specify
Do you feel well/sufficiently informed about what to expect from an applicant holding a Chemistry Bachelor's degree?			
Which dominate in your recruitment requirements at Bachelor level: academic or professional competences?			
In how far is the age of the applicant an argument for employment?			
Do you acknowledge the Chemistry Bachelors as an academic grade relevant to the job market?			
Do you offer particular entry positions for Chemistry Bachelor graduates? Which are these?			
Do you see particular career paths for Chemistry Bachelor graduates?			
Do you know what is taught during the Bachelor programme?			
Have you changed your recruitment policy after the introduction of the Bachelor's degree?			
Do Bachelor graduates face the same career perspectives as Master graduates do?			
Do you think the degree of acceptance of Bachelor graduates is related to company size (SME vs. big multinational)?			
Do you think there are other industries or professional fields that offer more scope for Bachelor graduates than your company does?			

**3. Experience with and/or expectations on Bachelor programmes and degrees**

<b>Question</b>	<b>Applies</b>	<b>Does not apply</b>	<b>Please specify</b>
The Bachelor's degree...			
...meets current demands from the labour market			
...leads to an increase in mobility of students and employees on an international level			
...supplies the labour market with younger graduates			
...involves transparency in the qualification of job applicants			
...competes with other, non-academic entry levels in out company			
...involves higher requirements on internal training			

**4. Collaboration of your company with Institutions of Higher Education (HEI)**

<b>Question</b>	<b>Applies</b>	<b>Does not apply</b>	<b>Please specify</b>
The Bachelor's degree...			
How does your company keep up-to-date with the changing world of higher education?			
Would you find it useful/make use of short courses offered to executives to show and describe the Bachelor?			
Do you offer regular internships for Bachelor chemistry students?			
Does (part of) your staff have regular contact with HEI?			
Is your company involved in accreditation process of chemistry courses?			
Does your regional representation (e.g. Industry Advisory Board) hold regular meetings with HEIs?			
Do you feel collaboration could be improved? How?			
Do you consider the time and resources spent to collaborate with HEI a worthwhile investment?			

**5. Expectations on / Requirements for Bachelor recruits**

<b>From your experience:</b>	<b>Ranking of competences</b>	<b>This competence is more likely to be...</b>		<b>This competence cannot be taught but will be acquired...</b>	
<b>Competences:</b>	Importance attached (* < ***) <sup>23</sup>	provided by Bachelor's degree	provided by Master's degree	during placements/internships	during a lifetime's career
Chemistry related knowledge and skills					
Basic knowledge on facts and methods in core chemistry areas					

<sup>23</sup> \*\*\* denoting highest degree of importance you attach to the respective competence

Expert knowledge in chemistry					
Knowledge in complementary fields (e.g. economics)					
Practical skills in chemistry					
Generic competences					
Information management (handle/work with diverse data)					
Creativity and flexibility in applying knowledge/methods					
Thinking chemistry in contexts (production, economical,...)					
Ability to work with people out of branch of scientific discipline					
Personal skills					
Ability to work autonomously and take responsibility					
Presentation and communication skills in mother tongue					
Presentation and communication skills in foreign language					
Intercultural competences					
Independent learning skills					
Ability to work with others as a team					
Business and/or Organisation Awareness					
Leadership skills					

## REFERENCES

Allen, Jim and Rolf van der Velden (2005) The Flexible Professional in the Knowledge Society: Conceptual Framework of the REFLEX Project. Maastricht: Research Centre for Education and the Labour Market  
<http://www.fdewb.unimaas.nl/roa/reflex/documents%20public/publications/REFLEX%20Working%20paper%20Conceptual%20Framework%20version%2010%20maart%202005.doc>.

AlmaLaurea, Report IX (2007) Occupational Conditions of Graduates, Bologna: Consorzio Interuniversitario Alma Laurea.  
<http://www.almalaurea.it/eng/universita/occupazione/occupazi one05.pdf>.

Bachelor for Labour Market Project (BaLaMa) (2007) Labour Market Challenges to Higher Education. Proceedings of the conference "Education for a knowledge society: linking higher education to the world of work" (unpublished paper).

Briedis, Kolja (2007) Übergänge und Erfahrungen nach dem Hochschulabschluss. Ergebnisse der HIS-Absolventenbefragung des Jahrganges 2005. in: *HIS: Forum Hochschule Nr. F13/2007*.

Briedis, Kolja (2007) Der Bachelor als Sprungbrett. Teil I & II. HIS: Hochschul Informations System, in: *HIS Kurzinformation A3/2005 und A4/2005*.

Biokarriere.net (2008) Bachelorkarrieren unter der Lupe. Erste Ergebnisse einer Studie über den Verbleib von Absolventen. [www.biokarriere.net/news/d/40152/?ps=&pw=a&t=&defop=a nd&wild=yes&sdate=01.01.1995&edate=06.05.2007&sort=1](http://www.biokarriere.net/news/d/40152/?ps=&pw=a&t=&defop=a nd&wild=yes&sdate=01.01.1995&edate=06.05.2007&sort=1)

Barr, David (2006) European Quality Label in Chemistry: The EuroBachelor. Presentation held at the Tuning Project Conference 2006.  
[http://www.tuning.unideusto.org/tuningeu/index.php?option=com\\_docman&task=view\\_category&Itemid=59&subcat=12&catid=20&limitstart=0&limit=5](http://www.tuning.unideusto.org/tuningeu/index.php?option=com_docman&task=view_category&Itemid=59&subcat=12&catid=20&limitstart=0&limit=5). P.75. Accessed 2008 March 13

Bundesagentur für Arbeit (2004) *Uni-Magazin*. Nürnberg: Bundesagentur für Arbeit.

The Confederation of EU Rectors' Conferences and the Association of European Universities (CRE) 1999: The Bologna Declaration on the European space for Higher Education.  
<http://ec.europa.eu/education/policies/educ/bologna/bologna.pdf>

Cammelli, Andrea (2007) The reform of university systems: lights and shadows six years on from implementation. Characteristics and performances of graduates from the class of 2006. Bologna: Consorzio Interuniversitario Alma Laurea.

<http://www.almalaurea.it/en/universita/profilo/profilo2006/pdf/chapter0.pdf>.

Cooke, Michael, Leo Gros, Maren Horz, Walter Zeller (eds.) (2005) Chemical Education for a Competitive and Dynamic Europe, in: *Impuls* 16, Bonn: Nationale Agentur Bildung für Europa beim Bundesinstitut für Berufsbildung (BIBB).

Crosier, David, Lewis Purser, Hanne Smidt (2007) Trends V: Universities shaping the European Higher Education Area. Brussels: European University Association EUA  
[http://www.eua.be/fileadmin/user\\_upload/files/Publications/Fin al\\_Trends\\_Report\\_\\_May\\_10.pdf](http://www.eua.be/fileadmin/user_upload/files/Publications/Fin al_Trends_Report__May_10.pdf).

Destatis (2007): Hochschulstandort Deutschland 2007. Wiesbaden: Statistische Bundesamt.

Diergardt, Nina (2007) Bachelor und Master in der Chemie – Kompetenz mit Profil? Unpublished presentation Merck AG.

Directorate-General for Education and Culture of the European Commission (2007). The Extent and Impact of Higher Education Curricular Reform across Europe. Enschede: Center for Higher Education Policy Studies (CHEPS)  
[http://ec.europa.eu/education/doc/reports/doc/curricular2\\_en.pdf](http://ec.europa.eu/education/doc/reports/doc/curricular2_en.pdf)

ECTN Association (2008). The Chemistry "EuroBachelor<sup>®</sup>".  
<http://ectn-assoc.cpe.fr/eurobachelor/>

ECTN Association (2007) EuroBachelor<sup>®</sup> Framework.  
[http://ectn-assoc.cpe.fr/chemistry-eurolabels/doc/officials/Off\\_EBL070131\\_Eurobachelor\\_Framework\\_2007V1.pdf](http://ectn-assoc.cpe.fr/chemistry-eurolabels/doc/officials/Off_EBL070131_Eurobachelor_Framework_2007V1.pdf)

The European Association for Chemical and Molecular Sciences (EuCheMS) (2007), Division of Chemical Education, Annual National Report 2006-2007. Leidschendam: KNCV.

Eurydice (2004/2005) Focus on the Structure of Higher Education in Europe. Brussels: Eurydice.  
<http://www.estatisticas.gpeari.mctes.pt/archive/doc/FSHE05EN.pdf>

Eurydice (2006/2007) Focus on the Structure of Higher Education in Europe. Brussels: Eurydice. <http://www.azvo.hr/lgs.axd?t=16&id=694> and [http://eacea.ec.europa.eu/ressources/eurydice/pdf/0\\_integral/086DE.pdf](http://eacea.ec.europa.eu/ressources/eurydice/pdf/0_integral/086DE.pdf)

Guggenberger, Helmut, Paul Kellermann, Gunhild Sagmeister, Astrid Steingruber (2007) The Flexible Professional in the Knowledge Society: New Demands on Higher Education in Europe. Klagenfurt: Institut für Soziologie.  
<http://www.fdewb.unimaas.nl/roa/reflex/>

Higher Education Authority (HEA, Ireland) (2007) What Do Graduates Do? The Class of 2005. Dublin: Higher Education Authority.

<http://drupal.heai.ie/files/files/file/archive/statistics/What%20Do%20Graduates%20Do,%20The%20Class%20of%202005.pdf>

Higher Education Careers Service Unit (2008) What Do Graduates Do 2008? Career Planning for Higher Education And Beyond. Manchester: HECSU.

[http://www.hecsu.ac.uk/cms/ShowPage/Home\\_page/Research\\_reports/What\\_Do\\_Graduates\\_Do\\_\\_2008/p!elkeXXf](http://www.hecsu.ac.uk/cms/ShowPage/Home_page/Research_reports/What_Do_Graduates_Do__2008/p!elkeXXf).

Hogart, Terence, Mark Winterbotham, Chris Hasluck, Katie Carter, Anne E. Grenn and Joe Morrisson (2007) Employer and University Engagement in the Use and Development of Graduate Level Skills. London: Department for Education and Skills.

IP Institut für Personalmanagement GmbH (2004) Mit Bachelor und Master nach Europa. Erwartungen der Wirtschaft an die Absolventen der neuen Studiengänge. Berlin: IP.

Jäkel, Christoph (2007) Die Beteiligungsmöglichkeit der Wirtschaft in den Akkreditierungsverfahren. Präsentation des Bologna-Zentrums der HRK und BAVC, DECHEMA, GDCh, IG BCE, VAA, VCI und ASIIN.

Konegen-Grenier, Christiane (2004) Akzeptanz und Karrierechancen von Bachelor- und Masterabsolventen deutscher Hochschulen. In: *Iw-trends 3/2004*. Köln: Institut der Deutschen Wirtschaft.

Meyer, Norbert (2007) Bachelor und Master in der BASF: Anforderungen an die Kompetenzprofile der Absolventen. Unpublished Presentation held at the Information event by BAVC, DECHEMA, GDCh, HRK, IG BCE, VAA, VCI and ASIIN on 11.9.2007.

Prospects – The UK's official graduates careers website: What do graduates do? (2008)

[http://www.prospects.ac.uk/cms/ShowPage/Home\\_page/What\\_do\\_graduates\\_do\\_\\_2008/p!eLaFFee](http://www.prospects.ac.uk/cms/ShowPage/Home_page/What_do_graduates_do__2008/p!eLaFFee)

Rehburg, Meike (2006) Hochschulreform und Arbeitsmarkt. In: Friedrich-Ebert-Stiftung (ed.)

*Uni (4/2004) Perspektive: Arbeitsmarkt Chemiker und Chemieingenieure.*

Stifterverband für die Deutsche Wissenschaft (2005) Karriere mit dem Bachelor: Berufswege und Berufschancen. In: *Positionen 4/2005*.

Union of Industrial and Employers' Confederation of Europe (Unice) (2004) The Bologna Process: UNICE's Positions and Expectations. *Position Paper 15*.

[http://www.bologna-bergen2005.no/Docs/03-Pos\\_pap-05/041015\\_UNICE.pdf](http://www.bologna-bergen2005.no/Docs/03-Pos_pap-05/041015_UNICE.pdf)

World Chemical Engineering Council (2004) How Does Chemical Engineering Education Meet the Requirements of Employment? Frankfurt: WCEC Secretariat c/o DECHEMA e.V.

[http://www.chemengcouncil.org/chemengworld\\_media/Downloads/Education\\_Kurzfassung\\_dt.pdf](http://www.chemengcouncil.org/chemengworld_media/Downloads/Education_Kurzfassung_dt.pdf)

STARTING SALARIES,  
2007 Chemistry graduates  
entered a still relatively strong  
U.S. job market and did quite  
well

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# QUALITY LABELS IN CHEMISTRY

**THE CHEMISTRY "EUROBACHELOR®"****TERENCE N. MITCHELL and RICHARD J. WHEWELL**<sup>a</sup> *TU Dortmund, 44221 Dortmund;* <sup>b</sup> *University of Strathclyde, Glasgow G1 1XL, Scotland*<sup>a</sup> *terence.mitchell@tu-dortmund.de;* <sup>b</sup> *r.j.whewell@strath.ac.uk***Preamble**

As a result of the Bologna Process, there are moves under way throughout Europe to revise chemistry degree structures. As decided at the Berlin conference in September 2003, a three-cycle structure is to be implemented ("BSc/MSc/PhD"). However, there is no general agreement on introducing the "3-5-8" model which has sometimes been misunderstood as the Bologna "recommendation". The Bologna process is gathering momentum very rapidly, and a Bologna first cycle degree as defined by the Helsinki conference in February 2001 will soon be the norm throughout the Bologna area, which now encompasses 45 countries (and stretches "from Cork to Vladivostok and from Crete to the North Cape").

Although the Helsinki consensus was that a "bachelor-type" degree should correspond to 180-240 ECTS credits (3-4 years), there are indications that the 180 credit degree will become much more common than the 240 credit degree, so that the Eurobachelor® model is based on 180 ECTS credits.

Those institutions which decide on 210 or 240 credits will obviously exceed the Eurobachelor® criteria as defined here, but will hopefully use the Eurobachelor® framework and define the remaining 30 or 60 credits according to principles which they will lay down (e.g. the Bachelor Thesis may well carry more credits or there may be an extended institution-supervised industrial placement).

In the context of lifelong learning, a first cycle degree can be seen as a landmark of progress in learning, achieved by a student who intends to proceed to a second cycle programme, either immediately or after a short break.

**The primary aim of the Eurobachelor® qualification is to provide a first cycle degree which will be recognised by other European institutions as being of a standard which will provide automatic right of access (though not right of admission, which is the prerogative of the receiving institution) to chemistry Master programmes.**

The goals of a first cycle study programme can be described by the Budapest Descriptors developed by the Chemistry Subject Area Group working in the project "Tuning Educational Structures in Europe". They are as follows:

First cycle degrees in chemistry\* are awarded to students who have shown themselves by appropriate assessment to:

- have a good grounding in the core areas of chemistry: inorganic, organic, physical, biological and analytical

chemistry; and in addition the necessary background in mathematics and physics;

- have basic knowledge in several other more specialised areas of chemistry\*
- have built up practical skills in chemistry during laboratory courses, at least in inorganic, organic and physical chemistry, in which they have worked individually or in groups as appropriate to the area;
- have developed generic skills in the context of chemistry which are applicable in many other contexts;
- have attained a standard of knowledge and competence which will give them access to second cycle course units or degree programmes.

**Such graduates will:**

- have the ability to gather and interpret relevant scientific data and make judgements that include reflection on relevant scientific and ethical issues;
- have the ability to communicate information, ideas, problems and solutions to informed audiences;
- have competences which fit them for entry-level graduate employment in the general workplace, including the chemical industry;
- have developed those learning skills that are necessary for them to undertake further study with a sufficient degree of autonomy.

Although the UK and Ireland have well-established bachelor degrees, the concepts of honours or pass degrees are not incorporated in the Eurobachelor® model for the BSc in chemistry, as these are not well understood in continental Europe and probably also not easily transferable.

Before presenting the model in detail, it seems advisable to list the options which should be available to any young chemist who obtains a Eurobachelor® qualification in chemistry. As stated in the Bologna declaration, this qualification should be relevant to the European labour market, the emphasis lying here on the word "European". Thus it is necessary that the degree become an accepted qualification in all countries which are signatories to the Bologna/Prague/Berlin agreements.

The chemistry Eurobachelor® should, provided that his/her performance has been of the required standard, be able to continue his/her tertiary education either at his/her degree-awarding institution, at another equivalent institution in his/her home country, or at an equivalent institution in another European country. (At a later stage one can hope that world-wide acceptance of the Eurobachelor® qualification will come into being). This continuation may either be immediate or, depending on the career planning of the individual, may take place after an intermediate period, for example in industry.

The continuation will often take the form of a course leading to an MSc degree, either in chemistry or in related fields. However, European institutions should pay regard to possibilities for providing "high flyers" with a direct or

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\* A Eurobachelor qualification

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\* Such as computational chemistry, materials chemistry, macromolecular chemistry, radiochemistry

(perhaps more often) indirect transition to a PhD course, if this is permitted by national rules.

It must be made clear at the outset that each institution providing Eurobachelor®-type degree programmes in chemistry is completely free to decide on the content, nature and organisation of its courses or modules. Chemistry degree programmes offered by individual institutions will thus logically have their own particular characteristics. The depth in which individual aspects are treated will vary with the nature of specific chemistry programmes.

It is of pre-eminent importance that institutions offering Eurobachelor® qualifications aim for high standards, so as to give their students good chances in the national or international job market as well as a good starting point to transfer to other academic programmes should they wish to do so.

### Employability

According to the Bologna declaration “The degree awarded after the first cycle shall also be relevant to the European labour market as an appropriate level of qualification”. This statement has led to discussion in many countries regarding employability of first cycle degree holders, particularly in those countries which have previously been used to long five-year first degrees.

Although subject knowledge is one criterion for employability, other competences and skills gained during the degree course are vital outcomes of an academic training for general employability. These can be divided into generic and subject-related competences and skills, and what follows refers to both chemistry-related outcomes and generic competences.

#### Outcomes: General

In 2000, the United Kingdom Quality Assurance Agency (QAA) has published useful “benchmarks” which provided a starting point for our discussions. It was not the intention of the QAA to “define a chemistry degree” but to provide a set of factors which should be considered by institutions when setting up degree programmes. Similarly, the outcomes listed below are intended to be indicative, rather than a prescription to be adopted word-by-word across all chemistry degree programmes. In modifying the QAA benchmarks, two aspects were particularly considered:

The benchmarks were written for a British BSc Honours degree, identified by QAA as a first cycle degree and yet leading directly to enrolment on a doctoral programme. The Eurobachelor® is intended only to prepare for entry to the second cycle, and some benchmarks have been deleted because they were considered more appropriate to the second cycle.

The benchmarks are intended to support education and employability, and it is recognised that many chemistry graduates obtain employment outside the discipline. The Tuning Project survey of employers and graduates in employment (2001) shows the importance of those outcomes which look beyond knowledge and recall of chemistry. Some

additions have been made in the light of the results of this survey.

### Outcomes: Subject Knowledge♥

It is suggested that all programmes ensure that students become conversant with the following main aspects of chemistry:

- a) Major aspects of chemical terminology, nomenclature, conventions and units
- b) The major types of chemical reaction and the main characteristics associated with them
- c) The principles and procedures used in chemical analysis and the characterisation of chemical compounds
- d) The principal techniques of structural investigations, including spectroscopy
- e) The characteristics of the different states of matter and the theories used to describe them.
- f) The principles of quantum mechanics and their application to the description of the structure and properties of atoms and molecules
- g) The principles of thermodynamics and their applications to chemistry
- h) The kinetics of chemical change, including catalysis; the mechanistic interpretation of chemical reactions
- i) The characteristic properties of elements and their compounds, including group relationships and trends within the Periodic Table
- j) The structural features of chemical elements and their compounds, including stereochemistry
- k) The properties of aliphatic, aromatic, heterocyclic and organometallic compounds
- l) The nature and behaviour of functional groups in organic molecules
- m) Major synthetic pathways in organic chemistry, involving functional group interconversions and carbon-carbon and carbon-heteroatom bond formation
- n) 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
- o) The structure and reactivity of important classes of biomolecules and the chemistry of important biological processes.

### Outcomes: Abilities and Skills♥

At Eurobachelor® level, students are expected to develop a wide range of different abilities, skills and competences.

These may be divided into three broad categories:

1. Chemistry-related cognitive abilities and competences, i.e. abilities and competences relating to intellectual tasks, including problem solving;

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♥ This section is derived from the chemistry subject benchmark published by the UK Quality Assurance body QAA.

2. Chemistry-related practical skills, e.g. skills relating to the conduct of laboratory work;
3. Generic competences that may be developed in the context of chemistry and are of a general nature and applicable in many other contexts.

The main abilities and competences that students are expected to have developed by the end of their Eurobachelor® programme in chemistry, are as follows.

#### 1. Chemistry-related cognitive abilities and competences

- 1.1 Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to the subject areas identified above.
- 1.2 Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of a familiar nature.
- 1.3 Competences in the evaluation, interpretation and synthesis of chemical information and data.
- 1.4 Ability to recognise and implement good measurement science and practice.
- 1.5 Competences in presenting scientific material and arguments in writing and orally, to an informed audience.
- 1.6 Computational and data-processing skills, relating to chemical information and data.

#### 2. Chemistry-related practical skills

- 2.1 Skills in the safe handling of chemical materials, taking into account their physical and chemical properties, including any specific hazards associated with their use.
- 2.2 Skills required for the conduct of standard laboratory procedures involved and use of instrumentation in synthetic and analytical work, in relation to both organic and inorganic systems.
- 2.3 Skills in the monitoring, by observation and measurement, of chemical properties, events or changes, and the systematic and reliable recording and documentation thereof.
- 2.4 Ability to interpret data derived from laboratory observations and measurements in terms of their significance and relate them to appropriate theory.
- 2.5 Ability to conduct risk assessments concerning the use of chemical substances and laboratory procedures.

#### 3. Generic competences

- 3.1 The capacity to apply knowledge in practice, in particular problem-solving competences, relating to both qualitative and quantitative information.
- 3.2 Numeracy and calculation skills, including such aspects as error analysis, order-of-magnitude estimations, and correct use of units.
- 3.3 Information-management competences, in relation to primary and secondary information sources, including information retrieval through on-line computer searches
- 3.4 Ability to analyse material and synthesise concepts.
- 3.5 The capacity to adapt to new situations and to make decisions.

- 3.6 Information-technology skills such as word-processing and spreadsheet use, data-logging and storage, subject-related use of the Internet.
- 3.7 Skills in planning and time management.
- 3.8 Interpersonal skills, relating to the ability to interact with other people and to engage in team-working.
- 3.9 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.
- 3.10 Study competences needed for continuing professional development. These will include in particular the ability to work autonomously.
- 3.11 Ethical commitment

#### Content

It is highly recommended that the Eurobachelor® course material should be presented in a modular form, whereby modules should correspond to at least 5 credits. The use of double or perhaps triple modules can certainly be envisaged, a Bachelor Thesis or equivalent requiring 15 credits. Thus a degree course should not contain more than 34 modules, but may well contain less. It must be remembered that 34 modules require more than 10 examinations per year.

Apart from the Bachelor Thesis<sup>▲</sup>, which will be the last module in the course to be completed, it appears logical to define modules as being compulsory, semi-optional (where a student is required to select one or more modules from a limited range), and elective (where the student may choose one or more modules from a normally much wider range).

While institutions should be encouraged to break down the traditional barriers between the chemical sub-disciplines, it is realised that this process will not always be rapid. Thus the traditional classification is retained in what follows.

Compulsory chemistry modules will deal with the main sub-disciplines:

- Analytical chemistry
- Inorganic chemistry
- Organic chemistry
- Physical chemistry
- Biological chemistry.

Depending on the staff structure of the department, semi-optional modules will deal with sub-disciplines such as:

- Computational chemistry
- Chemical technology
- Macromolecular chemistry
- Biochemistry

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<sup>▲</sup> An individual research or industrial project, the results of which will be presented in the form of a written report. This report may be subject to examination and will in any case be graded. Projects leading to the Bachelor Thesis could well involve teamwork, as this is an important aspect of employability which is often neglected in traditional chemistry degree courses.

Non-chemical modules will deal with mathematics, physics and biology. It can be expected that there will be compulsory mathematics and physics modules.

Practical courses may be organised as separate modules or as integrated modules. Both alternatives have advantages and disadvantages: if they are organised as separate modules, the practical content of the degree course will be more transparent. Integrated modules offer better possibilities for synchronising theory and practice.

**Modules corresponding to a total of at least 150 credits (including the Bachelor Thesis) should deal with chemistry, physics, biology or mathematics.**

Students should be informed in advance of the expected learning outcomes for each module.

### Distribution of credits

Each individual institution will of course make its own decision as to the distribution of credits between compulsory, semi-optional and elective modules. It will however be necessary to define a "core" in the form of a recommended minimum number of credits for the main sub-disciplines, mathematics and physics. This "core" should neither be too large nor too small, and a volume of 50% of the total number of credits, i.e. 90 out of 180, seems a good compromise in view of the different philosophies present in Europe.

**These 90 credits will cover the following areas:**

- Analytical chemistry
- Inorganic chemistry
- Organic chemistry
- Physical chemistry
- Biological chemistry
- Physics
- Mathematics

**In other words, the 90 credits form the "core" of the degree course. It must be noted that this is a minimum, which will often be exceeded, particularly in degree courses with 210 or 240 ECTS credits.**

As far as semi-optional modules in chemistry are concerned, it is recommended that the student should study **at least three** additional chemistry-related sub-disciplines, depending on the structure of the department: examples are biology, theoretical/computational chemistry, chemical technology, macromolecular chemistry. **Each of these should correspond to at least 5 credits.**

Additional semi-optional and elective modules will certainly be favoured in many institutions: these can be chemistry modules, but may also be taken from any other subjects defined by the appropriate Regulations.

Language modules (stand-alone or integrated) will often be semi-optional, as the Eurobachelor® should be proficient in a second major European language (these being English,

German, Italian, French and Spanish) as well as the language of his/her home country.

**In summary, for the 180 credits available,  $\geq 90$  credits are allocated to the core,  $\geq 15$  credits to the bachelor thesis,  $\geq 15$  credits to the semi-optional modules. The remaining credits (30 of which may come from modules not dealing with chemistry, mathematics, physics or biology) are freely allocable.**

### The Bachelor Thesis<sup>♦</sup>

The academic goal of the Bachelor degree in the chemical sciences is to give graduates an initial research experience. The intention is the graduate will successfully complete an individual research project. This is important not only for those going on to do higher degrees, but also for those leaving the system with a first degree, for whom it is vital that they have personal first-hand experience of what research is about. An industrial placement may be considered a valid alternative to a Bachelor Thesis; such placements should be organised in such a way that their outcomes are clearly documented and that they can be given credits. **Thus the Bachelor Thesis should normally carry at least 15 credits.**

The Thesis will be written in the language prescribed by the institution and defended according to the rules of the institution. It should be remembered that Thesis presentation can be used as a tool for improving presentation skills, also in a foreign language. The supervision (and assessment) of the Bachelor thesis must be transparent.

### Compensation/Condonement

The Chemistry Eurobachelor® does not recommend compensation (in which failed modules/course units are considered to be "passed" because of an overall grade average).

### Recognition of Credits Gained Abroad

The Eurobachelor® is concerned with mobility and recognition. Thus Eurobachelor® institutions must guarantee automatic recognition of credits gained at other institutions if they have been obtained according to the terms of a learning agreement. The institution must comply with the standard ECTS procedures:

- Learning agreements must be concluded with students going abroad before their departure and corrected if necessary during the stay at the host institution
- Because the learning agreement is a contract, it must be signed by someone in the Eurobachelor® institution who is responsible for recognition as well as by the student and by a responsible representative of the host institution
- Credits gained which are listed in the learning agreement must be recognised automatically and should be referred to or listed in the Diploma Supplement issued to the graduate. Alternatively, the Transcript of Records issued by the host institution can be appended to the Diploma Supplement.

- Grade transfer, if it occurs, must be carried out on the basis of ECTS rankings. If the foreign host institution does not use ECTS rankings, a procedure for grade transfer must be used which does not result in "downgrading" of the grades awarded by the host institution.

Mobility can also involve students seeking to enter programmes from elsewhere without a learning agreement; in such cases institutions will make judgements on an individual basis.

### ECTS and Student Workload

A European average for the total (expected) student workload per year is close to 1500 hours; this figure refers to full-time students in a standard academic programme. The average number of teaching weeks is around 25. Simple mathematics thus gives a theoretical workload of around 60 hours per week if the student only works during this period; such a high workload is obviously out of the question! However, generally European institutions seem to expect their students to do degree-relevant work during 36-40 weeks per year.

Thus it is important to have clear guidelines on student workload distribution. These should always include definition of pre-examination study periods and examination periods separate from the teaching period, as these periods form an integral part of the total workload.

When defining workload for the different teaching/learning elements of a chemistry degree course it must be taken into account that, for example, the total workload connected with a 1-hour lecture is different than that corresponding to 1 hour of practical work. Factors thus have to be introduced when workload is being estimated.

Initial institutional estimates of workload for the average student will of course not necessarily be correct; thus there must be a clear mechanism for continuous student feedback on actual workload and the use of this feedback to correct the structure of programmes where necessary.

### Modules and Mobility

Mobility must be an important feature of Eurobachelor® qualifications. It will obviously be made easier if subject areas can agree on module sizes, at least within the core of compulsory modules.

Mobility will only be possible in the second and third years, but will be restricted unnecessarily if institutions define a high proportion of course modules as being "non-transferable", i.e. they must be taken at the home institution. Thus wherever possible only first-year modules should be treated as "non-transferable".

Modules or course units should be fully described according to the ECTS "Key Features". Thus the following information is necessary for each course unit:

- Course title
- Course code

- Type of course
- Level of course
- Year of study
- Semester/trimester
- Number of credits allocated (workload based)
- Name of lecturer
- Objective of the course (expected learning outcomes and competences to be acquired)
- Prerequisites
- Course contents
- Recommended reading
- Teaching methods
- Assessment methods
- Language of instruction

### Methods of Teaching and Learning

Chemistry is an "unusual" subject in that the student not only has to learn, comprehend and apply factual material but also spends a large proportion of his/her studies on practical courses with "hands-on" experiments, i.e. there are important elements of "handicraft" involved.

Practical courses must continue to play an important role in university chemical education in spite of financial constraints imposed by the situation of individual institutions.

Lectures should be supported by multimedia teaching techniques wherever possible and also by problem-solving classes. These offer an ideal platform for teaching in smaller groups, and institutions are advised to consider the introduction of tutorial systems.

### Learning

We can help the student to learn and develop his/her capacity for learning by providing him or her with a constant flow of small learning tasks, for example in the form of regular problem-solving classes where it is necessary to give in answers by datelines clearly defined in advance.

It is obviously vital to have regular contacts between the teachers involved in the modules being taught to a class in any one semester to avoid overloading the student.

### Assessment procedures and performance criteria

#### a) Coursework

The assessment of student performance will be based on a combination of the following:

- Written examinations
- Oral examinations
- Laboratory reports
- Problem-solving exercises
- Oral presentations

Additional factors which may be taken into account when assessing student performance may be derived from:

- Literature surveys and evaluations

- Collaborative work
- Preparation and displays of posters reporting thesis or other work.

#### b) The Thesis

To ensure comparability of standards throughout institutions operating the programme, a significant part of the assessment should be 'competence based'. Different levels of performance clearly need to be defined, and this can be facilitated through a series of statements which describe student skills, attitude and behaviour during the Bachelor Thesis. Attainment levels achieved by particular students can then be judged and compared. For example, keys to a successful Bachelor Thesis are the intellectual and scientific input of the student, the comprehension of the project, organisation and planning besides a well-written report.

The following two statements might encapsulate the range of abilities expected of students under the heading of Intellectual and scientific input: 'The student demonstrated an enquiring mind and an ability to innovate by controlling the direction of the project' and 'The student provided a technical rather than an intellectual contribution to the project'. Such statements can be equated to a mark or grading. Use of such grading tools allows us to move beyond the sometimes subjective assessment of a written document which only reports on the outcome and background to a project. Used in conjunction with a report, student log book, oral presentation and poster, such a range of assessments can provide a very accurate picture of student ability.

Since Eurobachelor® programmes are credit-based, assessment should be carried out with examinations at the end of each term or semester. It should be noted that the use of ECTS does not automatically preclude the use of "comprehensive examinations" at the end of the degree course; if these are used they must however also be included in the credit distribution process and carry appropriate credits!

Written examinations will probably predominate over oral examinations, for objectivity reasons; these also allow a "second opinion" in the case of disagreement between examiner and student.

Examinations should not be overlong; 2-3 hour examinations will probably be the norm.

Examination questions should be problem-based as far as possible; though essay-type questions may be appropriate in some cases, questions involving the reproduction of material learned more or less by heart should be avoided as far as possible.

Questions should be designed to cover the following aspects:

- The knowledge base
- Conceptual understanding
- Problem-solving ability
- Experimental and related skills
- Transferable skills

The student should be provided with feedback wherever possible in the form of "model answers".

#### Grading

The ECTS ranking system will obviously form an integral part of Eurobachelor® assessment. While the national grading systems will no doubt initially be used alongside ECTS "grades", which are by definition based on ranking rather than "absolute" assessment criteria, it seems necessary to aim for the establishment of a recognised pan-European ranking system.

#### The Diploma Supplement

All chemistry Eurobachelors® should be provided with a Diploma Supplement (as described under [http://europa.eu.int/comm/education/policies/rec\\_qual/recognition/diploma\\_en.html](http://europa.eu.int/comm/education/policies/rec_qual/recognition/diploma_en.html)) in English and if required in the language of the degree-awarding institution.

#### Quality Assurance

The chemistry Eurobachelor® designation will be a quality label and must wherever possible involve national chemical societies and their pan-European counterpart (the European Association for Chemical and Molecular Sciences (EuCheMS)) as well as wider European chemistry organisations such as CEFIC and AllChemE. It will thus involve the formation of one of the first trans-national European quality assurance networks in the emerging European Higher Education Area.

*Version: January 2007: Replaces all earlier versions.*

*Original discussion paper written by T. N. Mitchell (Dortmund, DE) and R. J. Whewell (Glasgow, UK)*

*Discussed and modified by the Tuning Project Chemistry Group.*

*Presented and discussed at the European Chemistry Thematic Network Annual Meetings in Perugia (May 2002) and Prague (April 2003).*

*Discussed and approved by the FECS (now EuCheMS) General Assembly in Barcelona, October 2003.*

*Adopted as the basis for award of the Chemistry Eurobachelor® Label by the Assembly of the European Chemistry Thematic Network Association in Toulouse (April 2004).*

*Recommended by the Bologna seminar "Chemistry Studies in the European Higher Education Area", Dresden, June 2004.*

*Revised at the end of the Eurobachelor® pilot project, June 2006.*

**THE CHEMISTRY "EUROMASTER"****TERENCE N. MITCHELL**

TU Dortmund, 44221 Dortmund  
 terence.mitchell@tu-dortmund.de

**The Aims of the Euromaster**

*The primary aims of the Euromaster qualification are to provide a second cycle degree of the highest standard which will be:*

- *recognised by other European institutions as being of a standard which will provide automatic right of access (though not right of admission, which is the prerogative of the receiving institution) to chemistry doctoral programmes.*
- *recognised by employers as being of a standard which fit the graduates for employment as professional chemists in chemical and related industries or in public service*
- *recognised by the European Chemist Registration Board of EuCheMS as meeting the educational standard necessary to allow the graduates to obtain the status of European Chemist.*

It must be made clear at the outset that each institution providing Master-type degree programmes in chemistry is completely free to decide on the content, nature and organisation of its courses or modules. These degree programmes must relate to the European Qualifications Framework for the European Higher Education Area (EHEA) and to the corresponding National Qualifications Framework.

Chemistry degree programmes offered by individual institutions will thus logically have their own particular characteristics. The extent to which individual aspects are treated will vary with the nature of specific programmes.

**Outcomes: The Descriptor**

The goals of a second cycle study programme can be described by the "Budapest" Descriptors developed in May 2005 by the Chemistry Subject Area Group working in the project "Tuning Educational Structures in Europe". They are as follows:

Second cycle degrees in chemistry are awarded to students who have shown themselves by appropriate assessment to:

- have knowledge and understanding that is founded upon and extends that of the Bachelor's level in chemistry, and that provides a basis for originality in developing and applying ideas within a research context;
- have competences which fit them for employment as professional chemists in chemical and related industries or in public service;
- have attained a standard of knowledge and competence which will give them access to third cycle course units or degree programmes.

**Such graduates will:**

- have the ability to apply their knowledge and understanding, and problem solving abilities, in new or unfamiliar environments within broader (or multidisciplinary) contexts related to chemical sciences;
- have the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete or limited information, but that include reflecting on ethical responsibilities linked to the application of their knowledge and judgements;
- have the ability to communicate their conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences clearly and unambiguously;
- have developed those learning skills that will allow them to continue to study in a manner that may be largely self-directed or autonomous, and to take responsibility for their own professional development.

**Transition to the Third Cycle**

The chemistry Euromaster should, provided that his/her performance has been of the required standard, be able to continue his/her tertiary education either at his/her degree-awarding institution, at another equivalent institution in his/her home country, or at an equivalent institution in another European country. (At a later stage one can hope that worldwide acceptance of the Euromaster qualification will come into being).

This continuation will take the form of a course leading to a doctoral degree, either in chemistry or in related fields. Any master programme must end with a Thesis, as this will generally be considered to be the necessary prerequisite for access to the Bologna third cycle.

It is of pre-eminent importance that institutions offering Euromaster qualifications aim for high standards, so as to give their students good chances in the national or international job market as well as a good starting point to transfer to doctoral programmes should they wish to do so.

**Master Programmes in the Context of Bologna**

As a result of the Bologna Declaration, there are moves under way throughout Europe to revise chemistry degree structures. As decided at the Berlin conference in September 2003, a three-cycle structure is to be implemented ("BSc/MSc/PhD"). However, there is no general agreement on introducing the "3-5-8" model which has sometimes been misunderstood as the Bologna "recommendation".

The Helsinki Master Conference of March 2003 provided the following recommendation: Master study programmes should involve 90-120 credits, at least 60 of which must be at Master level. This recommendation was used in defining the Second Cycle in the Qualifications Framework for the EHEA. Master programmes with a research orientation form a link between the EHEA and the European Research Area.

In this European Qualifications Framework, the length of the Bachelor degree is defined as 180 to 240 credits.

Thus any national requirement that a combination of Bachelor and Master must be necessarily equivalent to 300 credits is contrary to the provisions of the European Qualifications Framework, which foresees a "corridor" of 270 (180 + 90) to a maximum of 360 (240 + 120) credits for a combination of Bachelor and Master. Mobile students must not be penalised by not allowing a Bachelor graduate with a 180-credit degree to take a 90-credit Master.

*Euromaster programmes will normally require 90-120 ECTS credits.*

Countries which have traditionally had "long" degrees qualifying for admission to PhD training will generally consider the Master programmes which they introduce to be similar in aim to the higher semesters in their earlier long degrees, but must of course not simply split long programmes into two (unequal) parts, which they then label Bachelor and Master.

### **Judging the Quality of Euromaster Programmes: "Fitness for Purpose"**

Since it is neither necessary nor advisable to set up stringent parameters for a Master programme in chemistry, the question immediately arises as to how a programme can be judged when a "Euromaster Label" is under consideration.

The "Budapest Descriptor" gives a global description of the aims of such a programme, and institutions are advised on the basis of this descriptor to start planning their programme by drafting a statement which defines the aims and the profile of the programme. Such a statement, which will probably run to between one and two pages of A4 text when a 12-point typeface is used, will describe the elements of the programme with reference to the above descriptor. It will describe the skills and competences which the graduate will have amassed at the end of the programme.

This statement defines the purpose of the programme, and the accreditation process will then be designed to find out whether the programme as set out in detail in the application is fit for the purpose for which it is designed.

The points which follow should be mentioned as appropriate in the statement of aims and profile, and will be the subject of questions in the Guidelines for Applicants.

### **Access and Entry**

According to the conclusions of the Helsinki conference on Master degrees: "All bachelor degrees should open access to master studies and all master degrees should give access to doctoral studies". Access is also considered in detail in the Lisbon recognition convention, which has so far been ratified by 40 countries and international institutions.

The prerequisite for entry will be either a qualification of Eurobachelor® standard or a first cycle degree in one of the disciplines defined by the institution for that particular programme.

Transnational mobility at the Bachelor/Master interface will often involve setting up admissions procedures at a level

previously unknown in many European countries. While European students will be aided by their possession of the Diploma Supplement, the detailed information which the latter contains may often not be available for students from countries outside the EHEA.

If Europe wishes to compete with countries such as the USA for the best graduate students, it must offer structures and possibilities as least as good as those present in such countries. Many regret that in the USA a Master in chemistry will very often in fact be a "failed PhD", and they plan to develop high quality programmes leading to Masters who are not failed PhD's.

### **The Number of Credits**

As stated above, Master study programmes should involve 90-120 ECTS credits, at least 60 of which must be at Master level. A normal academic year corresponds to 60 ECTS credits, a European average workload of 1500 hours and an average of 40 weeks per year during which the student will be studying.

Why the emphasis on "at Master level"? Because of the expected flexibility of Master programmes, it may for example be possible in a particular institution for a Physics Bachelor to enrol as a Chemistry Master. In such a case, the Master candidate may well have to make up work (at Bachelor level) in order to be able to reach the defined learning outcomes.

Depending on the structure of the individual programme and the number of credits involved, these may be EXTRA credits or may be included in the 90 or 120 which the complete programme carries. **Such "bridging" modules or course units must be given credit and mentioned in the Diploma Supplement.**

### **The Master Thesis**

The academic goal of the Master degree in the chemical sciences is to give graduates a research experience much broader and deeper than that involved in the limited Bachelor Thesis. The intention is the graduate will successfully complete a research project, the outcome of which is of a quality that is potentially publishable. **Thus the Master Thesis should normally carry at least 30 credits.**

The Thesis will be written in the language prescribed by the institution and defended according to the rules of the institution. It should be remembered that Thesis presentation can be used as a tool for improving presentation skills, also in a foreign language.

The supervision (and assessment) of the Master thesis must be transparent.

### **Teaching Staff**

The thesis supervisors referred to above bear a heavy responsibility in the Master programmes, as indeed do all members of staff involved at teaching at this level. Institutions applying for a Euromaster Label will be asked to provide brief details of the members of the teaching staff involved in the

degree programme and of their recent publication records and other scholarly activity.

This information is necessary in order to judge the background of the programme. Naturally no outside interference in the teaching staff policy of the institution is intended.

### Outcomes: Subject Knowledge

By its very nature, a Master programme will be much more flexible than a Bachelor programme. It is therefore neither necessary nor advisable to list areas of subject knowledge which the programme should cover. According to the needs of the institution, such programmes will be either broadly-based or specialised. Thus the second cycle graduate will often have an in depth knowledge of an area of specialism in chemical science.

*Euromaster programmes will have NO defined "core" comparable to the "core" of 90 credits in the Eurobachelor® framework.*

### Outcomes: Abilities and Skills

In addition to the aspects covered in the Descriptor, the following points should be taken into account.

At Euromaster level, students coming from a chemistry Eurobachelor® background are expected to develop further the range of abilities and skills already gained in the Eurobachelor® programme. If they come from a different undergraduate background, these abilities and skills may not always be present, but may need development during the Master phase.

The abilities and skills may be divided into three broad categories:

- Chemistry-related cognitive abilities and skills, i.e. abilities and skills relating to intellectual tasks, including problem solving;
- Chemistry-related practical skills, e.g. skills relating to the conduct of laboratory work;
- Generic skills that may be developed in the context of chemistry and are of a general nature and applicable in many other contexts. The generic skills defined in the Eurobachelor® document, which need to be developed further as appropriate during the Master phase, are listed in **Appendix 1**.

The main abilities and skills that students are expected to have by the end of their Euromaster programme in chemistry, are as follows.

#### *a. Chemistry-related cognitive abilities and skills*

Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to the subject areas studied during the Master programme.

Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature.

Ability to adopt and apply methodology to the solution of unfamiliar problems.

#### *b. Chemistry-related practical skills*

Skills required for the conduct of advanced laboratory procedures and use of instrumentation in synthetic and analytical work.

Ability to plan and carry out experiments independently and be self critical in the evaluation of experimental procedures and outcomes.

Ability to take responsibility for laboratory work.

Ability to use an understanding of the limits of accuracy of experimental data to inform the planning of future work.

#### *c. Generic skills*

Study skills needed for continuing professional development.

Ability to interact with scientists from other disciplines on inter or multidisciplinary problems.

Ability to assimilate, evaluate and present research results objectively

### Curricular Structure

It is highly recommended that the Euromaster course material should be presented in a modular form, whereby modules should correspond to at least 5 credits. The use of double or perhaps triple modules can certainly be envisaged, the Master Thesis requiring at least 30 credits. Apart

from the Master Thesis, it appears logical to define modules as being compulsory, semi-optional (where a student is required to select one or more modules from a limited range), and elective (where the student may choose one or more modules from a normally much wider range).

Students must be informed in advance of the expected learning outcomes for each module.

Each individual institution will of course make its own decision as to the distribution of credits between compulsory, semi-optional and elective modules.

*Because Euromaster programmes will often allow the student a considerable amount of freedom of choice when selecting course units or modules, institutions should provide study advisers to give guidance on course unit/module selection.*

### Language

At Euromaster level, where the research component forms a main component of the programme, language proficiency must include communication competences in English, the lingua franca of scientific communication. Competences in reading and understanding English should be achieved automatically, since the vast majority of the chemical literature to be consulted is now written in this language.

### ECTS and Student Workload

A European average for the total (expected) student workload per year is close to 1500 hours; this figure refers to full-time students in a standard academic programme. For most

institutions, this is based on a working week of 40 hours. Thus it is important to have clear guidelines on student workload distribution. These should always include definition of pre-examination study periods and examination periods separate from the teaching period, as these periods form an integral part of the total workload.

When defining workload for the different teaching/learning elements of a chemistry degree course it must be taken into account that, for example, the total workload connected with a 1-hour lecture is different than that corresponding to 1 hour of practical work.

Initial institutional estimates of workload for the average student will of course not necessarily be correct; thus there must be a clear mechanism for continuous student feedback on actual workload and the use of this feedback to correct the structure of programmes where necessary.

### Modules and Mobility

Mobility must be an important feature of Euromaster qualifications. It should be possible throughout the course, but particularly at the Thesis level, where use can be made of existing research cooperation with external partners.

Mobility will be restricted unnecessarily if institutions define a high proportion of course modules as being "non-transferable", i.e. they must be taken at the home institution. Modules or course units should be fully described according to the ECTS "Key Features" ([ec.europa.eu/education/programmes/socates/ects/index\\_en.htm](http://ec.europa.eu/education/programmes/socates/ects/index_en.htm)). Thus the following information is necessary for each course unit:

- Course title
- Course code
- Type of course
- Level of course
- Year of study
- Semester/trimester
- Number of credits allocated (workload based)
- Name of lecturer
- Objective of the course (expected learning outcomes and competences to be acquired)
- Prerequisites
- Course contents
- Recommended reading
- Teaching methods
- Assessment methods
- Language of instruction

### Compensation

The Chemistry Euromaster does not recommend compensation (in which failed modules/course units are considered to be "passed" because of an overall grade average).

### Recognition of Credits Gained Abroad

The Euromaster is concerned with mobility and recognition. Thus Euromaster institutions must guarantee automatic recognition of credits gained at foreign host

institutions if they have been obtained according to the terms of a learning agreement. The Euromaster institution must comply with the standard ECTS procedures:

- Learning agreements must be concluded with students going abroad before their departure and corrected if necessary during the stay at the host institution
- Because the learning agreement is a contract, it must be signed by someone in the Euromaster institution who is responsible for recognition as well as by the student and a responsible representative of the host institution
- Credits gained which are listed in the learning agreement must be recognised automatically and should be referred to or listed in the Diploma Supplement issued to the graduate. Alternatively, the Transcript of Records issued by the host institution can be appended to the Diploma Supplement.
- Grade transfer, if it occurs, must be carried out on the basis of ECTS rankings. If the foreign host institution does not use ECTS rankings, a procedure for grade transfer must be used which does not result in "downgrading" of the grades awarded by the host institution

### Methods of Teaching and Learning

A wide variety of learning and teaching approaches is to be recommended. The element of research involved in a Euromaster course will, as stated above, be considerable.

Lectures should be supported by multimedia teaching techniques wherever possible and also by problem-solving classes. These offer an ideal platform for teaching in smaller groups, and institutions are advised to consider the introduction of tutor/mentor systems as a standard feature of Master programmes, where the student will need guidance on his or her study programme because of the initially unexpected degree of freedom in choosing modules/course units.

### Assessment procedures and performance criteria

The assessment must be designed to cover the defined learning outcomes.

#### a) Coursework

The assessment of student performance must involve as many procedures as possible, such as:

- Written examinations
- Oral examinations
- Laboratory reports
- Problem-solving exercises
- Oral presentations
- Preparation and displays of posters reporting thesis or other work.

Since Euromaster programmes are credit-based, assessment should be carried out with examinations at the end of each term or semester. It should be noted that the use of ECTS does not automatically preclude the use of "comprehensive examinations" at the end of the degree course; if these are used

they must however also be included in the credit distribution process and carry appropriate credits!

Examination questions should be problem-based as far as possible; though essay-type questions may be appropriate in some cases, questions involving the reproduction of material learned more or less by heart should be avoided as far as possible.

Members of the teaching staff should aim for a consistent and transparent policy on assessment.

#### *b) The Thesis*

To ensure comparability of standards throughout institutions operating the programme, a significant part of the assessment should be 'competence based'. Different levels of performance clearly need to be defined, and this can be facilitated through a series of statements which describe student skills, attitude and behaviour during the Master Thesis. Attainment levels achieved by particular students can then be judged and compared. For example, keys to a successful Master Thesis are the intellectual and scientific input of the student, the comprehension of the project, organisation and planning besides a well-written report.

The following two statements might encapsulate the range of abilities expected of students under the heading of Intellectual and scientific input: 'The student demonstrated an enquiring mind and an ability to innovate by controlling the direction of the project' and 'The student provided a technical rather than an intellectual contribution to the project'. Such statements can be equated to a mark or grading. Use of such grading tools allows us to move beyond the sometimes subjective assessment of a written document which only reports on the outcome and background to a project. Used in conjunction with a report, student log book, oral presentation and poster, such a range of assessments can provide a very accurate picture of student ability.

#### **Grading**

While the national grading systems will be used initially, it seems necessary to aim for the establishment of a recognised pan-European grading system.

#### **The Diploma Supplement**

All chemistry Euromasters must be provided with a European Diploma Supplement (as described under [http://euro.pa.eu.int/comm/education/policies/rec\\_qual/recognition/diploma\\_en.html](http://euro.pa.eu.int/comm/education/policies/rec_qual/recognition/diploma_en.html)) in English and if required in the language of the degree-awarding institution.

#### **Quality Assurance**

The chemistry Euromaster designation will be a quality label and must involve national chemical societies and their pan-European counterpart (the European Association for Chemical and Molecular Sciences (EuCheMS)) as well as wider European chemistry organisations such as CEFIC and AllChemE. It will thus involve the formation of one of the first

trans-national European quality assurance networks in the emerging European Higher Education Area.

#### **Appendix I**

##### **Generic competences as defined in the Eurobachelor® framework**

- 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 of the home country.
- Study competences needed for continuing professional development. These will include in particular the ability to work autonomously.
- Ethical commitment

*Accepted by ECTNA Administrative Council, September 2006  
Original discussion paper written by T. N. Mitchell (Dortmund, DE)*

*Modified by the augmented chemistry Tuning group, April 2006*

*Approved by the ECTNA General Assembly, Vienna, April 2006*

**TUNING CHEMISTRY SUBJECT AREA GROUP AND EUROPEAN CHEMISTRY THEMATIC NETWORK RECOMMENDATIONS FOR THE THIRD CYCLE**

**TERENCE N. MITCHELL**

TU Dortmund, 44221 Dortmund  
terence.mitchell@tu-dortmund.de

**Preamble**

In June 2004 the first Bologna Seminar devoted to a single discipline was held in Dresden, Germany. The results of the seminar, “*Chemistry Studies in the European Higher Education Area*”, formed the basis for the discussions of the Tuning SAG and of a working party of ECTN. The recommendations presented below are the result of a joint meeting of both groups held in Helsinki, Finland, in February 2006. The Helsinki discussion also took account of the statements on the third cycle in the Bergen Communiqué 2005:

*“... doctoral level qualifications need to be fully aligned with the EHEA overarching framework for qualifications using the outcomes-based approach. The core component of doctoral training is the advancement of knowledge through original research. Considering the need for structured doctoral programmes and the need for transparent supervision and assessment, we note that the normal workload of the third cycle in most countries would correspond to 3-4 years full time. We urge universities to ensure that their doctoral programmes promote interdisciplinary training and the development of transferable skills, thus meeting the needs of the wider employment market. We need to achieve an overall increase in the numbers of doctoral candidates taking up research careers within the EHEA. We consider participants in third cycle programmes both as students and as early stage researchers. We charge the Bologna Follow-up Group with inviting the European University Association, together with other interested partners, to prepare a report under the responsibility of the Follow-up Group on the further development of the basic principles for doctoral programmes, to be presented to Ministers in 2007. Overregulation of doctoral programmes must be avoided.”*

**Chemistry and the EHEA Overarching Framework**

This framework was approved by the Ministers in Bergen. It is a simple framework with which national systems must be aligned. The main elements of the framework are Descriptors and ECTS credits.

The outcomes-based Descriptors used in the framework are the so-called “Dublin Descriptors”, and the chemistry Tuning group has used the Dublin descriptors as a basis for formulating chemistry cycle descriptors. The result is the set of “Budapest Descriptors”, and that for the third cycle follows:

**Third cycle (doctoral) degrees in chemistry are awarded to students who:**

- have demonstrated a systematic understanding of an aspect of the science of chemistry and mastery of those skills and methods of research associated with the topic of this research;
- have demonstrated the ability to conceive, design, implement and develop a substantial process of research in chemical sciences with rigour and integrity;
- have made a contribution through original research that extends the frontier of knowledge in chemical science by developing a substantial body of work, some of which merits international refereed publication;
- have competences which fit them for employment as professional chemists in research positions in chemical and related industries, in public service, or for a progression to a career in academic research.

**Such graduates:**

- are capable of critical analysis, evaluation and synthesis of new and complex ideas;
- can communicate with their general about their areas of expertise;
- can be expected to be able to promote, within both academic and professional contexts, scientific and technological advancement in a knowledge based society.

**Recommendations for Third Cycle Programmes in Chemistry**

In the discussion which follows, the Dresden Recommendations will be used as a framework, since they have lost none of their relevance. Indeed in many aspects the Bergen recommendations appear to have been derived from those formulated in Dresden! The recommendations will be illustrated, where possible, by examples of good practice.

**Structured degree programmes which include coursework (in the widest sense of the term) should become a common feature of European PhD studies; however, research must still be the major element of such programmes. Part-time PhD studies should remain possible in institutions where it has been a normal feature.**

Only structured programmes can be “tuned”! Thus any Tuning recommendations can only deal with programmes: the traditional “master-apprentice” system of doctoral supervision is no longer appropriate at the beginning of the 21st century. Naturally no-one wishes to suggest that a PhD in chemical science should not be gained because of the research done; doctorates which ONLY involve coursework should never be introduced in chemistry!

However, coursework – and here the important point is the phrase “in the widest sense of the term” – does have a vital role to play. The danger inherent in the master-apprentice system is that the student spends several years concentrating on a very narrow piece of research and loses some of the skills and competences gained during the first and second cycles. We must not forget that the research element of the PhD will in the vast majority of cases be something unique in the career of the young person involved.

He or she will almost certainly never again have the chance to work relatively undisturbed on a topic which is (hopefully) found to be fascinating. Later on in life various other elements will probably come to the fore:

- Work in an interdisciplinary team: thus it is vital that the PhD student continually looks outside the narrow area of the research project;
- Problem-solving: one could perhaps say that the whole purpose of our scientific training is to make us capable of problem-solving on ever higher levels;
- Communication and dialogue: communication and defence of one's own results and discussion of their relevance.

The "coursework" on offer should be oriented towards these goals and be output- rather than input oriented. Some examples of the elements which could well be involved are:

- Specialised lectures,
- Research seminars (not only within the student's own research group),
- Lectures by visiting scientists,
- Workshops,
- Participation in summer schools,
- Formulation of research projects and reports on their progress,
- Posters, lectures

Coursework must not necessarily count towards the award of a PhD, although it is often assessed. Instead a credit score can be assigned to various items to gauge how much has been completed; successful collection of a prescribed number of credits may entitle students to submit their thesis for examination. Coursework can be used as source material for oral questioning.

The quantity of coursework (in ECTS credits) varies widely throughout Europe, the typical range being 15-30 credits. More coursework than this should not be needed.

*The chemistry group in Tuning recommends that not less than 15 and not more than 30 ECTS credits should be required as part of the requirements for a PhD.*

Part-time students will often find it difficult to become involved in such activities; dependent on their background these may not be so necessary. Thus it seems logical not to forbid part-time PhDs in future, if these have in the past formed a normal part of the institution's structure.

**The average European PhD should spend 3 to 4 years on his or her studies. The research element of the PhD study programme should not be awarded ECTS credits.**

Students doing first and second cycle degree courses often work part-time and thus extend the time required to complete their courses. At the PhD level, however, it is vital that (apart from work done as a teaching assistant) the student should be able to work full-time on his or her studies (apart from the case just noted). Thus a period of three to four years of full-time study must suffice for a PhD.

There appears to be no advantage in quantifying a research-based third cycle degree course in terms of ECTS credits. Indeed, to award such credits to research work seems to be potentially very dangerous, now that ECTS credits are moving from being just a reflection of time spent on studying to being a measure of learning outcomes.

**ECTS credits should be used to quantify the coursework component. These credits can however be ungraded, as the correct use of the (relative) ECTS grading (ranking) scale will not be possible. Use of the national grading scale is of course possible.**

The coursework component of the PhD is, as we have stated above, outcome-oriented, and thus can indeed be quantified in terms of ECTS credits. Since it will not be possible to use the ECTS relative ranking scale for such coursework, there seems to be no advantage in grading this coursework (although if required the national grading scale can be used).

**Apart from research and coursework, further important elements of the PhD programme are teaching (as teaching assistants) and the training of key generic skills, such as those listed in the Chemistry Eurobachelor document.**

The Eurobachelor® document lists a number of key generic skills:

- 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.
- Study competences needed for continuing professional development. These will include in particular the ability to work autonomously.
- Ethical commitment.

These skills are not to be forgotten at the end of the first cycle, but must be developed further during second and third cycle studies. Work as teaching assistants, which is a normal

feature of the time spent on PhD research throughout Europe (though the financial background varies enormously), has a very positive effect on the development of most students.

PhD programmes should be flexible enough to include a component of teaching in the accumulation of 'coursework' credits, but it should not be considered as a compulsory component. The usual form of teaching is in the teaching laboratories, but graduates are also used to give tutorials, look after problem classes, and to check student exercises.

A common situation is that students may supervise laboratories provided a member of staff is responsible and on call. This may not be either good practice or legal, and other countries demand the presence of a staff member in the laboratory along with the graduate. Thus in Italy, where there are three levels of staff, PhD students are at the lowest level, and lab supervision is done by the highest level of staff (Professors). In the UK, academic related staff (Laboratory Managers or Instructors) assists with laboratory supervision.

Most graduates are paid for some or all of their teaching, but rates vary. Initially, this responsibility as a teaching assistant in a laboratory puts students in what can be a difficult situation, as they undergo a transformation from learner to teacher status.

*Thus it is vital that there be an induction phase before work as teaching assistants starts.*

**Institutions should issue transcripts containing information on all the coursework carried out, and on work done as a teaching assistant. Such transcripts will probably not use the standard European Diploma Supplement format.**

The European Diploma Supplement is perhaps not ideal for describing a PhD programme. The DS is composed of eight sections (information identifying the holder of the qualification, information identifying the qualification, information on the level of the qualification, information on the contents and results gained, information on the function of the qualification, additional information, certification of the Supplement, information on the national higher education system). The key component of the DS which makes it so valuable for the first and second cycles is section 4, information on the contents and results gained. Such information will be much less detailed for a PhD programme, the main contents of which are a thesis containing the results of the research. Nevertheless, it is important that the graduate be supplied with a transcript detailing coursework, as well as details of the activities in teaching, if any. The DS should be taken as a model and modified to fit the necessities of PhD programmes.

**Institutions are encouraged to develop "Graduate School" structures at departmental, interdepartmental or regional level in order to increase their national and international visibility, to increase their research potential and to foster cooperation both between staff and between s**

*"We underline the importance of higher education in further enhancing research and the importance of research in underpinning higher education for the economic and cultural development of our societies and for social cohesion. We note that the efforts to introduce structural change and improve the quality of teaching should not detract from the effort to strengthen research and innovation. We therefore emphasise the importance of research and research training in maintaining and improving the quality of and enhancing the competitiveness and attractiveness of the EHEA. With a view to achieving better results we recognise the need to improve the synergy between the higher education sector and other research sectors throughout our respective countries and between the EHEA and the European Research Area."*

Thus the reference in the Dresden conclusions to increasing the national and international visibility of HE institutions was slightly ahead of its time. The traditional master-apprentice system of PhD training can keep students within the limits of the research group in which they are working, which can of course be very large, but also very small. The idea of "Graduate School" structures in which the individual student is integrated into a departmental, interdepartmental, regional or even international structure will be a great help in putting the research project into perspective as well as for offering possibilities for advancing generic skills.

**National structures for setting up research networks should be extended in order to internationalise such networks. PhD students should spend part of their research time at other institutions, preferably in foreign countries.**

The European Research Area is intended to internationalise research within Europe, and the European Research Council will hopefully stimulate the formation of international research networks, both within EU Framework Plans and without. As research is internationalised, so will the possibilities increase for PhD students to do some of their project work in another institution, and they will often benefit more if this institution is in another country. Individual institutions should do all they can to encourage suitable students to spend a period of time in another institution.

**In appropriate circumstances, suitably qualified candidates (from foreign institutions) should be able to go directly to PhD studies without first completing a Master programme.**

Here it is necessary to quote from the recommendations of the Helsinki seminar on Master programmes, which provided the ground rules for Master programmes in the EHEA.

*"A transition from master level to doctoral studies without the formal award of a master's degree should be considered possible if the student demonstrates that he/she has the necessary abilities".*

The excellent student must be rewarded in the Bologna framework. He or she must be allowed to proceed faster than the majority. Why? These are young people who may well become the industry leaders, or the university professors, of tomorrow. They must be offered a "fast-track option". Students from foreign institutions may well have qualifications different from both a European bachelor and a European master; their needs must be catered for. The Dresden conference made it clear that institutional regulations should be written in such a way that this is indeed a real possibility. This has not yet been done in all national systems, so that competition for the best among European institutions may lead to a "brain drain" within Europe rather than just across the Atlantic! But certainly US institutions are coming to terms with the Europe a Bachelor, and will be pragmatic enough to take the best of these into their Graduate Schools, even if they do not have a Master's degree in their pocket.

Thus the phrase "from foreign institutions", which reflected the state of the discussion in Spring 2004, should now be removed, as our thinking has moved on. Thus the German Chemical Society (GDCh) and the Conference of Heads of Chemistry Departments (KFC) is preparing a document with recommendations on PhD programmes which deals in detail with the transition from Bachelor to PhD studies.

**In PhD examinations, institutions should consider the widespread involvement of external examiners. Examinations should be open. There appears to be no advantage in grading the PhD.**

There are many different ways in which PhD examinations are organised across Europe. One extreme is the UK/Ireland "viva", involving only the student and two examiners (neither of whom, however, is the PhD supervisor). The other extreme, of which there are several slightly different versions, is the completely open examination, with either a "jury" of professors (including external examiners) or participation by any professor in the department.

One general theme is that external examiners are present and actively involved in the examination process. "Incestual" systems in which the PhD supervisor dominates the examination proceedings are outdated. Open examinations are in a majority in Europe, and should be made possible without the possibility of a veto by the candidate.

Grading is not a standard feature, but does occur in some systems. "Grade inflation" can however mean that the results are questionable: thus of the close to 1200 PhDs awarded in Germany in 2005, 70% were awarded the grade of "very good" and another 16% were considered to be "excellent". When one realises that this grade is to a very large extent determined by the PhD supervisor, and that at least 80% of those who take their first degree (Diplom) go on to do a PhD, it becomes clear that such grades really mean that the academics are grading themselves!

### **Recommendations arising from Post-Dresden Discussions**

#### **PhD Supervision**

**Few countries appear to have training for supervisors of PhD students, and this is something that is to be encouraged.**

Too many regulations are to be avoided, as PhD students are adults, and should be responsible for their own development, but they must not be left to get on completely by themselves.

It is not justifiable to assume that because a person is a good researcher he or she will automatically be a good supervisor of research students (although in Germany a professor with Habilitation is assumed to have gained a licence to teach, and thus to supervise students, his capabilities in this second area are never tested). The academic community should seek to ensure that the students get the best possible guidance, or at least guarantee a minimum standard. Unfortunately institutions that have tried to impose regulations have been seen as interfering in academic freedom by some staff.

#### *Examples of good practice:*

Strathclyde (Glasgow, UK) has a one-day training session, and a handbook that sets out the responsibility of both student and supervisor. In Slovakia rules are set out for students in all Cycles, which are especially useful in the 3<sup>rd</sup> Cycle when many students are coming into a new environment from different institutions or countries. In the Netherlands, a PhD student becomes an employee of the university, and signs a contract that also outlines the responsibility of the supervisor. In Finland it is proposed that only professors should supervise PhDs; while in Slovakia, younger researchers understudy a more experienced professor before taking on students of their own.

In several countries the supervisor is not the only person with responsibility for the PhD student. An advisor may also be appointed, not necessarily from the same subject area as the student, or even a small support group. This group may not even include the supervisor on the once a year occasion when the student reports to it and outlines plans for the coming year. In the Czech Republic, this group effectively supervises the quality of the supervisors. Having a formal connection between graduate students and other specialists from the department can be beneficial both to student and staff member, and the valuable stimulus of interdisciplinarity has been confirmed in Italy, even at the Master thesis level.

A common arrangement is that students submit interim reports (at least every six months is usual) to be evaluated by their supervisor (sometimes an external staff member), which may take the form of a presentation; but in Italy, the student may not have much contact with the supervisor because of the way that PhD students are selected and allocated to projects. In the Czech Republic, a brief report is presented by the supervisor to a committee that oversees all PhD projects in their area of expertise, and which may include staff from other institutions. A normal allocation of PhD students to a supervisor could be 4-6, but it depends on whether the research group also includes a number of post-doctorate workers. Interaction between graduates at various stages of their PhDs is also valuable, but rarely needs regulation; though in large

research groups it is important for the supervisor to set up a 'chain of command'.

Quite unlike Arts PhD students, group working, group meetings, group support and a group spirit are the day-by-day experiences of researchers in chemistry and other science disciplines. Indeed this enables a requirement for teamwork and integration to be included in the coursework credits of a chemistry PhD student.

With tough selection procedures and highly motivated students, drop-out is usually low in the 3rd Cycle, and rarely for scientific reasons; does it most often occur, because of health, family or financial problems. More frequent is the situation where students fail to write up their theses after completing their research work because of the demands of taking up employment. In the UK, departments are penalised for any students who do not complete their PhDs; whereas in Slovakia, departments are rewarded for every PhD gained! In Poland students have to pay back their funding if they fail to gain their degree. In Finland an incomplete PhD can be written up for the lesser degree of Licentiate; and in the UK a distinctive Masters degree, MPhil, is awarded for theses that do not reach PhD standard.

**In the infrequent situation of a dispute between student and supervisor there should be a mechanism in place to bring about rapid resolution.**

Specifying a member of staff, at least as senior as the student's supervisor (senior professor, or Head of Department) as arbitrator is the usual approach. It must be someone who is prepared to listen to the student as well as to the staff member. Most disputes arise over misunderstandings and can readily be sorted out or endured. A change of supervisor should be allowable, but in practice this is rare, as it usually means a change of research topic part way through the programme.

#### **Assessment of PhD Candidates**

**Within each country the assessment of PhDs seems to be fundamentally the same across Arts and Sciences, but national differences need to be addressed.**

In some countries the preferred term is 'defence' of a thesis rather than an examination. The supervisor is not usually involved in this final process, except as an observer; but in almost every country one or more external experts (sometimes from other countries, not just other universities) participate.

In most countries the principal (or only) criterion for awarding a PhD is the quality and quantity of the research and its accurate, effective presentation in the thesis. Students are expected to produce a reasonable quantity of high-grade research, understand what they have done, and appreciate the wider context into which it fits.

In the Netherlands the work is first approved by a committee, then 300-500 copies of the thesis are printed before holding an open defence; Finland is similar. In Poland and Slovakia the thesis is available in the Library before the defence. Two referees (three in the Czech Republic) give written comments and decide whether the defence should be held. The questions asked from the floor and the student responses are all formally recorded. The candidate may also be examined beforehand on the area of the research, making assessment a three-stage process, as the work is proved to be acceptable successively to the supervisor (and department), experts in the field, and the chemistry community at large. As a result the assessment (and even the decision of the award) is often complete before the defence takes place (so this is largely a formality). In the UK a single stage procedure follows an informal agreement between student and supervisor that the thesis is ready for submission. An examination focused on the research in the thesis is conducted by a member of the Department (the internal examiner) and an external examiner.

**Institutions should formulate guidelines on how PhD assessment is carried out as part of their internal Quality Assurance mechanisms.**

*Version 1, November 2006*

## "EURCHEM" - THE CROWN JEWEL ON A EUROPEAN CHEMISTRY EDUCATION LADDER

**PAVEL DRAŠAR<sup>a</sup>, SERGIO FACCHETTI<sup>b</sup>, and RICHARD J. WHEWELL<sup>c</sup>**

<sup>a</sup> Czech Chemical Society and ICT Prague, 166 28 Praha;

<sup>b</sup> Consiglio Nazionale dei Chimici; <sup>c</sup> University of Strathclyde, Glasgow G1 1XL, Scotland

<sup>a</sup> Pavel.Drasar@vscht.cz; <sup>b</sup> s.facchetti@chimici.it;

<sup>c</sup> r.j.whewell@strath.ac.uk

'European Chemist' (designatory letters EurChem, used after surname) is a professional designation (qualification level acknowledgment) currently awarded by the European Chemist Registration Board (ECRB) of EuCheMS (formerly FECS). It was first introduced in 1992 by European Communities Chemistry Council (ECCC) on the initiation from the European administration. The ECRB maintains a Register of European Chemists<sup>1</sup>. After the ECCC was disbanded by FECS in October 2002, ProChemE (standing committee on PROFESSIONAL affairs, CHEMICAL education and Ethical practices) was created. ProChemE also took over the work of the former European Communities Chemistry Council on the European Chemist (EurChem) designation and education and training. Activities of ProChemE were terminated in 2009 and ECRB reports to the EuCheMS ExComm.

European Chemist is a professional designation that runs in parallel with the designations of European Engineer (EurIng) (28 000 – number of awards, as in 2005) awarded by FEANI<sup>2</sup>, European Geologist, EurGeol (600) awarded by the European Federation of Geologists<sup>3</sup>, European Physicist, EurPhys (120) awarded by the European Physical Society<sup>4</sup>, European Professional Biologist, EurProBiol (n/a) awarded by the ECBA, the European Countries Biologists Association<sup>5</sup>, i.a. All the professional qualification boards back the "European Professional" schemes by similar arguments, as i.a. the EurChem "pouvoir" given by the response of Mr. Monto on behalf of the EC from January 27, 1997 on inquiry of Mr. Michael Eliot (P-4107/06 of Jan. 10, 1997), which acknowledged the registered chemist by ECCC and asked for waiver from the requirements of article 4 / 89/48/EEC<sup>6-10</sup>. Moreover, European Commission recommended<sup>11</sup> formation of self-regulated profession scheme at European level as a model for professional groups in the technical and scientific sector, such as chemists and physicists, comparable to the FEANI EurIng<sup>2,12</sup>, capable of setting professional criteria<sup>13</sup>. After Bologna agreement was introduced, some of the professional and learned societies lost their interest in the scheme or they visibly decreased their driving force. This fact reflects common understanding, that in the education and professional qualification everything has been done by the Bologna system. This feeling is not totally accurate. Firstly, we will have in Europe for decades many professionals bearing diverse range of titles, designations and awards from the pre-Bolognian ages and secondly, the Bologna system does not tell anything about the practical and professional experience and ethical or

professional standards. Logically, there are sound expectations and arguments to be used for joint effort for active participation of all schemes of "European Professionals" by all the professional organisations hand in hand. Unified standards, procedures and visibility shall give the learned and professional societies and their European Associations strength to face similar groups in the US and serve better their own individual members.

The purpose of the European Chemist scheme is to set a common standard for the recognition of professional competence in Chemistry across European countries. As Europe increasingly develops common standards, it is important that the professional competence of those who oversee the maintenance of standards is recognised. EuCheMS (formerly FECS), through its standing committee ProChemE, maintains schedules of academic qualifications at the levels of full professional, senior technician and junior technician. However, academic qualifications alone have limited value. In providing an acceptable common professional standard, the European Chemist requires experience in the application of knowledge, level of skill, safety and environmental consciousness, sense of responsibility, ability to communicate and level of supervision received. Through the European Chemist designation the chemical societies in EuCheMS (formerly FECS) have ensured that there is an easily understood title to indicate a high level of competence in the practice of chemistry. The award of the European Chemist (EurChem) title should also ensure that individual chemists who wish to move to employment in other member states receive full recognition of their professional competence.

Currently it recognises professional competence in the practice and application of chemistry; provides evidence of development beyond academic qualifications; enhances the mobility of professional chemists within Europe, and provides a means of comparison of education and competence in chemistry.

The 'European Chemist' title may be awarded only to chemists who are members of participating national societies and denotes an academic qualification, plus a period of professional experience. The academic qualification must be one of those listed in the Schedule of Category-A minimum qualifications maintained by the European Communities Chemistry Council (ECCC). Consequently the candidate must have a minimum of eight years post-secondary school education/experience, including a minimum of three years post-graduation approved professional experience. It is also desirable that a European Chemist should have knowledge of a second European language.

Approved professional experience takes account of the following criteria:

- application of knowledge and the ability to apply mature chemical knowledge in planning, developing and performing of tasks,
- ability to make independent technical or scientific decision of detail,

safety and environmental consciousness and the ability to recognize and observe health, safety and environmental requirements relevant to the job,  
 sense of responsibility e.g. towards colleagues, employers, clients, the environment and society in general,  
 communication skills, as the ability to write clear concise and orderly reports, to give clear verbal presentation, to discuss the work convincingly with superiors and colleagues,  
 supervision received as the ability to work under limited supervision,  
 supervision exercised as the ability to assign and outline work for subordinates and to review work for accuracy and adequacy.

It is evident that the title was intended and created as a common standard across Europe to facilitate movement of chemists within Europe particularly for those seeking employment in the European chemical industry. This target is now more important as the EU includes new Member States whose education systems and industrial practices are not widely known to potential employers EU-wide.

As a basic requirement, the candidates for EurChem must<sup>14</sup>:

- Be a member of a participating national chemical society
- Hold a category-A schedule academic qualification
- Have at least three years' approved post-graduation professional experience
- Nominate a reviewer and a referee who must be member of the applicant's national chemical society
- Apply through a participating national society, which will provide an application form and a guide for applicants.

In 2006, the following were listed as Participating Societies: Belgium (Société Royale de Chimie, Royal Flemish Chemical Society), Czech Republic (Česká společnost chemická, Czech Chemical Society), Denmark (Ingeniørforening Kemiingeniørgruppen, Danish Chemical Society), Finland (Association of Finnish Chemical Societies), France (Société Française de Chimie), Germany (Gesellschaft Deutscher Chemiker, Verband angestellter Akademiker und Leitender Angestellter der Chemischen Industrie), Greece (Association of Greek Chemists), Republic of Ireland (Institute of Chemistry of Ireland), Italy (Società Chimica Italiana, Consiglio Nazionale dei Chimici), The Netherlands (Royal Netherlands Chemical Society), Norway (Norwegian Chemical Society), Portugal (Sociedade Portuguesa de Química), Spain (Real Sociedad Española de Química, Asociación Nacional de Químicos de España [ANQUE], Consejo General de Colegios Oficiales de Químicos de España), Sweden (Swedish Chemical Society), United Kingdom (Royal Society of Chemistry); while other societies expressed their willingness to be involved in the scheme. Since then has the GDCh officially withdrawn from the scheme and VAA is no longer a member of EuCheMS and the ECRB.

Increasingly the European Chemist can become the logical progression for EuroBachelor and EuroMaster

graduates entering the professional life and becoming fully operational and recognized professional chemists. Hence, it can become a part of the Bologna process implementation. As a result of the Bologna Declaration applied in practice, there were explicit and logical reasons to put the European Chemist professional designation at the top of the general three-cycle structure (BSc/MSc/PhD). This move on one side strengthened the requirements for practical aspects in the chemistry education profile and, from the other side enabled the European specialists registered as EurChem to operate on a common basis within a truly European professional guild.

In the context of lifelong learning, the European Chemist professional designation could be another accredited step within the European education and research area. Although the EurChem title cannot itself be considered as a 'diploma' within the meaning of Article 1(a) of Council Directive<sup>7</sup> on a general system for the recognition of higher education diplomas<sup>7</sup>, it may nevertheless be of assistance to the competent national authorities when they examine a request for recognition under Article 3 of the Directive. Registration in the EurChem register indicates that, whatever the duration or content of his or her initial training, the chemist has reached a certain level of professional competence, certified by his or her peers both at national and European level. Bearing in mind that Member States are required by the caselaw of the Court<sup>6</sup> to take post-diploma professional experience<sup>15</sup> into consideration, when reaching their decision on recognition, the Commission considers that a professional who has obtained the title EurChem should not normally be required to undertake an adaptation period or sit an aptitude test, as provided for in Article 4 of Directive 89/48/EEC<sup>7</sup>.

### Employability

According to the EC decision cited above, the EurChem professional designation can serve as an international reference point of education and experience, if supported, promoted and recognised by the national chemical societies and by industrial organisations such as CEFIC. Thus, the employability of chemists could be enhanced, especially as the EU includes new members whose education systems and industrial practices are not widely known to potential employers EU-wide. This fact is currently supported by a survey in several EU states, especially among SMEs.

### Qualification Tables

The qualification tables of ECCC (Schedule of qualifications in chemistry) are on the basis of Nicosia Executive Council of EuCheMS re-designed and are currently available to all member organisations for corrections and amendments.

The structure of the newly created tables shall reflect the new situation in the European Educational Area after the Bologna Declaration and should include the 3+2+3 scheme, plus pre-bachelor education system, vocational chemistry education and post-PhD career levels.

The necessity of a better understanding of the comparable qualifications (even though there will be quite understandable

pan-European system in close future) is apparent and may be, when finalised, submitted to the EU in the framework of the Directive on Recognition of Professional Qualifications. So, the qualification tables (when finished and maintained) could take important messages to personnel departments, administrators, professional employers, entrepreneurs, registration authorities etc.

### Outcome

The clear vision in front of the EurChem scheme is a formation of a true individual membership Professional "Guild" of European Chemists. Such a Guild is to be seen not as an exclusive club but as highly professional learned European assembly. Every EurChem shall be recognized as a "certified" professional with high occupational performance, ethical requirements and a will for life-long-learning. This body of registered professionals shall serve as a well organized and unified voice within the European Research Area<sup>16</sup>. Also, the rules, standards and schemes set could enhance the capability of future negotiations with "third countries" on recognition of qualifications<sup>17</sup>.

Based on the article 15 (see Appendix) of the directive 2005/36/EC, on the recognition of professional qualifications<sup>13</sup>, the scheme of European Chemist could form a platform with a defined set of criteria, and after approval of the Commission shall allow the European Chemists to become a registered profession.

### Mobility

Mobility must be an important feature of EurChem qualification<sup>18</sup>. It will obviously be made easier if such a scheme is not only supported by a single EC decision, but more widely, e.g. through CEFIC.

### Assessment procedures and performance criteria

The assessment procedure in the scheme is first and foremost secured by National Assessment Panels nominated by the national chemical societies. The second critical point is the existence of qualification tables, at least for the second cycle of education (MSc level). The role of the recommending "colleagues" must be developed into another element of strict assessment. Hence, it follows, that members of ECRB and National Assessment Panels should themselves be European Chemists.

### Grading

There will not be further grading among European chemists.

### The Certificate

All European Chemists shall receive a Certificate attesting their inclusion in the ECRB register. A translation of the scroll could be issued by the National Assessment Panel, if desired.

### Payments and Fees

The European Chemist registration procedure and the maintaining of the register are quality- based and validated procedures and must not be confused with those schemes in

which an applicant can get a diploma just by paying for it. However, the registration and re-registration procedures need to be funded, and the necessary fees must be presented in this light.

### Quality Assurance

The European Chemist professional designation, just like the Chemistry Eurobachelor and other "EuroLabels", shall be maintained as a quality label and must wherever possible involve national chemical societies and their pan-European counterpart (EuCheMS) as well as wider European chemistry organisations such as CEFIC, SusChem, i.a., following European rules<sup>13</sup>. It will thus involve the formation of one of the first trans-national European quality assurance networks in the emerging European Higher Education Area. As an independent quality assessor for the whole project, ECTN seems to be excellent choice, both for its experience and involvement of over 150 European higher educational institutions.

### Appendix

The authors, together with several authorities from European national chemical societies, ECTN specialists and others, do see the EurChem as a vital project, which could bring much more sense to its own existence when joined with the Chemistry EuroLabels scheme and taken into consideration by the chemistry group in the project "Tuning Educational Structures in Europe" (often called "the Tuning Project"). Close collaboration with the ECTN-Association and the Leonardo da Vinci projects as 'CITIES' or 'FACE' could only enhance the significance of the labels.

### Dresden Conclusions

There was included into conclusions<sup>19</sup> from the conference "Chemistry Studies in the European Higher Education Area" (Dresden, June 14th and 15th, 2004) a summarizing paragraph:  
 "Chemists across the European Higher Education Area should support the scheme of European Chemist professional designation and the revision of the qualification tables to take account of the Bologna process. Collaboration with the Federation of European Chemical Societies EuCheMS (formerly FECS) and with ECTN is highly recommended in this matter."

*Version 2008-I, Last revised September 19, 2008.*

*The original discussion paper was compiled and written by Pavel Drašar (Praha, CZ) and Richard J. Whewell (Glasgow, UK). The paper was presented at the conference "Chemistry Studies in the European Higher Education Area" (Dresden, June 14th and 15th, 2004) and discussed at the workshop "Employment Perspectives for B.Sc. and M.Sc." chaired by R.J. Whewell and adopted by ProChemE and included into Sergio Facchetti paper<sup>20</sup> for the 2004 EuCheMS (formerly FECS)-EuCheMS meeting in Bucharest (October 13-15, 2004).*

### REFERENCES

- 1 <http://www.chemsoc.org/networks/enc/ecrb.htm> (May 11, 2004).

- 2 <http://www.feani.org/> (January 7, 2005).
- 3 <http://www.eurogeologists.de/> (January 8, 2005).
- 4 <http://www.eps.org/> (January 8, 2005).
- 5 [www.europeanbiologists.org/](http://www.europeanbiologists.org/) (January 8, 2005).
- 6 CF, case C-240/98 Vassopoulou (1989) ECR I-2357.
- 7 Council Directive 92/51/EEC of 18 June 1992 on a Second General System for the Recognition of Professional Education and Training to Supplement Directive 89/48/EEC, Official Journal L 209 of 24.07.1992. Cf. <http://europa.eu.int/scadplus/leg/en/cha/c11022c.htm> (January 8, 2005).
- 8 Council Directive 89/48/EEC of 21 December 1988 on a general system for the recognition of higher-education diplomas awarded on completion of professional education and training of at least three years' duration, Official Journal L 019, 24/01/1989 P. 0016 - 0023.
- 9 Chemistry in Europe, Nov., 5 (1997).
- 10 <http://www.uochb.cas.cz/Bulletin/bulletin293/9803-09.html>, Bull. Assoc. Czech Chem. Soc. 29 No. 3, 1998.
- 11 Statement from the European Commission on a question addressed by Mr Christian Rovsing (PPE), 10 March 1994, Written Question E-3429/93, Official Journal of the European Communities, Information and Notices, English edition, C 268 Vol. 37 / No. C 268/38, 1994.
- 12 <http://www.feani.org/Statements/StatementEurCommission.doc> (January 7, 2005).
- 13 Directive 2005/36/EC of the European Parliament and of the Council, of 7 September 2005, on the recognition of professional qualifications; Official Journal of the European Union L 255/22 EN 30.9.2005
- 14 Further information is available from: Dr David Barr CChem MRSC, ECRB Secretariat, Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge CB4 0WF, UK, tel. +44 (0)1223 432258, fax +44 (0)1223 432133, Email [barrd@rsc.org](mailto:barrd@rsc.org) (May 11, 2004) or since 2009 from Dr. Helena Pokorná, ECRB Secretariat, Czech Chemical Society, Novotného Lávka 5, CZ-116 68 Praha 1, Czech Republic, tel. +420 222 220 184, email: [csch@csch.cz](mailto:csch@csch.cz).
- 15 Reply to Written Question No. 2790/93; cited in Official Journal of the European Communities, Information and Notices, English edition, C 268 Vol. 37 / No. C 268/38, 1994.
- 16 <http://www.cordis.lu/era/home.html> (January 8, 2005).
- 17 Bugnot P., Recommendation from the Commission to the Council in order to authorise the Commission to open, under certain conditions, negotiations with third countries towards mutual recognition agreements of qualifications of natural persons supplying professional services, SEC(2004) 133 final, (6225/04), Brussels 10/2 2004.
- 18 <http://europa.eu.int/scadplus/leg/en/lvb/l32027.htm> (January 8, 2005); Commission Communication COM(97) 586 final.
- 19 Drasar P., Jahn D., Laganà A., Maelicke A., Mimero P., Mitchell T., Náray-Szabó G., Salzer R., Whewell R., van der Gen A., Chemistry Studies in the European Higher Education Area: Recommendations, Dresden, GDCh, 2004.
- 20 Facchetti S., Future Role of European Chemist Designation, Material for the FECS-EuCheMS General Assembly meeting in Bucharest, FECS/EX/1004:12, October 13-15, 2004.



# CONCLUSIONS

## CONCLUSIONS OF THE PROJECT AND FUTURE ACTIONS OF THE ECTN EMPLOYABILITY WG

PAVEL DRAŠAR

*Czech Chemical Society and ICT Prague, 166 28 Praha  
Pavel.Drasar@vscht.cz*

Firstly, we see a great need to stipulate effective communication between employers and educators. We are not starting from nothing, however, as some companies are already involved in the formulation of educational pathways. As a good example we can cite the Czech generic pharmaceutical company Zentiva that actively originated the course on Synthesis of Pharmaceutical Substances at the Prague Institute of Chemical Technology. This course immediately became very popular and is considered as an 'elite' course. There are many such good examples. Companies communicate with HEIs, collaborate in sandwich internships, and organise their own courses and even universities. Moreover, the SusChem platform is involved in some activities linking academia and industry, such as the organisation of seminars, creation of committees and holding of meetings, where chemistry education is analysed from the point of view of the employer, in connection with academic institutions and the ECTN.

This is the only way to help universities to avoid the creation of courses and graduates just '*l'art pour l'art*' with no connection to real life and with a highly specialised qualification and very low employability. In the future it will be very useful to develop some elite bachelor courses, some at least having a quality label, many as good, and the rest as courses that will give the student a sound basis of technical and scientific knowledge together with all the necessary skills and competences. For those who will not continue their education in chemistry, the courses should provide a good basis, for example, for another type of education (MBA, Master in Patent Law, special toxicology, forensics, environmental or drug analysis, etc.), in order for graduates to obtain good employment. A sound basis for future employability must not be an extensive list of different specialised courses but rather, for the Chemistry Bachelor only, the fulfilment of the Budapest descriptors. **It shows up again and again that the employable bachelor must know reasonable essentials from "chemistry" plus he/she must have a good level of the necessary skills and competences, full stop.** Additional knowledge can be achieved by Life-Long-Learning, or additional study, both with the same good value for the employer. Not far from the truth, one Eastern philosopher, who was very popular in the past and who is now being slowly forgotten, wrote that practical life needs "to learn, to learn, to learn".

As stated above, the SusChem Education Team Members prepared, among other items, during the Prague SusChem conference in February 2009, skills workshops with themes such as:

What are the 5 most critical scientific / technical skills in the next 10 years for:

Chemical industry managers?

Engineers and scientists?  
Plant operators and production workers?  
Plant & machinery repair and maintenance workers?

What are the main threats and opportunities facing the European Chemical Industry and what impact are these likely to have on employment in terms of:

Numbers of scientifically/vocationally skilled people?  
Demand for specific skills?

What regional issues are likely to affect the ability of the member state chemical industries to recruit and retain scientifically/vocationally trained people?

What are the critical scientific/vocational enabling and supporting skills that are vital to the sustainable success of the European Chemical Industry, e.g. toxicology?

Answering these types of questions by people from academia, industry and SMEs together is a vital step towards the formulation of a profile, which will serve the purposes of all partners in the process of education and employment. The quality of this educational process could then be supported and certified by quality labels such as the Eurobachelor®.

There still persist in Europe rather large specificities of traditionally different education systems. We see French, German, Russian, British, Irish, Austro-Hungarian and other schemes that still survive behind the unified Bologna cover painting, which look 'Bolognese' but if you look closely enough you will find credits mathematically calculated from "Semester-per-Woche-Stunden", 1-2-3-4-5 or 5-4-3-2-1 grading, extremely specialised courses to please certain VIP professors, a lack of a good proportion of mathematics and other basic technically oriented educational disciplines on the one hand or biochemistry on the other, no collaboration "across national borders", and material form a 5-year study programme packed into a 3-year bachelor programme.

Here there is a need for a lot of educational, political and media actions to reach some point of common language and common understanding. A mapping of the "former" and the "contemporary" educational schemes in all European countries as was done in the 1990's will definitely help to overcome at least the major discrepancies and non-homogeneities in the European Higher Education Area. There are signs that these "Qualification Tables" originally created in chemical education by the ECCC are to be revitalised in a new initiative from EuCheMS.

This publication reprints for comparison the analysis of the employability of chemists in the US. We should try to link much more effectively with the American schemes, for example *via* the American Chemical Society. Such a link will help to prevent the creation of two separated educational systems in the US and in Europe that will not be compatible enough to enable the free exchange of students, researchers and even employees. Both systems will have some problems with their own technically well educated people on the job market in the future. We can see that visa issues for Far Eastern students coming into the US are causing problems in some universities,

as well as the situation in Europe where some countries (such as the Czech Republic) are not fully prepared for the influx of a **qualified** workforce and students. A harmonised policy in Europe will help the future development of both the HEIs and the job market.

The ECTN employability working group will continue its work in the future period, for example by helping EuCheMS with the “Qualification Tables”. The working group will collaborate with the Label Committee of the ECTNA in further promoting the idea of Quality Labels as the key quality indicator for universities, employees and the general public. Last but not least, the working group will maintain a good link with SusChem as this is the link with the “practical world of chemistry”.

The ECTN may, in the future, help the harmonisation (or tuning) of the university teacher qualification, possibly by reaching the status of a registered profession for them.

The aims and targets were once more discussed and refined at the Poznan WG meeting on April 16, 2009. Among the main future actions were following listed themes:

- Employers as well as students must be better informed about the bachelor degree.
- Employers as well as students must get ready for demographic, political, and economical changes.
- Continue optimizing the degree(s) but also address attitudes, behaviour and mentalities in students and employers. Courses should to some extent touch management skills, law, regulations and economical aspects.
- Help the dialogue between employers and HEI.
- Collaborate further with EUChemS, SusChem and CEFIC.
- Inform politicians there could be surplus of bachelors on the job market.
- Compare the situation after several years, compare the situation of chemists with other disciplines, and keep comparing with the US. Compare the situation with companies that “do not employ chemists”.
- Help the secondary educational institutions (CITIES, for example).

Prague, May 2009



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Typesetting and printing, Czech Chemical Society publishing office “Chemicke Listy”, 2009.

ISBN

978-80-86238-66-1

