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http://ectn-assoc.cpe.fr/chemistry-eurolabels/cel/8_ced01_Introduction.htm

Tuning Chemistry Subject Area Group and European Chemistry Thematic Network

Recommendations for the Third Cycle

November 2006

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 peers, the larger scholarly community and with society in 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 by 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 is taught.
- 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 students.

The following passage is taken from the Bergen communiqué:

"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 ha 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 European 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 encourage*d.**

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 3rd 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; it most often occurs, 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.

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As a policy
- 17.10.06: Only English documentation is officially released by the ECTN Association on the website. No documentation in other languages is now valid;
- 27.10.06: When a new version is officially published, the previous one is automatically withdrawn and becomes invalid.

ECTN Association Statutes and Bylaws referring to the Label Committee activities - check.

Chemistry Eurolabels Documents

Document Titles	Version N°	Released	Format (size)
ECTS Grading Scale and Grading Table	13-01	28.01.13	PDF (101 Kb)
Chemistry Euromaster® and Chemistry Doctorate Eurolabel® Site Visit Team Inspection Suggestions - Sept. 2012 - v1	01 / 12-09	12.09.12	PDF (1.2 Mb)
Guidelines for Applications for the Chemistry Eurolabel® Renewal 2012 v2 version 1 withdrawn	12-02	20.04.12	PDF (3.2 Mb) DOC (654 Kb)
Transparency Table V2 version 1 withdrawn	12-02	20.04.12	PDF (927 Kb) DOC (245 Kb)

Chemistry Eurodoctor Documents-

Document Titles	Version N°	Released	Format (size)
Guidelines for the Application to the Chemistry Doctorate Eurolabel 2012 v1	12-01	22.05.12	PDF (3.3 Mb) DOC (680 Kb)
Eurodoctorate Framework 2006 v1	06-01	17.10.06	PDF (140 Kb)

Chemistry Euromaster® Documents

Document Titles	Version N°	Released	Format (size)
Guidelines for the Application to the Euromaster® Label 2012 v6 version 5 withdrawn	12-06	22.05.12	DOC (713 Kb) PDF (3.5 Mb)
Euromaster® Framework 2006 v1	06-01	30.09.06	PDF (117 Kb)
Euromaster® Slideshow Presentation 2007 v1 version 0 withdrawn	07-01	10.02.07	PPS (248 Kb)

Chemistry Eurobachelor® Documents

Document Titles	Version N°	Released	Format (size)
Guidelines for the Application to the Eurobachelor® Label 2012 v7 version 6a withdrawn	11-07	22.05.12	DOC (740 Kb) PDF (3.3 Mb)
Good Practice Advice for Evaluation of the Applications for the Chemistry Eurobachelor® Label v1	10-01	18.02.11	PDF (86 Kb)
Eurobachelor® Framework 2007 v4 version 3a withdrawn	07-04	31.01.07	PDF (152 Kb)
Eurobachelor® Slideshow Presentation 2007 v2 version 1 withdrawn	07-02	10.02.07	PPS (741 Kb)

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Trademarks and classifications	25.01.10	PDF (171 Kb)

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Eurobachelor® and Euromaster	06.05.07	JPG (2.8 Mb)
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Logo Chemistry Eurodoctor	20.04.12	JPG (70 Kb)
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Papers and Articles' Titles

Document Titles	Released	Format (size)
Designing European Third Cycle Programmes in Chemistry "Chemistry Doctorate Eurolabel®" - T.N. Mitchell and E. Varella.	12.09.12	PDF (65 Kb)
The Chemical Technology "EUROMASTER" - T.N. Mitchell, Z. Belohlav, and P. Drašar.	12.09.12	PDF (110 Kb)
"EurChem" - The Crown Jewel on a European Chemistry Education Ladder - P. Drašar, S. Facchetti and R.J. Whewell.	25.01.10	PDF (204 Kb)
Tuning Chemistry Subject Area Group and European Chemistry Thematic Network Recommendations for the Third Cycle - T.N. Mitchell.	25.01.10	PDF (205 Kb)
The Chemistry "Euromaster" - T.N. Mitchell.	25.01.10	PDF (631 Kb)
The Chemistry "Eurobachelor®" - T.N. Mitchell and R.J. Whewell.	25.01.10	PDF (236 Kb)
The Chemistry goes Bologna	June 2004	PDF (27 Kb)
Bologna / Dresden Recommendations to BFUG Bologna / Dresden Report Bologna / Dresden Conclusions	June 2004	PDF (31 Kb) PDF (59 Kb) PDF (118 Kb)

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