

DESIGNING EUROPEAN THIRD CYCLE PROGRAMMES IN CHEMISTRY CHEMISTRY DOCTORATE EUROLABEL[®]

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Preamble

At the Berlin conference in 2003 it was decided to include doctoral study as the “third cycle” of the Bologna process.

Two years later, in Bergen, important statements on the nature of this third cycle were made:

“The core component of doctoral training is the advancement of knowledge through original research”.

“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 consider participants in third cycle programmes both as students and as early stage researchers”.

Following on from our work on the first (**EUROBACHELOR[®]**) and second (**EUROMASTER[®]**) cycles, we think it useful to provide institutions with guidelines on designing doctoral programmes in chemistry.

Outcomes: The Descriptor

The goals of a third 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:

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 rigor 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 national or international refereed publication;*
- *Have competences which fit them for employment as professional chemists in senior 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 context, scientific and technological advancement in a knowledge based society;*
- *Are able to develop and apply methodology to the solution of novel problems, defining a strategy and an action plan to solve that problem.*

These descriptors were themselves based on the “Dublin descriptors” which form the basis of the Qualifications Framework for the European Higher Education Area adopted in May 2005 (<http://www.ehea.info/Uploads/Documents/QF-EHEA-May2005.pdf>).

Guidelines for Designing Programmes

These guidelines deal with doctoral degrees in general; in many cases the doctoral candidate is taking a degree in a certain faculty/department at a particular institution and dealing with a research topic in a single discipline.

Should the research topic be interdisciplinary in nature, some modifications to these guidelines are necessary. The same is true if the candidate is enrolled for a joint degree, for instance in the case of an interdisciplinary transnational doctorate school. These modifications are made in the descriptors and guidelines for joint interface third-cycle degrees in chemistry.

1. Entry to Doctoral Programmes

The normal entry qualification for doctoral programmes is a Master’s degree from an institution within the European Higher Education Area EHEA (such as a **EUROMASTER[®]** degree).

National and/or institutional regulations can also define entry procedures for

- Non-EHEA Master graduates
- Bachelor graduates with extensive work experience
- Bachelor graduates of exceptionally high standard

Such regulations must document the way in which decisions are taken as to whether such graduates have reached or how they will be enabled to reach EHEA Master’s level.

For graduates with Master’s degrees, the admission criteria should not be too narrowly defined with respect to the Master’s degree syllabus as documented in the graduate’s Diploma Supplement.

2. The Length of Doctoral Studies

The average European doctoral candidate should spend 3 to 4 years of full-time study working towards his or her degree.

The Qualification Framework for the European Higher Education Area does not quantify the length of the third cycle, either in ECTS credits or in years of study. However, the Bergen Communiqué of 2005 makes the following statement:

“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”.

Students doing first and second cycle degree courses often work part-time and thus extend the time required to

complete their courses. At the doctoral level, however, it is extremely important that the doctoral candidate should be able to work full-time on his or her studies (apart from any work done as a teaching assistant). National and/or institutional regulations can however permit part-time study for a doctoral degree.

There appears to be no advantage in quantifying a research-based third cycle degree programme in terms of credits. Indeed, to award 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.

The research element of the doctoral study programme should not be awarded ECTS credits.

3. Doctoral Programmes

Structured degree programmes which include coursework (in the widest sense of the term) should become a common feature of European doctoral studies.

Doctoral candidates should spend part of their research time at other institutions, preferably in foreign countries.

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 so-called “master-apprentice” system is that the doctoral candidate spends several years concentrating on a very narrow piece of research and loses skills and competences gained during the first and second cycles.

We must not forget that the research element of the doctorate 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 doctoral candidate continually looks outside the narrow area of the research project
- Problem-solving: one could perhaps say that the whole purpose of scientific training is to make the researcher capable of problem-solving at ever higher levels
- Communication and dialogue: communication and defence of results and discussion of their relevance.

The “coursework” on offer should be oriented towards these goals and be output- rather than input-oriented. It should also be oriented towards widening the perspective of the doctoral candidate.

Some examples of the elements which could well be involved are:

- Specialised lectures/courses (not only in the areas of the research projects of doctoral candidates)
- Lectures by visiting scientists
- Research seminars (not only within the doctoral candidate’s own research group)
- Workshops
- Participation in intensive schools
- Formulation of research projects and reports on their progress
- Lectures and/or posters presented at national or international conferences

4. Coursework and Credits

This document uses the term “credits” rather than “ECTS credits”. ECTS credits were devised originally for credit transfer and were based on the idea that an academic year corresponds to a certain total workload (in hours), set equal to 60 credits. The concept of an academic year with a certain number of weeks allocated to teaching, another to examination preparation, and a third to the examinations themselves, simply does not fit with the way doctoral studies are carried out.

There is no accepted definition of an ECTS credit for the third cycle.

Thus at present institutions can allocate credits in any form they wish. However, a definition of credit allocation must be given in the Transcript issued to the graduate. Otherwise the credit process is not transparent. Coursework must not necessarily count towards the award of a doctoral degree. Credits can be assigned to various items of coursework; successful collection of a prescribed number of credits may be made a prerequisite for the award of the doctoral degree.

Credits should be used to quantify the evaluated coursework component. These credits can however be ungraded; use of the national grading scale is of course possible.

The quantity of coursework (expressed in terms of doctoral credits) varies widely throughout Europe, the typical range being 15-30 credits. These should be distributed in such a way that more can be gained in the earlier phase of the programme.

More coursework than this should not normally be needed, although institutions are of course free to exceed 30 credits. It should however be remembered that award of a large number of credits to coursework may be seen as understating the research component of the degree programme.

Not less than 15 and not more than 30 doctoral credits should normally be required as part of the requirements for a doctoral degree.

In interdisciplinary programmes it may from time to time be necessary for doctoral candidates to take introductory courses at a level below doctoral level. Such courses should be assigned credits and included in transcripts, but should not normally count towards the award of the doctoral degree.

5. Further important elements of the doctoral programme

In general, there are two: teaching (as teaching assistants) and the training of key generic skills.

5.1 Teaching

Work as teaching assistants, which is a normal feature of the time spent on doctoral research throughout Europe (though the financial background varies enormously), has a very positive effect on the development of doctoral candidates.

Doctoral programmes should be flexible enough to include a component of teaching in the accumulation of ‘coursework’ credits. 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.

Initially, responsibility as a teaching assistant in a laboratory puts doctoral candidates in what can be a

difficult situation, as they undergo an instantaneous transformation from learner to teacher status.

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

5.2 Generic Skills

According to the Budapest Descriptor, third cycle degrees in chemistry are awarded to graduates who in addition to their scientific competences:

- 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
- are able to develop and apply methodology to the solution of novel problems, defining a strategy and an action plan to solve that problem.

Generic competences for the third cycle are necessary for entering the labour market and are addressing environments the candidate is likely to meet during any forthcoming career connected to his/her qualifications.

They presume original, independent and critical thinking. In addition to scientific competence, they include the ability to effectively develop in an industrial or other environment, to act independently and to have leadership capabilities. The future doctor in chemical sciences would therefore be open to future development on the following issues:

- the planning process – objectives, strategies, policies, decision making
- the structure and process of organization – authority vs. self-contained work, organizational flexibility, adaptability to novel situations, time management
- the management of human resources – qualifications vs. requirements, orienting new team members, team building, organization of individual tasks and duties, formulating motivation strategies
- the management of information – analysis, evaluation, synthesis and selection of complex concepts and facts
- the communication process – communication skills (including presentation techniques, language skills, writing of project proposals and reports), tutoring and training skills, ability for knowledge transfer and interaction with peers, audiences and panels, the scholarly community and society in general under multilingual conditions
- the development process – internal and external training, handling innovation
- the management of financial issues – facing budgetary and market-oriented questions, dealing with budgetary restrictions
- the process of controlling and assessing quality
- social responsibility and ethics.

Institutions must take the acquisition of generic competences into account when planning their programmes. Many of these competences can be acquired during the work on the research project, while others require coursework.

6. Transcripts

Institutions should issue transcripts containing information on all the coursework carried out, and on work done as a teaching assistant.

Such transcripts will however probably not use the standard European Diploma Supplement format.

The European DS should be taken as a model and modified to fit the necessities of doctoral programmes.

The European Diploma Supplement (DS) is not ideal for describing a doctoral programme; it 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.

This information will be much less detailed for a doctoral 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.

7. Graduate Schools

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 doctoral candidates.

The traditional "master-apprentice" system of doctoral training can keep doctoral candidates within the limits of the research group in which they are working, which can of course sometimes be very large, but may also be very small. The idea of "Graduate School" structures in which the individual doctoral candidate 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. It fits particularly well to interdisciplinary studies.

Ensuring critical mass and critical diversity in the research environment is central to successful doctoral education. In fact, achieving the critical mass for an inspiring research environment, and supporting it by transparent procedures, is the main challenge for structured programmes. Therefore, doctoral programmes should seek to achieve critical mass and should draw on different types of innovative practice being introduced in universities across Europe, bearing in mind that different solutions may be appropriate to different contexts and in particular across larger and smaller European countries.

While institutional graduate schools can readily become viable in major universities, international, national and regional collaboration between universities and also

* The term „Graduate School“ is used in a general sense. Other terms often used are “research school” or “doctoral school”.

between universities and external research institutions can be used to form wider graduate school networks.

Strategies for achieving critical mass will thus include the creation of institutional interdisciplinary doctoral programmes, creation of local/regional or national doctoral programmes or networks within specific disciplines, and finally creation of hybrid doctoral programmes combining on-line and in-campus lecturing and tutoring.

8. Supervision of Doctoral Candidates

It is obvious that in respect of individual doctoral candidates, arrangements for supervision and assessment should be based on a transparent contractual framework of shared responsibilities between doctoral candidates, supervisors and the institution (and where appropriate including other partners). Supervision should be tailored to meet the requirements of the individual doctoral candidate and his/her development. In any case, the main supervisor should be a recognised, active researcher with academic credentials and affiliation to a university. Each doctoral candidate should have at least one co-supervisor, with explicit responsibilities, while joint programmes should envisage multiple supervision, with perhaps three tutors originating from different countries.

Thus, strategies for transparent supervision include individually adapted supervision, multiple supervision, and a training and supervision scheme/agreement specifying the extent, mode and frequency of supervision.

Training for supervisors of doctoral candidates is something that is to be encouraged.

The academic community should seek to ensure that doctoral candidates get the best possible supervision, or at least guarantee a minimum standard.

In the situation of a dispute between doctoral candidate 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 doctoral candidate'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 doctoral candidate 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.

9. Final Doctoral Examinations

In doctoral examinations, institutions should consider the widespread involvement of external examiners. Examinations should be open.

There are many different ways in which doctoral examinations are organised across Europe. One extreme is a system involving only the doctoral candidate and two examiners (neither of whom, however, is the PhD supervisor). The other extreme is the completely open examination, with a "jury" of professors (including external examiners) or even participation by any professor in the department.

Whenever possible, international external examiners should be present and actively involved in the examination process. Systems in which the doctoral supervisor dominates the examination proceedings are outdated.

Examinations which are open to a wider audience (academics, doctoral candidates, students, even the public)

are in a majority in Europe, and should be made possible without the possibility of a veto by the doctoral candidate.

10. Assessment of Doctoral Candidates

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 doctorate is the quality and quantity of the research and its accurate, effective presentation in the thesis. Doctoral candidates 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.

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

11. Quality Assurance

Institutions as well as faculties/departments must have defined quality assurance procedures.

Quality assurance must encompass both the quality of doctoral training and the quality of research. Institutions must commit themselves to develop indicators based on institutional priorities.

12. Joint Degrees

A research project may involve research groups from more than one institution. In such cases, the award of a joint degree should be considered. Such a degree will naturally require that the doctoral candidate studies for six months **or more** at a second institution, with appropriate regulations regarding joint supervision, examination and assessment.

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