Good Practice Elements in Doctoral Training

Follow-on paper to

Doctoral degrees beyond 2010: Training talented researchers for society

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1. Executive Summary

Doctoral training has changed significantly in recent years. It is now widely recognised that doctoral graduates make significant contributions to innovation and that they need both a thorough and broad skill set to do so. With many graduates gaining employment outside of academia, the tradition of doctoral training only for replenishment of academia belongs to the past. This recognition has resulted in the growth of structured doctorates and institutional structures to ensure breadth and consistency of training at universities.

At the European policy level, the EU has included doctoral training as one of the priorities to build a European Research ERA (EC, 2012). In the 2012 paper on ERA, the EU invites research stakeholder organisations, including universities, to provide structured doctoral training based on the Principles for Innovative Doctoral Training (EC, 2011) and invites Member States to support the setting up and running of structured innovative doctoral training programmes applying the Principles for Innovative Doctoral Training.

LERU published its vision for doctoral education in a 2010 position paper entitled 'Training talented researchers for society: doctoral education beyond 2010'. In the present follow-up paper we document some of the practices that LERU universities have introduced, which demonstrate our commitment to the principles in the previous paper. The paper aims also to promote innovation in doctoral education by juxtaposing many of our existing ideas in the hope of encouraging ourselves and other universities to build on these ideas to grow and develop the scope and modes of provision and to promote collaboration in doctoral education.

The paper documents good practice elements in doctoral training at LERU universities in four different categories:

1. Much professional development for researchers is now done through formal workshop-style professional development sessions to develop skills which can then be put to use in research and will be valuable in future careers. Examples of good practice at LERU universities under this first category are given under the heading of '**formal research training'**.

2. A doctoral candidate's ability to drive initiatives is part of the process of becoming an independent researcher. Examples of opportunities provided by LERU universities in this category are described under '**activities driven by doctoral candidates'**.

3. The section on '**career development'** provides examples of activities at LERU universities to promote awareness of both academic and non-academic careers that are open to doctoral graduates, highlighting in particular some areas that are less well known to our candidates.

4. The fourth category '**concepts and structures**' describes some of the innovative structures that LERU universities have developed for managing and promoting innovation in doctoral programmes, particularly for providing international and interdisciplinary exposure.

There are many desirable commonalities between activities and programmes at LERU universities, but the examples given also illustrate a healthy diversity of practice and implementation. Moreover, as large comprehensive universities, LERU members engage continually in processes of development and refreshment of programmes in order to stay at the forefront of training tomorrow's talent. We encourage interested parties to look at the LERU universities' websites for further information on these programmes and on others that might interest them.

While our focus is primarily on good practice, there are also policy implications in relation to doctoral training to be made on the basis of the practical evidence given in this paper.

Therefore, we end the paper with recommendations not only for universities, but also for policy makers, governments, funders and employers.

Universities should, while keeping in mind the principles of excellence in doctoral training proposed in LERU (2010) and the innovative doctoral training principles developed by the EC (2011), provide a doctoral training system and mechanisms which include well-rounded, versatile and personalisable professional development opportunities and programmes, enabling doctoral researchers to take control of, track and self-assess their development with the necessary guidance from supervisory teams, so that, by the time of graduation, they are able to seek out those job opportunities that are best suited to their talents, expertise and skills. For this reason (but not only for this one), it is important that universities engage with various types of employers to ensure that professional development of researchers is fit for both academic and non-academic employment. Universities also have a responsibility to promote innovation and sharing of best practice in skills training within the university and beyond, using appropriate institutional, national and international networks and fora to share skills development provision.

Policy makers, governments and funding agencies should promote and support the principles for innovative doctoral training and seek ways to stimulate their uptake with the necessary flexibility, taking into account different aims and circumstances across countries, institutions and disciplines. They should furthermore ensure that funded programmes demonstrate their effectiveness in developing skills and independence in doctoral graduates, and they should support programmes that encourage intellectual risk taking and creativity, whilst not losing sight of other issues such as time to completion. Finally, they too should encourage continued innovation and sharing of good practice between programmes nationally and internationally.

Employers should engage with universities in the formation of doctoral graduates, in shaping and delivering training provision as well as through research, which is most beneficial through sustained contact and structured approaches. Such engagement is based on a common understanding that frontier research is the core business of research-intensive universities and that, through their unique capacity to bring together higher education, research and innovation, research-intensive universities are an essential asset in ensuring long-term competitiveness and welfare, locally and globally (LERU, 2011; AAU, C9, Go8, LERU, 2013)[1].

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[1] For more information about the joint statement issued by the AAU, C9, Go8 and LERU on the characteristics of research-intensive universities, see http://www.leru.org/index.php/public/international-collaboration/.

2. Introduction

There have been significant changes in doctoral education in Europe in recent years. Three drivers have led many universities to introduce change: the first is the recognition that many doctoral graduates seek employment outside the academy and their high level skills are much sought after, secondly that the model of the lone scholar is no longer appropriate, and thirdly that heavy reliance on a single PhD supervisor guiding the development of the PhD candidate is not robust.

This has led to the development of structured PhDs where 1) doctoral programmes bring together cohorts of candidates and include elements of professional development training, regular involvement in activities of research groups such as seminars and journal clubs, teaching, sometimes also technical courses, and where 2) institutions have central or overarching administrative structures such as one or more graduate or doctoral schools to support doctoral programmes. These elements are an integral, although usually only a relatively small, part of the total programme allowing PhD candidates to concentrate on their research towards the doctorate, firmly anchored in a rich research environment with access to colleagues outside of their supervisory team to interact with. Candidates are overseen by a supervisory team sometime involving experts beyond the awarding university.

The professional development training develops a range of skills that help PhD candidates to be more effective in their research but also to work on a broader range of skills that will be useful in their future lives and careers. These skills are often known as transferable skills. In the UK, VITAE has developed the Researcher Development Framework (RDF), which "articulates the knowledge, behaviours and attributes of successful researchers and encourages them to aspire to excellence through achieving higher levels of development"[2]. Skill development should be driven by the doctoral candidates themselves, in consultation with their supervisory team, to help them to mature and become independent both in their research and in their personal development.

LERU first published a position paper on the need for excellence in researcher training in Europe (LERU, 2007), followed by a second position paper presenting a vision for the future of doctoral training in Europe (LERU, 2012). In the latter we argue that the doctorate is primarily about training 'creative, critical, autonomous intellectual risk-takers'. The primary output is trained researchers who produce a thesis as documentary evidence of their original ideas and evidence to support them. An examination or defence demonstrates that the doctoral researcher can communicate and defend his/her own complex ideas and see his/her work within the context of the work of others. We also believe that a researcher should be trained in an environment that is international (research is international business), interdisciplinary (all research pushes disciplinary boundaries) and intersectoral (research must serve society, therefore it is important that its wider context is understood[3]).

The European Commission has supported LERU's ideas by developing 'Principles for Innovative Doctoral Training'[4] (EC, 2011) and by including doctoral training as one of the priorities to build a European Research (ERA). In particular, on 17 July 2012 the EC published a Communication on ERA (EC, 2012), in which it invites research stakeholder organisations, including universities, to provide structured doctoral training based on the Principles for Innovative Doctoral Training (IDT) and invites Member States to support the setting up and running of structured innovative doctoral training programmes applying the IDT Principles. On the same day, LERU and the European Commission signed a Memorandum of Understanding on the further realisation of ERA, in which LERU commits itself to encourage its member universities to carry out, by the end of 2013, a number of actions on open recruitment, research careers, gender, mobility, doctoral training, open access, knowledge transfer, e-science and scientific cooperation. Together with other stakeholder organisations and the

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[2] For more information on the Researcher Development Framework (RDF), see the VITAE website at http://www.vitae.ac.uk/researchers/428241/Researcher-Development-Framework.html
[3] And of course many doctoral graduates will indeed leave the academy and thus need experience beyond the sector.

EC, LERU then also signed a Joint Statement "on working in partnership in achieving the European Research Area".

The present paper revisits the principles put forward in the LERU (2012) paper, reporting on how they are implemented at LERU universities and giving examples of innovative practices, steeped as they are in the research-intensive environment of broad-based universities. The examples are described briefly but interested readers are welcome to contact each university directly. Web references are given where possible. The paper furthermore draws conclusions from our good practice examples, which are formulated at the end as recommendations for providers of doctoral training, for policy makers, governments, funders, and for employers to demonstrate some of the many opportunities available to doctoral candidates. We hope this LERU advice paper will help to highlight the value of universities delivering highly talented and thoroughly trained doctoral graduates with expert skills, who are deployed in a wide variety of jobs and employment sectors.

The body of the paper is organised into four sections, illustrating the implementation of the principles with examples from the LERU universities from four perspectives: 1) **formal research training**, with examples of formal activities where candidates are brought together to discuss and learn aspects of research training that they have in common, 2) **activities driven by doctoral candidates**, including both personal development and research activities, 3) **career development** for both academic and non-academic careers, and 4) **concepts and structures** in which some innovative changes to governance and collaboration are described.

3. Formal Research Training

One of the key changes in doctoral education in recent years has been the introduction of a wide range of professional development training. This was pioneered in the UK following the 'SET for Success' report (2002) by Sir Gareth Roberts, who reported that doctoral graduates' skill sets were too narrow and that all programmes should include the provision of at least two weeks dedicated training a year, principally in transferable skills. The eighth of the Salzburg Principles on doctoral training of the Bologna Process was 'the promotion of innovative structures to meet the challenge of interdisciplinary training and the development of transferable skills' (EUA, 2006). In the UK, Vitae published the Researcher Development Framework (RDF) in 2010, which divides skills into four domains and 12 subdomains. All universities in the UK with doctoral programmes have pursued this agenda vigorously.

From professional development programmes doctoral candidates are able to develop formally the skills they need for their project and for their future careers, without having to rely on their supervisor(s) for this training. By 'formal' here we mean organised programmes where candidates come together to explore specific skills, in contrast to informal training which is done on the job. Doctoral graduates become more prepared for the workplace in both academic and non-academic organisations. They identify their own training needs in consultation with their supervisory team - this aspect is discussed below in the section entitled self-assessment and self-awareness. The programmes also have the benefit of developing research networks beyond their own discipline for a future research career which is unlikely to stay in one narrow domain. All LERU Universities now offer comprehensive professional development programmes for researchers.

LERU's 2010 report, 'Doctoral Studies beyond 2010', categorised the skill set developed during a PhD into intellectual, academic and technical, and personal and professional development skills:

❖ Intellectual skills, which comprise the ability to

- think analytically and synthetically

- be creative, inquisitive, and original

- take intellectual risks

- deploy specific technical research related tools and techniques

❖ <u>Academic and technical skills, which comprise the ability to</u>

- understand, test and advance complex theories or hypotheses and to deploy sophisticated concepts, methodologies and tools in the chosen subject to a very high level

- be able to identify issues and translate them into questions amenable to scholarly enquiry

- successfully pursue original research in the chosen field

- use critical judgment in an objective manner based on verifiable evidence

- apply highest standards of rigour in the proof of ideas

- manage a high degree of uncertainty both in method and in outcomes

- develop and demonstrate academic credibility and become recognised as a member of an international scholarly community

- understand the workings of a specific high level research-intensive environment

- transfer new knowledge to scholarly communities and communicate it to society

- work according to ethical principles

- work in an interdisciplinarity setting or on an interdisciplinary topic

❖ <u>Personal and professional management skills, which comprise the ability to</u>

- persist in achieving long terms goals

- manage projects with uncertain outcomes in diverse settings and organisations

- take a project through all its stages: from developing the original idea, to developing a plan, garnering the evidence, and communicating the results and their significance

- be self-motivated and autonomous

- work to achieve results with minimum supervision

- be flexible and adaptable in approaching complex and uncertain problems

- communicate very complex concepts

- network internationally

- work in a team

- speak and present effectively in public

The following skills are sometimes also developed:

- the ability to lead other researchers

- the ability to teach and train others

- the ability to organise conferences and workshops

These skills may be developed as part of the research project but are specifically addressed in formal training programmes. Inevitably there is overlap between these headings. In the following sections we present some of the innovative practices at LERU universities in each of the three skill set areas listed above.

3.1 Intellectual Skills - analytical and synthetic thinking, creativity, encouraging intellectual risk taking

Masterclass Inspiring Research (UCL)

UCL's Skills Development Programme covers a wide range of transferable skills workshops that support students through all stages of their degree with 250 distinct courses (12,000 registrations for over 650 events in 2012/13). The programme covers all areas of the Researcher Development Framework (RDF). One particular course aimed at developing broad intellectual perspectives is the UCL Masterclass – Inspiring Research: a programme of talks and workshops designed for researchers to hear from, interact with and be inspired by eminent academic researchers. The event is very informal and it gives students the chance to listen to and talk to senior members of the global research community. Recent events have included discussions with distinguished UCL professors of Cardiovascular Pharmacology, Cognitive Neuroscience, and the History of Anglo-American relations. The events are open to doctoral candidates of any discipline.

http://courses.grad.ucl.ac.uk/

Facilitating more creative research (Imperial College London)

Partly funded by Vitae, Imperial undertook a project to better support researchers in being creative, particularly seeking to encourage them to 'think big' and facilitate intellectual risk-taking. This project enquired into the understandings and attitudes of doctoral researchers towards creativity. Some evidence was found of negativity about creativity and its value and relevance to scientific work. In extreme cases, researchers only associated creativity with art rather than science. There was a suggestion that the 'Impact' agenda and funding cuts are pushing researchers further in an 'anti-creativity' direction by adding to conservatism and casting creativity as an unaffordable luxury. The findings of the research element of the project were disseminated to establish and strengthen a positive message about creativity and its essential role in scientific and technological research, especially in financially straightened times.

By interviewing researchers with a range of experience, the project also sought to capture sound advice on how to practically support early career researchers in doing creative research. Three items emerged as being crucial for the realisation of creative research. Firstly, the research culture must be positive, e.g. researchers need to experience the appropriate balance of support and freedom. Secondly, there needs to be plenty of communication, both formal and informal, for ideas to flourish. Thirdly, researchers simply need 'permission', time and space to be creative. Three good practice guides (one for supervisors, one for postdocs and one for doctoral researchers) expanding on these basic findings and giving detailed practical guidance were published and disseminated.

http://www3.imperial.ac.uk/graduateschool/studentexperience/creative

Research Skills Toolkit (Oxford University)

The Library Service and the Computing Services have combined efforts in development and delivery of the Research Skills Toolkit. The Toolkit explores IT & Library tools, tips and techniques to support researchers in their work, presented in a way which connects the tools to particular stages in the research cycle. After a short introductory session, students can access the web-based contents.

http://www.skillstoolkit.ox.ac.uk/

3.2 Academic Skills - managing uncertainty, scholarly networking, understanding of high level research-intensive environment, knowledge exchange/transfer, ethical principles, interdisciplinarity

Kickstart to Academic Life (**Lund University**)

The Kickstart to Academic Life course provides PhD candidates with generic knowledge (knowledge that is not discipline-specific) about how to conduct one's PhD studies when it comes to the two key domains of information management and publication processes. It is intended to give a kick-start to their PhD studies. The course is not a course in methodology or theory of science. It is, instead, a course in the practicalities of research that lie outside scientific methods but nevertheless structure the work of producing a PhD thesis. The course combines an introduction to the process of managing one's need of information as a PhD candidate, and an introduction to the process of managing the publication of one's results.

Concerning the process of information management, the course introduces the PhD student to structured information searches combined with the use of reference management software (e.g. Endnote). It also introduces two evaluation and bibliometric tools, describing the rationale and roles of these tools in the publication process. Concerning the process of publishing one's results, the course introduces the PhD candidate to the specificities of academic rhetoric in speech and in writing, features the differences between monographs and compilation theses, and provides grounds to design a publication strategy adapted to any of these. It also provides a theoretical and practical introduction to the ethical and stylistic rules of referencing. The course further introduces PhD candidates to the grant application process and teaches them to assess if a project should be subjected to a formal ethical review or not, and to plan their future career.

The course is meant to be taken early in the programme of PhD studies, preferably no later than the first year.

http://www.sam.lu.se/o.o.i.s/32688

Academic Professionalism (University of Utrecht)

At Utrecht University, every PhD candidate is a member of one of six graduate schools. These graduate schools are responsible for the training and supervision of PhD candidates. Every PhD student has a Training and Supervision Agreement that is signed off by the director of the graduate school, specifying the proposed training programme. Graduate Schools offer courses both in transferable skills and in more specific skills related to areas of research. A good example of a course offered by our graduate schools is the Programme Academic Professionalism, offered by the Graduate School of Humanities for first-year PhD students. The programme Academic Professionalism helps candidates improve their personal effectiveness, which in turn enables them to finish their thesis successfully and on time. Academic Professionalism consists of several modules concerning topics that are relevant to all PhD students. By means of coaching and peer meetings the participants receive structured and continuous support which fits their specific personal situations. The programme is focused on activating and developing the PhD students' independence.

http://www.uu.nl/faculty/humanities/en/organisation/schools/graduateschoolofhumanities/phdprogrammes/courses/pages/deafult.aspx

Bioethical training (University of Barcelona)

The Bioethics and Law Observatory at UB is a research and knowledge transfer centre working on the ethical, legal and social implications of biotechnology and biomedicine for both doctoral candidates and postdoctoral researchers. The Observatory offers customised training for organisations and also educational packs. Particular groups often require specific tuition channelled

towards solving concrete interests and needs. Customised courses provide bioethical training, both theoretical and practical for ethics committees, members of which require specific knowledge and training oriented towards the analysis and satisfactory solution of the ethical aspects of research and patient's treatment. Courses are also designed for various different types of legal practitioners, and other professionals whose activity has to deal with particular bioethical problems.
http://www.pcb.ub.edu/bioeticaidret/index.php?option=com_content&task=view&id=46&Itemid=61

The 'Open' Programme (UCL)

The 'Open' is a collaborative leadership development programme which helps researchers to initiate collaborative and interdisciplinary projects. It is a multi-institutional programme that offers a friendly, supportive and managed risk environment in which to activate or build professional networks and learn public and industry engagement techniques.

3.3 Personal and Professional - research project management, communicating complex concepts, team work (especially if research specific) leadership in research, teaching, conference organisation, collaboration and communication with non-specialists.

Leadership in Action (UCL)

UCL runs an experiential leadership programme "Leadership in Action" in collaboration with other universities designed to prepare researchers for leadership roles in any chosen research field. Participants have the opportunity to lead various activities, practice their unique leadership styles and receive coaching.

Developing the mental toughness and resilience to sail through the PhD (UCL)

It is estimated that mental toughness accounts for 25% of our performance. This interactive workshop gives researchers the opportunity to test their level of mental toughness and to find out the qualities required to increase it. This leads to better performance, wellbeing and an improved work life balance. Researchers get personal professional coaching to help them implement their development actions.

Understanding Decision Making Preferences (University of Oxford)

The Careers Service has recently started offering Myers-Briggs Type Indicator (MBTI - a psychometric questionnaire designed to measure psychological preferences in how people perceive the world and make decisions) group sessions for researchers, recognizing the usefulness of MBTI for doctoral students in thinking about their personal style and preferences, essential to effective career planning. The workshop involves multiple facilitated exercises to allow students to learn from one another and enable understanding of different perspectives while establishing their best fit personality type and learning more about how this can help them in their career planning.

Commercial Awareness for Science and Engineering Researchers (University of Oxford)

This was an initiative of a Chemistry Masters student who saw how 'the finishing DPhils in my research group are struggling to find a job, research or commercial'. The student supplemented the alumni panel events offered by the Careers Service and organisations such as Oxbridge Biotech Roundtable, negotiating the use of college venues and finding his own speakers for three events on Research in Industry, IP and Patent Law, and Entrepreneurism, open to all Science and Engineering researchers.

Qualification courses for PhD candidates and postdocs (University of Zurich)

At UZH, a total of about 280 courses per year are offered to PhD candidates and postdocs on topics such as methods for research & academia (e.g. acquisition of funding, teaching, writing/publishing, presentation etc.), personal development (leadership, self-/time-/stress-management, ethics, etc.), non-academic careers (job application training, self-evaluation, economic know-how, etc.). The courses are in German or English and those for PhD candidates typically last two to three full days. These courses are organised by different divisions of the University such as the Graduate Campus, the Center for University Teaching and Learning or the Career Services. A list of all courses for the current semester is available at http://www.grc.uzh.ch/phd-postdoc/courses-uzh_en.html. In addition, the Language Centre offers 400 courses each year in nine European languages as well as Arabic, Chinese, Russian and Japanese.

Entrepreneurship (KU Leuven)

Intellectual risk taking, management and entrepreneurship have been identified as the most underdeveloped skills in young doctorates. To meet this need, the tech transfer department of KU Leuven, in collaboration with industry, has initiated a course 'Technology & knowledge transfer, exploitation of research'. In a first step, participants are informed about collaborating with industry, starting a spin-off company, managing intellectual property and resources for funding of the innovation process, during a four-day course. Subsequently, the participants join in small groups to make a business plan based on their own idea, which is ultimately presented and defended in front of a professional jury.

The KU Leuven has developed a competence profile for doctoral students. This profile should draw attention to more non-academic skills such as management and communication during the course of doctoral research. Especially these skills prove to be very important in the present job market. A thorough command of these skills can facilitate the transition to the job market.

Combining commitment and flexibility (University of Amsterdam)

PhD education at the Graduate School of Humanities (GSH) is a combination of obligatory and optional skills courses (including organisation of PhD project, cooperation, networking, communication, presentation, and preparing for future employment, 12 skills courses in total) and content-based coursework (at one of the local research institutes or a national research school).

Four skills courses are obligatory for each PhD candidate: PhD Project Management, Career Orientation, Advanced Academic Writing, and Presentation Skills. The other eight skills courses are electives. By offering a mixture of obligatory and elective courses, the Graduate School of the Humanities emphasizes the importance of the educational part of the PhD trajectory but offers at the same time tailor-made programmes for all PhD candidates. Flexibility in meeting the educational needs of the individual PhD candidates is important; it is guaranteed by the following rules and practices:

- PhD candidates choose their elective courses in consultation with their supervisors.
- PhD candidates become a junior member of one national research school, but they have the option to follow discipline specific courses from all other national research schools in the Humanities.
- GSH facilitates the skill courses and the teaching of UvA faculty in the research schools. For the PhDs all skills courses and disciplinary courses are free of charge and each PhD candidate has a personal budget of 1,000 euro per year for other education (e.g. additional foreign language courses and additional academic and professional skills courses).

Centre for Leadership and People Management (LMU Munich)

The Centre provides a specific human resource development programme that promotes and facilitates the academic excellence of junior and senior faculty. Special services for PhD students are courses on Leadership and related topics.

http://www.en.peoplemanagement.uni-muenchen.de/index.html

Communication, engagement and policy (UCL)

The programme offers a coherent public engagement strand relevant to students from all disciplines. This is a comprehensive programme run by three different departments (UCL Department of Science and Technology, the UCL Public Engagement Unit and the Public Policy Unit) that provides researchers with the opportunity to work with expert practitioners to develop their own public engagement activity: from creating the idea to project planning and partnership start-up, sourcing funding and evaluating success.

Individual Training Plan (UPMC)

Early in the doctorate, each PhD candidate must, in consultation with her/his supervisor, elaborate an Individual Training Plan (ITP), which is validated by the doctoral school (ED). This ITP evolves as needed throughout the PhD. Training is organised by the Doctoral Training Institute (IFD[5]), by the doctoral schools (ED) and by external partners. The ED is responsible for a proper balance of the ITPs between scientific and transversal training. The IFD training policy is based on the accountability of all actors, through information, counselling, accompaniment and encouragement, and not on a requirement of equal training volume for all: all candidates do not have the same needs for training. Nevertheless, IFD recommends an average of 5 to 10 days of training annually over all topics.

The key message that the IFD wants to give to PhD candidates and their supervisors is that the more doctoral candidates anticipate the preparation for their career, the greater will be their job satisfaction and the easier their job search. This message is confirmed by surveys of UPMC doctors: we found that the risk of being unemployed, even several years after PhD, is lower for doctors who start to plan their professional project and their job search early. Similarly, 76% of the doctors who are 'very satisfied' in their first job after their doctorate started planning their professional project before the last year of their doctorate.

http://www.ifd.upmc.fr/fr/formation/catalogue.html

Centre for Entrepreneurship "Fundació Bosch i Gimpera" (University of Barcelona)

The Centre promotes entrepreneurship through a programme to help create new technology-based spin-offs and to provide resources. In collaboration with the Bosch i Gimpera Foundation, UB organizes seminars related to creativity. The Bosch i Gimpera Foundation (FBG)* focuses on promoting and managing the transfer of the knowledge and technology generated at the University of Barcelona. Its goal is to bring the scientific and technical skills and the results of the research generated at the UB to the market by means of contracts, consultancy services and the protection, valuation and licensing of patents and the creation of new knowledge-based enterprises.

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[5] See section 6.1 further in the paper.

The University has created a Chair in Entrepreneurship with support from a private sector bank to strengthen the academic dimension of company formation and to promote initiatives that can help students with entrepreneurial interests to acquire knowledge and skills they need to be successful. The chair works closely with the Business Creation Centre run by the Bosch I Gimpera Foundation.

http://www.fbg.ub.edu/index.php?option=com_content&task=view&id=67&Itemid=123&lang=english

4. Activities Driven by Doctoral Candidates

A vital part of doctoral training consists of ensuring that the doctoral graduates are able to work autonomously, are strongly self-motivated and that they become 'drivers of their own professional development'. Europe needs independent entrepreneurial thinkers – and doers - to help drive innovation in the European economy, and specifically the European Commission's Horizon 2020 agenda. Doctoral training should foster this. To achieve this doctoral candidates need advice from their supervisory team and other colleagues inside and outside the university, but most of all they need opportunities to try out ideas. We learn from training with practice.

In this section we highlight opportunities where doctoral candidates are given opportunities to lead and drive activities related to their research area, nationally and internationally, and in their own personal development. The examples are given in three sections: skills awareness and self-assessment, student-led activities, and international research student networks.

4.1 Skills awareness and self-assessment

Skills Review and Training Needs Analysis (University of Oxford)

Research students are actively encouraged to review and discuss their skills with their supervisor throughout the duration of their doctoral studies, beginning when they first arrive with the identification of strengths and weaknesses. Having identified their training needs with their supervisor, students are supported in finding the training they need by providing them with 'menus' of training courses that give access to a wide range of training, delivered in a variety of formats. As a specific example, the Social Sciences Division has introduced and embedded a Skills Review and Training Needs Analysis (TNA) for all their research students; a key part of the TNA framework is a section which covers career development. The University's termly reporting system has been developed to prompt regular consideration of skills training opportunities by both students and supervisors.

On-line Research Student Log (UCL)

Research students and supervisors monitor project progress through the use of UCL's *Research Student Log,* a research project management tool that helps to ensure quality of research programmes. Students identify their training needs through the use of an online *Skills Self-Assessment Tool* that covers all RDF[6] categories and has been included in the Research Student Log. Through a series of open-ended questions, the self-assessment tool helps researchers identify their needs and have further discussions with their supervisors to guide their development.

At UCL, researchers have a dedicated session that focuses on skills awareness and self-assessment: Introduction to Skills Development and the Research Student Log. The session aims to encourage

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[6] Research Development Framework - http://www.vitae.ac.uk/researchers/428241/Researcher-Development-Framework.html

students to identify their own training needs and take charge of their development by becoming independent professional researchers.

https://researchlog.grad.ucl.ac.uk/

Researcher-Led Initiative Fund (University of Edinburgh)

The University of Edinburgh's Researcher-Led Initiative Fund is available for specific projects, activities or events initiated by research students or research staff for the benefit of groups of researchers at a School, research unit or research group level. The aim is to allow researchers themselves to have a greater input into the ways they are supported and developed and to complement the training and development opportunities provided through Schools and at a College or University level (e.g. through the Institute for Academic Development and Careers Service). The hope is that this initiative will encourage research students and research staff to think more creatively and proactively about ways in which this fund might facilitate and enhance their generic skills development.

The Fund gives researchers greater input into the ways they are supported and developed at the University, creates and promotes a range of development ideas and approaches, and fosters the use and building, of generic skills for those directly involved in these funded initiatives (e.g. working in a team, communication skills, project planning, project management, leadership, etc).

http://www.ed.ac.uk/schools-departments/institute-academic-development/postgraduate/doctoral/funding/researcher-led

Feedback by PhD candidates (University of Amsterdam)

The following system of feedback on the programme by the doctoral candidates themselves has been set up by the Graduate School of Humanities (GSH). The Dean and other representatives of GSH meet with the Graduate Studies Committee (GSH's advisory board existing of the four directors of the local research institutes and five representatives of the PhD candidates) on a regular basis. They also have consultations with a delegation of the Humanities PhD Council on educational matters. At the end of each academic year the skills programme is assessed and adjusted on the basis of the outcome of these meetings as well as individual evaluations. Each PhD candidate is invited to fill in an evaluation form.

4.2 Candidate-led activities

Doctoral Candidate Association Doc'Up (UPMC)

Since January 2006, Doc'Up has been the doctoral candidates' association at UPMC. Its aims are to promote doctoral training and to allow all its members to engage in concrete actions highlighting their doctoral training. Doc'Up aspires to bring together doctoral candidates from all disciplines and promote their networking by organising events: breakfasts, aperitifs, dinners, or discussion forums. Doc'Up informs candidates on job perspectives, putting them in contact with private or public stakeholders, mostly doctors themselves, and synthesising information and disseminating it to the greatest number. Doc'Up is committed to defending the candidates' rights by promoting their participation in the academic representative bodies, both at UPMC and national level. Beyond these "missions", Doc'Up is also there to help doctoral candidates to valorise their training by such actions as the festival "Researchers do their Cinema."

Doc'Up has the ambition to create a scalable network of doctoral candidates. It operates with project teams. Each member of the association can join a team according to her/his desires, skills and availability. Members can propose new activities thus becoming project leaders, or join an existing

team. Their involvement helps renewing active teams but also to develop new projects.

Networking (University of Freiburg)

The university-wide doctoral candidate initiative Prodoc works to increase the visibility and codetermination of the university's doctoral candidates. Prodoc has its own office with a lounge, which serves as a central meeting point for exchange among the members of the initiative. The doctoral candidates in the various structured programmes generally have a voice in the programmes, are represented in their governing bodies, and have influence over the selection of new scholarship recipients. Since most of the doctoral candidate representatives of the programmes are also members of Prodoc, there is active networking between all of the doctoral candidate representatives at the university.

www.prodoc.uni-freiburg.de

Involvement in Governance (University of Zurich)

One important feature of the University's Graduate Campus is that doctoral candidates and postdocs are actively involved in the development of the Campus and in defining and shaping what it has to offer. Six junior researchers take part in the decision-making boards of the Graduate Campus. They are regarded as independent junior researchers, whose voice and opinions are taken seriously and contribute to the decision making process of the Graduate Campus. Through their function as representatives of the doctoral candidates and postdoctoral researchers, the visibility of junior researchers is increased within the University and in the governance of the University.

As board members, the representatives participate in the planning and evaluation of offers of the Campus and decide on the allocation of funds for PhD candidates and postdocs. In this capacity they discuss with professors and coordinators of doctoral programmes and, furthermore, gain insights into the structure, discussions and management of a multi-disciplinary university. By taking part in the allocation of grants, the representatives of junior researchers study and evaluate proposals for interdisciplinary projects, thereby exposing themselves to a wide array of research areas and expanding their scientific horizon.

The representatives in the boards furthermore take initiatives to establish new events such as a monthly meetings of junior researchers and regular information and networking events for postdocs and experienced PhD candidates with topics relevant to a scientific career.

http://www.grc.uzh.ch/phd-postdoc/forum_en.html

Funding for self-initiated, self-organised, interdisciplinary projects and peer-mentoring groups (University of Zurich)

The Graduate Campus allocates funding to junior researchers for interdisciplinary activities (e.g. workshops, lecture series, etc.) and peer-mentoring groups which are initiated and organised by PhD candidates and postdocs at UZH. With this measure, teams of junior researchers can combine the expertise and knowledge of different research areas not only through discussions among the junior participants themselves but also by the invitation of (international) speakers. With the funding they receive, they are enabled to implement their own ideas, invite renowned professors and to create a broader network among junior researchers at UZH. Proposals can be submitted several times a year and are funded by up to CHF 10,000 (approx. EUR 8,300).

http://www.grc.uzh.ch/calls/grants_en.html

Doctoral candidate led networking/ conference organisation (University of Oxford)

The Annual DPhil Day is an opportunity for research students from across the Medical Sciences Division to formally present and discuss their work. The diversity of departments in the Division, from Molecular Medicine to Experimental Psychology, gives students the chance to communicate their work to a non-specialist audience. In addition, the mainly student audience creates an atmosphere which encourages everyone present to ask questions and join in discussions. This event is arranged and delivered by research students from the Medical Sciences Division.

A similar event in Philosophy led to the development of student-led training on conference organising. Two doctoral students in Philosophy (organisers of the Philosophy Faculty's large annual postgraduate conference) coordinated a Humanities Division workshop on organising conferences. An output from the workshop was a Web-based conference-organising wiki which is an active and sustainable resource.

Researcher- and graduate student-led groups and seminars, such as Females in Engineering, Science and Technology (FEST) enable free exchange of ideas and dialogue.

Early scientific independence, group building, cooperative supervision (University of Heidelberg)

In the *Heidelberg Graduate School for Fundamental Physics*, doctoral students are eligible for add-on funding for workshops, to invite guest speakers, to accompany advisors in the course of sabbaticals and to visit other research institutions within the international educational and the "learning at the frontier of research" programmes. All these measures serve to foster creativity, intellectual risk-taking and early scientific independence of doctoral students. Moreover, doctoral students are part of Young Researcher Groups, which have proven to influence the academic environment of the doctoral researchers significantly and positively, supplementing the relationship between doctoral student and supervisor by a strong interaction with advisors, postdoctoral researchers and peers.

Another example of successful group building comes from the *Graduate Programme for Transcultural Studies*. Pursuing a doctoral project in the humanities even nowadays tends to mean work mostly individually in libraries, archives etc. with little exchange beyond the specific community. New research questions and approaches, such as the transcultural, require the individual to look beyond the classical disciplinary frameworks. Although challenging for the individual, students have unanimously reported that the aspect of working in a group is essential for a successful doctoral project. Doctoral students are provided with a room of 12 to 16 workstations, where each students has his/her own desk, shelf, PC etc. The dynamic of the spirit of working together – however unrelated the projects may be – is experienced as a big asset towards one's own success. The University is furthermore supportive towards the groups' self-organisation by encouraging group events beyond research and training.

In the Graduate Schools, but increasingly also in fields without structured doctoral programmes, elements of cooperative supervision and mentoring have become the norm. In addition, the University of Heidelberg has appointed ombudsmen for doctoral students who can be contacted in cases of scientific misconduct or conflicts between supervisee and supervisor.

International Graduate Academy (University of Freiburg)

The University's International Graduate Academy (IGA) and the structured doctoral programmes promote and encourage bottom-up initiatives from doctoral candidates of all faculties. For example, doctoral candidates have the opportunity to organise a mini-conference and to decide for themselves which speakers to invite. By way of illustration, doctoral candidates organised the iCoNeT PhD conference "Spiking Neural Networks – Dynamics, Structure and Plasticity". Another conference

planned and organised with the help of doctoral candidates was the summer academy "Hierarchized communication - Representation and Class Consciousness in the Middle Ages". Since the participants themselves determine the content and programme together, these research groups largely reflect the research interests of the doctoral candidates. In order to promote bottom-up networking on the part of doctoral candidates, the IGA also regularly publishes calls for proposals offering financial support for networking projects.

Train and Engage (UCL)

Postgraduate students who have good ideas for activities that involve people outside the university can apply for grants of up to £750. The programme provides training, advice, guidance and resources to support designing, developing and delivering researcher's own public engagement project.

Funding Initiatives (LMU Munich)

The GraduateCenter^{LMU} offers financial and conceptual support for events that are specifically designed for doctoral students and in which doctoral students actively participate in defining the content and the organisation. The spectrum of funded events ranges from workshops focusing on a particular topic to faculty-wide doctoral students' days. More than 35 events have been supported since 2009. Two examples are:

<interact> - providing a platform for young life science researchers in Munich to exchange knowledge, discuss about science and build a network to support their current projects and future aspirations. Renowned international keynote speakers, talks by graduate students and poster sessions are the main core of the symposium. Since 2008 <interact> has attracted more than 300 participants each year. www.munich-interact.org

Languagetalks - an interdisciplinary series of conferences organised at regular intervals by members of the two structured PhD programmes, ProLit and LIPP, at the Faculty of Languages and Literatures at LMU. The distinctive feature of Languagetalks is its interdisciplinary character. The conference aims to provide a forum in which current discourses can be taken up, developed and, if possible, extended beyond the boundaries of the subjects of language and literature. Specialists from the field are invited to give guest lectures. The results of the conference are published as collections of essays. (www.languagetalks.fak13.uni-muenchen.de

4.3 International doctoral candidate networks

Internationalisation at home (KU Leuven)

International orientation is an important focus point at KU Leuven. With 35-40% international PhD students, 'Internationalisation at home' is contributing to exposure of young scientists to different scientific traditions and cultures. But several funding schemes also facilitate short and long international experience. The largest scheme is called JuMo (Junior Mobility) which co-finances international stays for 6-12 months. In addition, co-financing schemes for short stays (2-4 weeks) exist, to learn a technique, perform a specific set of experiments, or to establish a collaboration. Finally, attending international meetings are co-funded through several schemes.

International Partnership programmes (University of Freiburg)

The University of Freiburg encourages doctoral candidates to engage in interdisciplinary and international networking. Funding is available to support trips abroad, invite visiting scholars, etc. This is seen not only in the numerous partnerships the University's programmes maintain with several institutions abroad but also in the members of the programmes themselves, approximately one third of whom (ca. 1,000 doctoral candidates) are from abroad.

There is particularly close contact and exchange between the members of the EUCOR network (Freiburg, Strasbourg, Basel, Karlsruhe, Mulhouse), motivating the Presidents and Rectors of these universities to sign a joint agreement on increased support for bi-nationally supervised doctorates (co-tutelle) within the confederation and to publish an informational brochure on the topic. http://www.iga.uni-freiburg.de/Nachrichten/cotutellede.pdf.pdf

Doctoral candidates at the University of Freiburg receive funding from various sources. All programmes offer scholarships and/or research and teaching positions, and many also provide funding for travel costs. In addition, doctoral candidates can also apply for a scholarship to cover their travel to a conference. These travel scholarships are awarded in a competitive procedure and allow doctoral candidates of all disciplines to present their findings at international conferences and symposia and establish contact with internationally renowned researchers.

http://www.iga.uni-freiburg.de/Nachrichten-en/reisestipendien.

Another service is a language tandem programme), which supports doctoral candidates who intend to share their native language with a partner and thus to improve their foreign language skills.

(http://www.iga.uni-freiburg.de/Angebote-en/tandem

Training scientists from developing countries (LMU Munich)
The vision of the Centre for International Health (CIH^{LMU}) is to enable developing countries to develop their own strategies on how to solve their health related problems. Training of scientists that can plan and conduct research is therefore a major aim of the CIH^{LMU}, in accordance with the human resource crisis in health services in developing countries, as declared by the World Health Organisation. At LMU Munich a three-year PhD programme has been specifically developed for health professionals from developing countries to acquire high quality research and in parallel carry out an ambitious research project in their countries of origin. The curriculum is designed as a sandwich programme offering up to one year of course work in modules to enhance research and personal skills. The research skills part comprises study design and research ethics, literature search, publication skills, and biostatistics, capacity for leadership and management in a health system as well as epidemiology and public health, environmental and occupational health, and policymaking. This part is organised at LMU Munich. The practical research part is conducted for two years within established research settings in the students' home countries. During this period each PhD candidate is mentored by a local supervisor. In addition the PhD candidates keep a web-based log file for documenting their progress and receive regular feedback from the LMU Mentor. The degree (PhD) is awarded by LMU Munich. Financial support is given by German Academic Exchange Service (DAAD) (2009-2017*).

International professional skills development opportunities and research placements (Imperial College London)

To enable our doctoral researchers to have international experience during their degrees, Imperial has established international collaborative professional skills development summer schools with partner universities in Asia, including NUS and NTU in Singapore and Hong Kong University. Wherever possible other institutions have been invited to participate to expand the opportunities for global networking. Most recently, students from one of the Indian Institutes of Technology joined the programme in Hong Kong. Students spend five days working in interdisciplinary teams, solving a number of problems and creating collaborative research proposals to tackle global challenges. The

Imperial students then stay on in the hosting country for three weeks to undertake research mini-placements.

Although the duration of the placements is very limited, the researchers have found them to be productive. Post-placement questionnaires have demonstrated that many students continue to collaborate afterwards with the hosting research group, publish jointly and are able to improve the quality of the research they include in their thesis. The success of the placements is at least partly attributable to the fact that the researchers themselves take the initiative in arranging them, locating and negotiating with their hosts. Because of this, the arrangements have not always been built upon established relationships and they have been highly effective in establishing new international connections. The programme is an excellent means of broadening the global horizons of its participants.

http://www3.imperial.ac.uk/international/current/opportunities/summer

European Plant Science Retreat for PhD students (Université Paris-Sud)
The European Plant Science Retreat is an annual conference and networking event organised by and for PhD candidates. This international collaboration aims at improving research, training and education of plant science PhD researchers in Europe. There have been five meetings since 2008 organised by five different European Universities. For the 2013 meeting see: http://www.psb.ugent.be/~madub/EPSR5/

5. Career Development

Doctoral studies lead to a wide range of careers, both academic and non-academic. The Royal Society (2010) recently reported that more than 50% of doctoral candidates in the UK take up employment outside the academy after their PhD and only 3.5% end up in permanent academic positions. Unfortunately some supervisors discourage their PhD candidates from considering careers outside the academy.   Many employers value the creativity, originality and rigour of recently graduated doctors. Increasingly they are also being encouraged to be entrepreneurial and to consider starting or contributing to small start-up ventures. These opportunities need to be well publicised and encouraged.

Highlighting the wide range of possible career opportunities for doctoral graduates to our candidates is a very important part of any doctoral programme. It is also important that candidates are supported in identifying and developing the skills they may need for the options that they seek to follow. IN addition, it is vital to help drive the European innovation agenda.

A number of initiatives at LERU universities for both academic and non-academic careers are outlined here.

5.1 Non-Academic

Career Days and Fairs (University of Freiburg)

The implementation of career-relevant measures for doctoral candidates takes high priority at the University of Freiburg. Once a year, the university holds the career fair Head & Hands, which puts young researchers in contact with potential employers and provides them information on career opportunities and continuing education programmes (http://www.zukx.de/service/messen/heads-hands-universitat-freiburg-2013/). As a complement to the career fair, the University holds a trans-disciplinary Career Day, which reports on topics like career opportunities in Switzerland, the

advantages and disadvantages of having a doctorate as a secondary school teacher, and what companies expect from young jobseekers.

In addition, several doctoral training programmes hold career evenings, career days, or career talks with external speakers from the private sector and research institutions. These events provide information on career paths or career areas and are tailored to the specific needs and qualifications of graduates in the fields in question. Doctoral programmes focusing on the life sciences, for instance, have invited experts to speak at their informational events from specialist companies and non governmental organisations such as the World Health Organisation.

Several doctoral programmes offer seminars on topics like "Identifying Career Potential," "Application Training," or talent coaching, as well as individual career advising to help doctoral candidates plan their future career path and discuss initial steps to implementing these plans. These measures are complemented by mentoring programmes and career support measures intended especially for women or parents, like the Female Mentoring Programme in the natural sciences or seminars on successful salary negotiations for women. Several programmes encourage close contact between female doctoral candidates and experienced scholars so that the latter can serve as role models.

PhD Activating Career Event (PHACE) (University of Utrecht)

Many people start their PhD thinking that they will continue with a career in academia, whereas in fact only a relatively small proportion of PhDs end up in long-term academic careers. The 'PHD Activating Career Event' (PHACE) aims to help PhD candidates at the end of the doctorate to think about their future career. During this two-day event PhD candidates in the penultimate year of their PhD can explore different career options. Should they stay in academia or not? What are the alternative possibilities and how do their skills and competencies fit in to these new career choices? PhD candidates explore this by identifying what motivates them in work and which skills they have acquired over the years in the first workshop session. The second workshop session is meant to broaden or enhance skill sets by tackling skills they may not have developed fully. Whilst the third workshop session will cover skills they need when entering the job market. Seven different career tracks are explained by PhDs who work in academia, R&D in companies, teaching, consultancy, government, and management. Participants can learn how they shaped their careers and which skills they needed to develop in order to get to the position they have reached.

http://www.uu.nl/EN/informationfor/intstaffandvisitors/human-resources/werkenaanontwikkeling/careerdevelopmnet/phace/Pages/deafult.aspx

Understanding graduate destinations (UPMC)

UPMC publishes a regular newsletter (IFD - Mag) which includes surveys on the professional future of UPMC doctors. For example, it published in 2012 the most detailed survey to date, called "operation Dr. X Wanted", which probed seven promotions of doctors (4,200 doctors) two to eight years after the PhD defence. Awareness of the social and economic environment is carried out through actions conducted jointly with enterprises, local authorities, and associations. Five information days are organised every year, with presentations by companies (e.g. Boston Consulting Group, Thales and L'Oréal in 2012), round tables, etc. The objective is to bring together different professional backgrounds, illustrate the careers of doctors by testimonies, and open up opportunities for PhD candidates.

Use of questionnaires (Lund University)

During the term before the defence, and before the meeting with the director of postgraduate studies (*doktorandsamtal*) in that term, each PhD student and his/her supervisors meet for a discussion about career possibilities and opportunities. They can also ask additional people to come, for instance the discipline chair (*ämnesföreträdare*) or other supervisors in the discipline. The aim is to give students guidance to find interesting and realistic career possibilities and help to advance their career.

There are questions on sheets, one for the supervisors and one for the student. Both student and supervisors prepare notes on their sheets in order to stimulate the discussion. On the last page of the student sheet there is a section where the student can note questions for the director of postgraduate studies, and a section for comments to improve this procedure. A copy of the last page, signed by all involved, is handed to the director of post-graduate studies at the *doktorandsamtal* in the same term.

PhD Employer Forums *(*UCL)

The forums provide research students with opportunities to hear from, and network with, employers from all areas of the labour market. A panel of speakers who themselves are PhD holders are invited to talk about their sector, their career progression and the best routes into these positions.

Employer-Led Careers Skills Workshops (UCL)

Researchers get the opportunity to meet and network with potential employers and find out about career paths in a range of sectors. The topics cover the practicalities of successfully navigating the recruitment process, as well as essential workplace skills such as commercial awareness as well as gaining a better understanding of the UK labour market.

Four Steps to Career Success (Oxford University)

is the Careers Service skills programme for doctoral students. It comprises four workshops: Career Planning, Networking Skills, CV and Cover Letter Skills, Interview Skills. The workshops are designed to complement each other but students can pick and choose which to come to according to their requirements. The Career Planning and Networking sessions include facilitated group activities that help students to learn from themselves and each other. Career Planning uses interactive exercises to help researchers identify their values, skills and interests in order to more effectively evaluate their career options and begin action planning. Networking skills uses interactive activities to increase understanding of methods of online and offline networking in academic and non-academic settings, as well as the chance to practice networking and evaluate different approaches. CV and cover letter skills and interview skills workshops are also largely interactive with opportunities for peer review and practice of CV and interview skills in a supportive environment.

Careers for graduates with a PhD in the humanities (LMU Munich)

There are a variety of attractive vocational fields beyond a classic academic career for graduates with a PhD in the humanities. To illustrate this, the GraduateCenter^{LMU} organises a series of events which offer insights into these occasionally less well-known occupational fields. At the same time, the events are designed to encourage students to think about what they will do after their PhD while they are working on their dissertation or even before they start work on their dissertation. Speakers from different professions present their vocational fields. Topics covered in the current series of talks in 2013 were: archives, libraries, coaching/training, digital humanities, strategic consulting, publishing, and academic management.

www.graduatecenter.uni-muenchen.de/veranstaltungen/berufsfelder

5.2 Academic

Preparation for Academic Practice (Oxford University)

The Oxford Centre for Excellence in Teaching and Learning (CETL) - Preparation for Academic Practice (which ran until September 2010) devised, developed and embedded support for Oxford's early career academics, particularly through training for teachers through staged progression. The Centre has also undertaken and sponsored research and disseminated the findings on career development and needs of research students and staff, and this and related work from other universities in the CETL network is presented on a dedicated website (www.apprise.ox.ac.uk).

Teaching skills (University of Amsterdam)

In the Humanities, a large proportion of the doctoral candidates aspires to an academic career (for GSH ca. 50 % of the graduates). For this reason the skills programme of GSH includes a Teaching Skills course. Besides there is a possibility to get an additional appointment of six months as a junior university teacher; many PhD candidates make use of this. The Teaching Skills course is also a useful preparation for the Basic Teaching Qualification each university teacher has to acquire. Several skill courses also help to prepare PhD candidates at GSH for an academic career: Presentation Skills, Advanced Academic Writing, Building an Academic Career, and Blogging and Twitter for Academics.

5.3 Intersectoral

OUIIP - Oxford's International Internship Programme (University of Oxford)

The OUIIP programme was set up within the Career Service in 2008 to provide the University's students with access to international work experience. It offers summer internships with companies of all shapes and sizes, all over the world. The University has found that the best opportunities are generated where there is an existing relationship with the partner institute. The three key routes for generating internships have been:

- Oxford Alumni (both individually and as representatives of organisations): Most of the programme's partnerships are generated through this route. The fact that so many (up to a third) of Oxford's students are international ensures that it has a rich international community of potential partners upon which to draw.
- Educational Partnerships: The University's admissions team keep a list of international schools with whom they have a relationship, and the programme often partners with these institutions.
- Business Partnerships: Oxford University's Employer Engagement Officer focuses particularly on building and maintaining relationships with various employers, many of whom are, again, key partners for the programme.

The Student Consultancy (University of Oxford)

The Student Consultancy is a programme of learning and development activities that links University of Oxford students to local Oxfordshire businesses and community organisations. It is an innovative and unique programme, in that it provides employability skills training and work-based experiences to students and an opportunity for local SMEs, charities and community organisations to access free consultancy services. Students from all disciplines and year levels participate in the programme and work in teams to address a strategic issue or business problem affecting the organisation. The Student Consultancy is not specifically for research students but 10%-15% are doctoral candidates. It

works well for doctoral students because it gives them work experience yet only requires them to take a few hours away from their studies each week.

OpenLAB (University of Strasbourg)

Situated in the École Doctorale des Sciences de la Vie et de la Santé (PhD programme for Life and Health Sciences), the OpenLAB program selects six PhD students for a full year to visit all possible high schools of the Region Alsace and to train high school teenagers over a two-hours practical (typically a laboratory class), giving them hands-on laboratory training and experience. During the visits there is some time for discussions on the various university training programmes, discussion on questions related to research, to the definition of a PhD, related salaries and life conditions, and any question relative to the possible future of the students. The PhD students work under the supervision of two senior scientists, travel in groups of two or three by car and take with them all the necessary material. Over the years 2008-2012 the programme reached about 60 classes in 35 schools and 19 cities per year. In four years 4,344 students have benefitted from OpenLAB. The workshop topic was PCR amplification of DNA and was taught as a crime-solving issue. Even the high-school teachers were highly interested in solving the enigma. Since 2012-2013, a new workshop on proteins is taught, going from gene expression to protein structure and disease (drepanocytosis) diagnostics. The topics are chosen and discussed with senior researchers. PhD students are eager to participate and transmit their passion for science to the youngest. They develop unprecedented pedagogical, oral and organisational skills. Each PhD student gets an additional salary for 64 hours per year. Furthermore, a first group of PhD students has published a paper on the program in an international higher education journal. The cost of the action is shared by Université de Strasbourg (the newly launched Initiative d'Excellence), Region Alsace, CNRS, Charities and several sponsors (free access to material and molecular biology products).

HELO - Higher Education London Outreach (UCL)

HELO aims to give UCL students experience in working directly with a business. Students work on specific consultancy programmes and get to build their own networks and links with the business industry.

BioNews Internships – Science News Reporting for Research Students (UCL)

UCL Graduate School and Progress Educational Trust (PET) provide an opportunity for Life Sciences, Biomedical Sciences and Law research students interested in science communication and legal/ethical issues arising from scientific developments to gain practical news writing experience under expert supervision through BioNews internships.

UB Solidarity Foundation (University of Barcelona)

The UB Solidarity Foundation was jointly created in 1996 by the Món-3 Foundation and the University of Barcelona. Its mission is to apply university policies in development aid and, as part of the UB's commitment to social responsibility, foster initiatives defending human rights and promoting social action. An important part of the work undertaken by the UB Solidarity Foundation consists in providing technical assistance and consultancy to the UB community and to public and government institutions in the Foundation's specialist areas: development aid, the defence of human rights and social action. The Foundation has been active in this area for more than ten years, providing its services to the Catalan government (Generalitat de Catalunya), the Barcelona City Council and the Barcelona Provincial Council, and to government offices in other Catalan administrative divisions, a number of universities, and municipal associations.

Intersectoral activities in the Humanities (University of Freiburg)

The doctoral programmes in the humanities are cooperating increasingly with external institutions, such as the German Literary Archive in Marbach, the Berthold-Gymnasium in Freiburg, the Meister-Eckhart-Gesellschaft, the Huygens Institute in Den Haag, and the Société Internationale pour l'Étude de la Philosophie Médiévale.

Principal's Career Development Scholarships (University of Edinburgh)

In order to attract the best and brightest PhD students, the University of Edinburgh has an innovative programme of integrated research, training and career development, designed to provide development opportunities which will support research students as they progress beyond their PhD. The scholarship scheme provides a valuable opportunity for postgraduate research students to undertake a package of training and development which will help them to develop the necessary skills required to meet their career choices and offer them a breadth of development opportunities in areas such as teaching, public engagement, entrepreneurship, and research. Scholars focus on one career development area. These include teaching, public engagement, entrepreneurship and research.

http://www.ed.ac.uk/schools-departments/student-funding/postgraduate/uk-eu/university-scholarships/development

6. Concepts and Structures

Increasingly doctoral education is being organised into Graduate or Doctoral Schools or Centres. Mostly they concentrate on doctoral candidates but some also include postdoctoral researchers and some Masters students. Some are unitary across a whole university while some are at faculty level sharing some activities. While there are common themes, each school operates slightly differently and the terms are used in different ways in different countries. For example, UCL has had a single Graduate School since 1993 and LMU created its Graduate Centre in 2008. Many American Universities have Graduate Schools but their role and functions also vary widely. Some of the more recent developments in the creation of Graduate or Doctoral Schools are described below, including mechanisms for national and international co-operation, and some innovative structures for interdisciplinary work.

6.1 Graduate/Doctoral Schools/Centres

The Institute for Academic Development (University of Edinburgh)

Doctoral candidates at the University of Edinburgh participate in a wide range of training courses and other researcher development activities provided by disciplinary Graduate Schools, the Institute for Academic Development, other University support services, and through collaborative arrangements across different institutions (including research pools and Doctoral Training Centres).

The university-wide Institute for Academic Development (IAD) alone provides around 200 research student training and development events each year, at 4 levels. Level 1 (school, discipline or cohort specific training) is linked to the milestones of the PhD, and is often concerned with supporting specific cohorts (e.g. through inductions or by providing training to DTC/P cohorts or Research Pools). Level 2 (College level training) focuses on generic skills, but is tailored to the differing needs of each college (e.g. academic writing training and some careers support). Level 3 (university level training)

offers generic skills training irrespective of subject area, can be delivered online or through face-to-face workshops and ranges from basic training events (such as one-day presentation skills workshop) to high impact events (such as the seven-day, residential Ingenious Women programme). Level 4 (regional or International training) is high impact training which benefits from a multi-institutional or international cohort (e.g. part-time researcher conference or EU-funded Leader Summer School). Funding is devolved directly to Graduate Schools to provide additional tailored provision whilst the IAD and Schools work closely with the Careers Service.

http://www.ed.ac.uk/schools-departments/institute-academic-development

The Institute for Doctoral Training (UPMC)

French regulations devolve the organisation of PhD studies to Doctoral Schools (ED), federations of research teams headed by a director. At UPMC, all 19 EDs belong to the Institute for Doctoral Training (IFD), a department of UPMC under the Vice-President Research. IFD is responsible for implementing the University's doctoral policy and consolidates all services dedicated to the doctorate. The IFD is headed by a Director, assisted by a Council composed of all Directors of EDs, elected representatives of doctoral candidates, supervisors, and administrative personnel, as well as external members. The Council validates the use of the budget attributed by UPMC to doctoral education, regarding both the distribution of doctoral contracts and financial means between the ED. Furthermore, the Council provides a forum for stakeholders of the doctorate where they can compare experiences, and converge towards the common adoption of best practices. IFD ensures the coordination and the pooling of many missions that regulations attribute to doctoral schools; in particular:

• production of statistics and indicators on doctoral education (number of candidates and doctors, genres, nationalities, number of candidates per supervisor, duration, financing, etc.) and on the professional future of doctors (unemployment rate, types of employment and employers, location of doctors, job satisfaction, etc.) in a perspective of self-assessment and continuous improvement;

• support for doctoral candidates in planning their professional project and the preparation of their career, as well as training supervisors to the problems of the employment of doctors and doctoral projects management;

• development of international and European cooperation, such as LERU.

The objective is to free the ED of a large number of common tasks and allow them to focus on close monitoring of the doctoral projects in their field of science, including the selection/validation of doctoral projects proposed by the research teams, recruitment of doctoral candidates, follow-up of the doctoral research projects (monitoring committees, mid-term defences, etc.), individualised follow-up of the doctoral candidates with an individual training plan, etc.

Reorganising for quality (University of Helsinki)

The University of Helsinki began preparing the reorganisation of its doctoral education in 2012. The goal was to collaborate with faculties, doctoral programmes and other parties involved in doctoral education to determine the optimal way of organising doctoral education at the University of Helsinki. The reorganisation aims to develop the consistency and quality of the University's doctoral education, improve the conditions for developing the content of doctoral education and the supervision of doctoral students, clarify the profile of doctoral education at the University of Helsinki, as well as enhance its visibility in Finland and abroad. Following extensive consultation the University has established four doctoral schools in the following fields: Humanities and social sciences, Natural sciences, Health sciences, and Biological, environmental and food sciences. The doctoral schools are in charge of coordinating, steering and supporting doctoral programmes as a whole, as well as

developing quality in different ways. The schools feature doctoral programmes that are sufficiently closely related in terms of their scientific foundation. Special attention must be focused on ensuring that no barriers or obstacles to cooperation arise between the schools.

Doctoral education is offered in research- and researcher-oriented doctoral programmes, which provide teaching and supervision to all doctoral students. All doctoral students at the University of Helsinki belong to a doctoral programme. In addition to their own doctoral programme, doctoral students may participate in education offered by other programmes in their own and other doctoral schools. Research communities in the programmes may network with other fields of research and doctoral programmes within the University, as well as nationally and internationally. Faculties continue to be responsible for the quality of their degrees and grant the right to pursue a doctoral degree and confer the degree. Doctoral programmes provide education which faculties may incorporate into their doctoral degrees, while departments see to the facilities, equipment and other resources needed in doctoral education.

All participants in doctoral education at the University of Helsinki have found a place in the four doctoral schools model. The doctoral school structure is based on research and researcher-oriented doctoral education, interdisciplinarity and multidisciplinarity. It features streamlined administration, and the organisation model can be further developed based on the experiences gained from actual operations.

Graduate Campus (University of Zurich)

The Graduate Campus (GRC) was established in 2011 to support junior researchers at the University of Zurich (UZH) and to improve the conditions and training offers for doctoral candidates and postdoctoral fellows. The Graduate Campus offers its services to all junior researchers of the University (4,500 PhD candidates and about 1,000 postdocs). The main activities can be divided into four areas:

- Funding instruments for junior researchers
- Cooperative quality development with respect to doctoral education
- Educational services and course offerings
- Dialogue with the public and politics

www.grc.uzh.ch

Contracts for candidates as employees (Université Paris-Sud)

A new contract was established in France in 2009 for doctoral students that are employed by universities and public research organisations. In this context, two doctoral students can be hired for 1/6 of their annual working time (32 days per year) to do several extra activities:

- teaching in university (this was already possible before 2009)
- dissemination of scientific culture
- valorisation of research results coming from public research laboratories
- consultancy on technical, scientific, or organizational questions.

For most of doctoral students the extra activity concerned is teaching, given that this possibility existed for many years.

'Doctoral Missions' (Université Paris-Sud)

Paris-Sud has been very active since 2009 in order to provide doctoral students opportunities to engage in extra activities that are not teaching, in the form of what we call "doctoral missions". These

are activities dedicated to dissemination of scientific culture, valorisation of research results or consultancy. Every year we organize a call for projects in order to identify doctoral missions that can be proposed to the doctoral students. This call is open to all parts of the university: faculties, laboratories, administrative services; and also to entities outside the university that are active in dissemination of the scientific culture: museums, cultural centers, "houses of sciences" etc.. This call leads to the employment of about 60 doctoral students every year on doctoral missions. In comparison, approximately 600 doctoral students (out of 1,800) are employed each year for teaching activities.

The doctoral missions are a very powerful tool in terms of doctoral training, as they offer to doctoral students the opportunity to implement their skills in professional activities that are different from classical research activity and outside their research team. During the mission, professional activities are completed with training courses that are related to these activities, for instance courses on innovation or industrial property for doctoral students in charge of valorisation of research results. Through these missions, doctoral students can be well prepared to work after their PhD in activities connected to research.

Overall structure and supportive environment (University of Heidelberg)

The University of Heidelberg has established an overall structure which accords doctoral training a high profile and brings together decentralised and centralised elements in order to create a supportive environment. Doctoral training at Heidelberg has evolved within a decentralized structure, with twelve Faculties being mainly responsible for it and the individual research project without a structured programme being the rule in the past. During the last years, however, three large Graduate Schools (in Molecular and Cellular Biology, Fundamental Physics, and Mathematical and Computational Methods for the Sciences) and many smaller structured doctoral programmes have been established. At the same time, a central unit, the *Graduate Academy*, is serving as a coordinating body for all support services related to general advising, professional and academic development and financial assistance for doctoral candidates. In addition, a *Council for Graduate Studies*, comprising representatives of all faculties, graduate schools and the Graduate Academy, has been set up to steer the development of doctoral training across the University. This way, the University defines and continuously updates university-wide guidelines for its graduate education and standards for quality assurance in doctoral training.

Research Services Office – freedom for creativity (University of Freiburg)

By establishing a new central Research Services Office, the University of Freiburg is creating a highly professionalised unit dedicated to providing comprehensive services to researchers of the University of Freiburg in all career phases (from graduate students, doctoral candidates, and postdocs to full professors), thus giving them the freedom to devote their full attention to their research. Researchers of the University of Freiburg can find answers to all of their questions concerning research funding and qualification in a single service department. The planned Research Services Office will include the International Graduate Academy, the Science Support Centre, the EU Office, and the Department for Contract Advising, Project Implementation and Transfer, offering individual advising, courses and workshops providing further qualifications, and project and transfer coaching for researchers in all career phases.

The objective behind this consolidation of responsibilities is to increase the efficiency of the university's entire research system by providing the best possible support to assist researchers in preparing, submitting, and processing applications for third-party funding and to further their careers in science and research. The Research Services Office will provide a professional administrative environment for enabling and promoting top-level research.

6.2 National and International Collaboration Schemes

International co-supervision (UPMC)

International cooperation of UPMC at the doctoral level is also expressed through international doctoral programmes, whose role is to promote co-supervision. An example is the International Doctoral Programme "Modelling complex systems" (PDI - MSC), which was implemented in 2010 at the initiative of UPMC and the *Institut de Recherche pour le développement* (IRD). This programme has four objectives:

1. put in place a structure that grants doctoral candidates from Southern countries high-level doctoral training,
2. promote the mobility of graduates from different disciplinary backgrounds, both in Northern and Southern countries,
3. bring together and animate this community for enhancing interdisciplinarity,
4. focus on the modelling of concrete problems with actual data to foster the development of the South.

PDI - MSC is supported by the UPMC doctoral schools in the North and the IRD teams in the South. Three weeks of training, bringing together all of doctoral students, are held each year on the IRD campus in Bondy. The programme currently comprises 40 doctoral candidates in co-supervision with Southern countries.

The Bloomsbury Postgraduate Skills Network (UCL)

The BPSN was created in 2005/6 and is managed by UCL with the purpose of sharing best practice and transferable skills training provision for research students in Universities the Bloomsbury area. The shared BPSN skills training programme allows research students in the participating institutions to enhance their generic research skills and personal transferable skills, through attending training courses and workshops at other member institutions. Whilst each institution offers its own training to its registered students, the BPSN programme allows access to a variety of different training from other member institutions. The skills attained from the programme are intended to help research and also to enhance life skills and employability. The members are leading higher education institutions within Bloomsbury, from smaller specialist institutions to large multi-faculty ones: Birkbeck College, Institute of Education, London School of Hygiene and Tropical Medicine, Royal Veterinary College, School of Advanced Study, London School of Economics, School of Oriental and African Studies. In the 2011/12 academic year a total of 1,052 places were offered across 75 courses by member institutions through the BPSN programme. Now in its ninth year, the network continues to be a successful way of enhancing training opportunities in the local area.

National Research Schools (University of Utrecht)

The Netherlands has a number of national research schools in specific areas of research. These research schools organise training for PhD students in a specific area of research. An example is CERES, a research school in the field of study of societal transformation. The training programme offered by CERES consists of the following elements:

- Basic Training Course: The core of the programme consists of elements combining theoretical concepts, methodology and practical support in order to further develop, write and present the research proposal. This is the only course in the programme that is standardised and should in principle be taken by all candidates of a specific year group.
- Methodology seminars: Training courses on qualitative and quantitative methodology as part of the Basic Training Programme.

- CERES thematic seminars: Annual seminars organised around CERES' research themes.
- CERES Annual Meeting/CERES Summer school: The CERES Annual Meeting offers a platform for PhD-students to present research results and pick up on recent developments in CERES' research domain.
- General skills courses, offered by participating institutions

http://ceres.fss.uu.nl/component/option.com_frontpage/Itemid,1

The Graduate School for East and Southeast European Studies (**LMU Munich)**

The Graduate School is located at LMU Munich and Universität Regensburg and provides an excellent framework for innovative research projects investigating history, politics, law, language, culture, and the arts in Eastern and Southeastern Europe. The individual projects introduce new prospects for discussion and cooperation across the disciplines. In a ground-breaking approach the region is regarded in its interdependencies with other world regions, such as East Asia, Turkey, Western Europe, or North America, as East and Southeast European societies are strongly influenced by transregional relations such as migration, or the antagonism between "East" and "West" during the Cold War period. Vice versa, European history can only be fully understood if Eastern and Southeastern Europe are conceived as integral parts of European history. The curriculum is designed to support graduate students in their future career plans inside or outside academia, for example in national and international organizations or administration units, political consulting, media, cultural education, or the private sector.

Flemish inter-university events (KU Leuven)

The KU Leuven organises several inter-university events (workshops, summer schools, symposia) together with other Flemish universities, to stimulate scholarly networking of young scientists with a common interest. These events are organised to a large extent by the young researchers themselves, and active participation is further stimulated by short-talk and poster sessions.

International exchange contracts (Université Paris-Sud)

Université Paris-Sud has partnership agreements with several foreign countries for training of their young scientists. For example, the Chinese Science Council of the People's Republic sends up to 40 three- or four-year new PhD fellowships per year. Similar, though smaller arrangements exist with the Higher Education Commission of Pakistan, the Ministry of Education of the Republic of China (Taiwan) and with Brazil via "Science without Borders".

In France (Université Pierre et Marie Curie, Université Paris-Sud, Université de Strasbourg) many PhD contracts are funded directly by industry, which receives large tax credits from the government for these contracts (http://www.anrt.asso.fr/). Therefore these doctoral contracts are effectively co-financed by the private and public sectors but the initiative comes from industry.

6.3 Interdisciplinary training structures

It is recognised that most, if not all, doctoral projects stretch discipline boundaries but increasingly research is tackling fundamental problems that need contributions from more than one discipline. It is important therefore that doctoral candidates get the opportunity to develop both their project and their skills in an interdisciplinary setting. Here are some more recent initiatives that help provide this.

An interdisciplinary programme for literature and the Arts (LMU Munich)

International Doctoral Programme MIMESIS at LMU Munich is dedicated to innovative doctoral research in the fields of literature and the arts, with special emphasis on historical, theoretical and transdisciplinary perspectives. With its broad spectrum of participating disciplines, the programme offers a forum for cooperation between projects in literature, theatre, performance, music, film studies, architecture and the visual arts. Its research programme is framed by the term mimesis, a key concept throughout the history of the arts, right up to the most recent developments in critical and cultural theory. In collaboration with the Technische Universität München and the University of Television and Film Munich, MIMESIS is integrated in a rich research landscape. The curriculum combines seminars, workshops, lecture series and master classes. Further key components of its profile are exchange programmes with international partner universities and internships with leading cultural institutions. MIMESIS aims at providing graduates with ideal qualifications for a broad spectrum of professional careers.

www.mimesis-doc.lmu.de

Interdisciplinary Doctoral Programme Environment and Society (LMU Munich)

Research on the complex relationships between the environment and society can only be carried out on an interdisciplinary basis. The Doctoral Programme Environment and Society is therefore aimed at graduates from the humanities, social sciences and natural sciences who wish to research questions concerning the nature/culture/environment interface. Within the scope of the programme, the doctoral students acquire the ability to understand the origins and interactions of complex natural and social processes. The Doctoral Programme brings together expertise on environmental research from university and non-university institutions in Munich. The programme is based at the Rachel Carson Center for Environment and Society, a joint initiative of LMU Munich and the Deutsches Museum. The stimulating research environment, the intensive supervision and the opportunity to form international networks mean that the programme offers excellent conditions for doctoral students.

www.proenviron.carsoncenter.lmu.de

LIVES – An NCCR Doctoral Programme (University of Geneva and University of Lausanne)

In the Swiss scientific landscape, the National Centre for Competences in Research (NCCR) are important grants attributed to a team working in a strategic are for a period of four years with, in case of success, two renewals and consequently a total duration of 12 years. They must have a long-term impact. Each NCCR has a doctoral programme. For example, "LIVES - Overcoming Vulnerability - Life course perspective" is a doctoral programme that was started in 2011 and enrols more than 80 participants. Including sociologists, psychologists, demographers and (socio-)economists, the project as a whole, and the Doctoral Programme particularly, have a strong interdisciplinary engagement. Led by a member of the NCCR Board of Directors and a Doctoral officer, controlled by a scientific council where the PhD students are represented, the Programme has a four-year duration and offers four types of training sessions, usually of one to three days: theoretical workshops (on vulnerability, life course and life span, and other interdisciplinary concepts), methodological workshops (quantitative and qualitative methods), soft skills, and the "Doctoriales", where each year all the PhD students have to write a paper and make an oral presentation, receiving feedback from two experts who are not members of their thesis committee. In the soft skills workshops increasing attention is paid to the transferable skills. Specific training sessions are being developed about academic and non-academic careers. We believe that in both cases interdisciplinarity will be an important asset.

Science and Management (UPMC)

Since September 2009 UPMC and the Collège des Ingénieurs have joined forces to offer a doctoral programme requiring double competence: 'Science & Management'. This programme, which leads to a double degree (PhD and MBA), includes 14 weeks of theoretical and practical management training, spread over the three years of the thesis. The training is provided by world-renowned senior managers and professors (from among others Insead, HEC Lausanne, University of St. Gallen, Northwestern University, Harvard Business School, MIT). The doctoral programme is particularly attractive for young scientists seeking positions of high responsibility in public or private companies, after training with high-level research. A feature of this programme is the six-month mission immediately following the doctorate to work as junior consultant in an international company. 28 doctoral candidates are today registered in the doctoral programme "Science and Management", belonging to 11 doctoral schools, and the first graduate has just ended the business mission.

Interdisciplinary Teaching (University of Heidelberg)

In accordance with the university-wide concept of "research-oriented teaching", new forms of research-based (collaborative) teaching have been tested in the interdisciplinary graduate schools and doctoral programmes, in order to enhance teaching opportunities for doctoral candidates. In addition, structured and interdisciplinary teaching programmes, career development plans and tutoring concepts supplement the individual research activities of doctoral members of the Graduate schools. In the *Graduate Programme for Transcultural Studies,* for example, doctoral students are offered a structured programme of courses, workshops and individual mentoring.

At the doctoral level, students are rather hesitant to engage in a curriculum with an intensive weekly schedule. Nevertheless, in an innovative, interdisciplinary research environment it is essential to put them on a solid theoretical and methodological foundation. The structured syllabus consists of two weekly courses, one research colloquium and one reading class. Both courses provide students a platform to exchange their ideas and the progress of their work amongst their peers. However, it has proven to be especially fruitful if supervisors and senior researchers working in similar areas attend specific sessions and partake in the discussion. Such interdisciplinary formats are still rather new in the humanities, but the success of transcultural projects is – to a large extent – due to them. Further training is provided, for example in academic writing in English, or in research management, in concise workshops of two or three days. Workshops seem to be an excellent tool for an intensive training in a seemingly short time. Furthermore, such workshops are highly conducive to the building of a group of peers.

The Graduate Academy also offers a wide range of workshops open to all doctoral students of the University, ranging from academic writing techniques, publications skills to project management and career development.

Doctoral Training Centres in the Sciences (University of Oxford)

The Doctoral Training Centres (DTC) in the Sciences at Oxford have been designed around the principle of providing a broad, individually-tailored training programme to each student: Undergraduate degrees are not designed to, and therefore in general do not, provide the basic training in research techniques necessary to undertake research in interdisciplinary science. There is therefore a need to provide advanced courses in core techniques (for example in (non-linear) mathematical modelling, computer programming, and data analysis), in addition to courses introducing the specific area of research. The way in which the taught-training components of the existing DTC programmes are delivered means that each student can tailor their learning to their own specific needs and backgrounds, allowing them to make a successful transition from undergraduate learner to well-equipped researcher. The key point is that courses are designed to provide *research*

training, so that students engage with the material within the context of ongoing (and usually very recent) research in the field. This ensures that all courses are immediately relevant to the students, so that motivation is not an issue, and allows the students ultimately to make extremely rapid progress once they commence the research component of the D.Phil.

Multidisciplinary Graduate Schools (University of Heidelberg)

Heidelberg University strives to ensure that its doctoral students, even if their research work is highly specialised, are exposed to the broad knowledge and understanding that is increasingly important to address the complex challenges of the modern world. To this end, graduate training takes place in an environment that is characterised by openness to dialogue across subject boundaries at all levels. This is not only reflected in the establishment of large multidisciplinary graduate schools and several smaller interdisciplinary doctoral programmes, but increasingly also in fields without structured doctoral programmes, for example through promotion schemes for young researchers (i.e. Interdisciplinary Junior Research Groups) or the establishment of a centre for advanced studies, the *Marsilius Kolleg,* as central forum for interdisciplinary research projects.

Interdisciplinary MRes/PhD programme in 'Modeling Biological Complexity' (UCL)

UCL has eight interdisciplinary Centres for Doctoral Training funded by the Engineering and Physical Sciences Research Council. The programme on 'Modeling Biological Complexity' trains researchers to use mathematical modelling methods to solve problems in the life and medical sciences. It is a four-year interdisciplinary PhD programme where the first year consists of an MRes. After successful completion of the MRes students continue for a three-year period of research leading to a PhD. The first year (the MRes year) involves two technical courses (mathematical modelling of biological systems and advanced experimental techniques), generic skills training, and four projects in distinct life science areas, most involving modelling, all with two supervisors, one mathematical modeller and one from the Life Sciences. Projects are available from a range of areas including Biomolecular Mechanisms, Integration of Cellular Function, Physiological and Neural Systems, Evolution and Dynamics of Populations, Cardiovascular Research, Cancer Biology and other areas of Systems Biology and Physiology. Students are exposed to a range of areas which broadens their biological knowledge and experience, and allows them to make a more informed choice for their PhD project which follows.

Combining disciplinary education and skills education (University of Amsterdam)

Under the responsibility of the Graduate School of Humanities, discipline-specific education is offered by the research institutes and national research schools, while transferable skills courses are provided by the Graduate School. In the Netherlands there are 15 national research schools in the Humanities, each specialised in a certain research field. Each PhD candidate becomes a member of one of these 15 research schools. The differentiation (organisation and content) between disciplinary courses and skills courses enhances the quality of the content of the PhD education. Furthermore, it gives the PhD candidates broader opportunities for networking, cooperation and sharing experiences: among colleagues of the same discipline in the national research schools and among the broader community of PhD candidates of the Faculty of Humanities of the University of Amsterdam by participating in the local skills courses of the Graduate School.

The Graduate Research School in Genomic Ecology (Lund University)

Genomic Ecology (GENECO) is an interdisciplinary research field at the interface between ecology and evolution, molecular biology, and genomics. It forges the links between molecular biologists who

work with cutting-edge genomics (and "post-genomic" tools), evolutionary biologists and ecologists who aim to understand the genetic mechanisms that underlie the process of evolution: changes in gene frequencies, adaptation, and interactions between organisms. In this "spirit" GENECO should provide a platform for research collaboration and exchange of techniques, theory and study systems in genomic ecology, and train PhD students at the highest international scientific level. It enables doctoral education that will prepare for a career both within and outside academia.

Computer simulation for scientific discovery (Lund University)

COMPUTE is a research school in the Faculty of Science with a focus on scientific discovery using computer simulations. COMPUTE, which complements existing PhD programmes, brings together partners from several different departments at the Faculty of Science.The common theme for the activities is the use of computer simulations in driving research forward. Problems span all length scales from the astronomically large to the microscopically small and from pure basic research to applications of direct relevance for the challenges facing society today. The new graduate courses are targeted at students with diverse backgrounds from a large number of participating departments. Course development is compensated to the home department of the lecturers.

6.4 Other initiatives

Thesis Committees (University of Edinburgh)

Across many schools of the University a Thesis Committee is assigned when the PhD is started. The Committee has between three and five members, including both of the student's supervisors and at least one independent person who has not been involved to any significant extent, either academically or administratively, with the student. This arrangement brings security to the assessment process. Students report that they particularly value the contribution of the Thesis Committee's external member.

Management of Graduate Studies (LMU Munich)

The LMU Graduate Centre encourages professionalisation of doctoral programme management and doctoral programme coordinators by supporting the recruitment of doctoral students (with an online application tool developed and hosted by GraduateCenterLMU), public relations and quality assurance (e.g. specifically designed doctoral programme evaluations). In addition the Centre offers special training and networking events for doctoral programme co-ordinators such as information meetings, workshops to obtain further qualifications and regular coordinator meetings.

The Doctoral Research Training (DRT) funding programme (LMU Munich)

The programme provides incentives for the introduction of structural elements to the PhD phase. Applications are invited at regular intervals and the programme makes funding available on three levels in a competitive application procedure:

- LMU Doctoral Research Training I – Funding for Events (DRT I). DRT I funds events for doctoral students – such as symposia, workshops or doctoral students' days – and can be applied for by professors and leaders of junior research groups. This level of funding, which is primarily aimed at (sub-)faculties, in which no doctoral programmes are as yet offered, has already several times acted as the catalyst for the establishment of or an application for a doctoral programme.

- LMU Doctoral Research Training II – Support for Applications for Research Training Groups (DRT II). DRT II supports professors who wish to jointly make an application to a provider of third-party funding to establish a research training group and who have already developed a concept.

- LMU Doctoral Research Training III – Funding of Doctoral Programmes (DRT III). DRT III provides start-up funding for a programme coordinator and materials for the establishment of doctoral programmes for which several professors are jointly responsible. The programmes are expected to apply for further funding from a provider of third-party funding.

Funding gender-oriented issues (University of Freiburg)

Funding is provided for gender-oriented initiatives, such as individual advising services and measures to reserve and fund child care for the children of doctoral candidates and to provide subsidies for computer workstations at home. Furthermore, doctoral candidates with children can apply to have their own student assistant or to receive support from a student assistant during maternity leave. Finally, funding is also made available for the university's cooperation with *futura mentoring e.v.* or external gender-specific continuing education courses.

7. Conclusions and recommendations

This LERU paper has documented some of the innovative doctoral training practices at LERU universities. Some have been well established for years, others are fairly new, still others are being revamped and updated. It should be noted that these examples represent just a brief selection at one particular moment in time. As large comprehensive universities, LERU members engage continually in processes of development and refreshment of programmes. We encourage interested parties to look at the LERU universities' websites for further information on these programmes and on others that might interest them.

There are many commonalities between programmes at LERU universities, but we have chosen the examples here to reflect the diversity. Professional development training is an area where good practice should be shared with encouragement to follow. Of course innovation is crucial, since cohorts of doctoral candidates change, their needs and those of society change. Naturally, cultural differences may require modifications to any programme to make it suitable.

We commend these examples and hope that they may be an inspiration to other universities, particularly for those where these changes have not yet taken root. The development of researchers to take their place in driving innovation in Europe will depend on their having a comprehensive range of professional development opportunities to develop themselves as 'creative critical autonomous intellectual risk-takers'.

Finally, we trust this LERU advice paper informs policy views about doctoral training as well as good practice, for the benefit of universities, governments, funders and employers, and that it thus helps to highlight the value of universities delivering highly talented and thoroughly trained doctoral graduates with expert skills, who are deployed in a wide variety of jobs and employment sectors. We therefore end this paper with a number of recommendations for the following audiences:

Universities should:

- Keep in mind the principles of excellence in doctoral training proposed in LERU (2010) and the innovative doctoral training principles developed by the EC (2011);

- Provide a well-rounded professional development programme which enables doctoral candidates to assemble an individual training programme tailored to their needs;

- Devise systems that allow candidates to take control of, track and self-assess their own development, with guidance from supervisory teams;

- Promote innovation and sharing of best practice in skills training within the institution and also with other Universities nationally and internationally;

- Use national and international networks and fora, where appropriate, to share skills development provision;

- Ensure that their doctoral training structures and programmes are regularly refreshed in order for them to remain innovative and responsive to change;

- Engage with employers to ensure that professional development of researchers is fit for both academic and non-academic employers.

LERU universities are committed to attract and train the best possible doctoral researchers. They will continue to work through the LERU partnership at informing policy, at leading by example and at sharing good practice with others.

Policy makers, governments and funding agencies should:

- Promote and support the principles for innovative doctoral training and seek ways to stimulate their uptake with the necessary flexibility taking into account different aims and circumstances across countries, institutions and disciplines;
- Ensure that funded programmes demonstrate their effectiveness in developing skills and independence in doctoral graduates;
- Support programmes that encourage intellectual risk taking and creativity whilst not losing sight of other issues such as time to completion;
- Encourage continued innovation and sharing of good practice between programmes nationally and internationally.

In particular LERU urges the European Commission to take up these recommendations in the further development of the European Research Area and in the deployment of Horizon 2020 and other research-related funding programmes. LERU is willing to engage with EU policy makers and other stakeholders in dialogue and initiatives to promote the uptake of innovative doctoral training principles.

Employers should:

- Engage with universities in the formation of doctoral graduates, in shaping and delivering training provision as well as through research, which is most beneficial through sustained contact and structured approaches;
- Recognise that frontier research is the core business of research-intensive universities and that through their unique capacity to bring together higher education, research and innovation they are an essential asset in ensuring Europe's long-term competitiveness and welfare.

LERU is willing to engage with employers to discuss good practice in doctoral training to optimise the employability of doctoral graduates in all sectors of society.

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