



THE FUTURE OF
GRADUATE EDUCATION
IN CHEMISTRY AND PHYSICS

REPORT OF A DISCUSSION MEETING
HELD ON 18 NOVEMBER 2009



EXECUTIVE SUMMARY

There has been extensive debate and discussion in the past few years on the nature of PhD education. A meeting held on 18 November 2009 at the Royal Irish Academy focused on PhD education in chemistry and physics, and their related interdisciplinary areas. The participants were largely those in third-level establishments who are responsible for delivering PhD education, and most chemistry and physics departments with PhD programmes in Ireland were represented.

There was strong support for establishing structured PhD programmes in chemistry and physics for all PhD students. The consensus of the participants was that structured PhD programmes should be administered on a discipline-specific basis (i.e. in chemistry or in physics) and that interdisciplinary PhD programmes exist in a common framework with discipline-specific programmes. Module sharing across programmes should be pursued to avoid duplication.

Structured PhD programmes will require additional support and funding in order to maintain the excellent international reputation of PhD graduates from Irish Universities. In addition to moving to a four-year cycle for student stipends and fees, funding is required principally for academic (academic course delivery), technical (e.g running video-conference facilities) and administrative (organisational) staff.

The 'professional skills' part of the structured PhD should largely be delivered early in the PhD programme, so as to improve the efficiency of the students in their research. It should be delivered, where possible, by instructors aware of the subject areas of chemistry and physics.

The academic courses of the structured PhD should be relevant for each student's PhD research, and typically could total on the order of 30 ECTS.

Industry should be encouraged to engage in PhD education, for example through the IRCSET Enterprise Scheme.

BACKGROUND

The nature of PhD education is changing in response to the requirements of society. The traditional apprentice model of a research-only PhD is being challenged on the grounds that the skill-set that emerges is too narrow and could benefit from the inclusion of appropriately focused academic and professional skills courses. This applies equally to those seeking careers in industry and commerce or within the academic system. However, chemistry and physics PhD graduates have always been actively recruited to industry, so it is necessary to probe deeper into whether, and why, changes to the traditional model are required in these disciplines. Furthermore, although several meetings¹ have been held in Ireland in recent years to discuss potential changes, they have generally not engaged the majority of academic staff responsible for delivering change, nor have they addressed the issues specific to chemistry and physics.

The Discussion Meeting held on 18 November 2009, and organised by the Chemical and Physical Sciences Committee of the Royal Irish Academy, was focused on the particular requirements of chemistry and physics PhD education. The 60 participants were largely academic staff from chemistry and physics departments in Universities and Institutes of Technology throughout Ireland. Given that the participants had collectively graduated many hundreds of PhD students in their careers, and had a wealth of experience in educating young chemists and physicists at this crucial stage of their career, it was deemed important that this constituency be actively involved in determining the future direction of PhD education in their subject area. At the same time, the participants fully recognised that others with a legitimate interest, such as educators, administrators, those working in industry and, not least, the students themselves, must be engaged in discussions of any changes that might be made.

The meeting was organised around four breakout sessions followed by an extended discussion period. Prior to this, three presentations on successful structured PhD programmes were delivered, and these set the scene for the subsequent discussions. The presentations were:

'Dublin Chemistry', Dr Susan Quinn, UCD

'SUPA² Graduate School in Physics', Dr John Jeffers, University of Strathclyde

'INSPIRE Graduate School', Dr Jim Greer, Tyndall National Institute

THE FOUR BREAKOUT SESSION THEMES WERE:

- 1 'Graduate training in chemistry' (Chair: Professor John Kelly, TCD)
- 2 'Graduate training in physics' (Chair: Professor Anthony Murphy, NUIM)
- 3 'Professional and generic skills, links to industry' (Chair: Dr Eamon Judge, Eli Lilly)
- 4 'Funding, management and resources' (Chair: Professor Frank Hegarty, UCD)

¹ See e.g. <http://www.4thlevelireland.ie>

² Scottish Universities Physics Alliance

THE MAIN POINTS

SHOULD THERE BE STRUCTURED PHD PROGRAMMES?

There was *very strong agreement* that a structured PhD was in the best interests of the PhD students. A research project must remain the principal focus of the PhD, but all students should be given the opportunity to take a number of academic courses in the discipline relevant to their PhD topic. In addition, appropriate professional skills courses (already taken by many PhD students) should be offered to all students.

Since some Universities were already moving towards structured PhDs in chemistry and physics, there emerged a strong case for a national coordinated approach, and perhaps formal accreditation through, for example in physics, The Institute of Physics.

SHOULD PHD PROGRAMMES BE DISCIPLINE-SPECIFIC?

Historically, many PhD projects involving chemistry and physics have been interdisciplinary in nature, and in recent years interdisciplinary research has become the norm for many researchers in chemistry and physics. There is a clear need to provide the right academic basis for interdisciplinary research, and the structured PhD can provide this basis. For example, there is a nanotechnology structured PhD programme emerging in Ireland (INSPIRE³) that involves both chemistry and physics as well as engineering and materials science. The consensus of the participants was that the academic course content of all structured PhD programmes involving chemistry and physics should be open to all students in chemistry and physics, and should be coordinated by discipline-specific graduate committees within schools/departments of chemistry and physics. In essence, each school/department would offer a number of academic courses open to all students, some of which would form part of specific interdisciplinary PhD programmes.

WHAT KIND OF PROFESSIONAL SKILLS ARE NEEDED?

A graduate who had directly joined a company immediately after their undergraduate degree would have accumulated typically four years experience during the time that another student would take to complete a PhD. The employed graduate would have acquired many skills needed to perform efficiently and successfully in a business environment. PhD postgraduates need to acquire aspects of this skill-set during their training, not only to compete within a company environment but equally to improve the quality of their PhD training and research. This particularly applies to time-management and being able to work both independently and in a team as appropriate, qualities that are required both for a PhD and for a post in a company. The ability to communicate clearly (both verbally and in writing) is also an essential skill. In most well-organised research groups, this ability is developed

³ See <http://www.inspirenano.com/Teaching-Learning.aspx>

by giving regular oral presentations and written reports. The submission of a substantial written report (and its *viva voce* defence) after the first year are also means of assessing that these skills are being attained. Because they have the potential to improve the research of the student, such professional skills courses should mainly be provided towards the start of the PhD. However, other courses such as those in entrepreneurship are possibly best taken closer to the end of the period of study.

WHAT SHOULD BE THE NATURE AND NUMBER OF ACADEMIC COURSES?

The consensus of the participants was that we should not be prescriptive on an all-Ireland basis, but encourage local diversity, both as regards the content and assigned number of courses. Each PhD awarding institution will, in any case, have its own local requirements for PhD students. On the basis that a 5 ECTS⁴ course (125 hours student effort) would involve an order of 20 hours of formal lectures and some form of assessment (oral exam, written exam, project and/or class work), the figure of 30 ECTS—the equivalent of 6 such courses—was suggested as being a non-prescriptive guideline, being concentrated in the earlier years of the PhD. These should be academic courses, specifically at the PhD-level, and not, in general, merely advanced undergraduate courses offered to PhD students. Depending on the needs of the students, it may be required to undertake a few core courses, followed by optional subjects or preceded by lower-level preparatory courses. A blend of delivery formats was considered the best approach, with continuous assessment rather than formal exams appropriate in some subjects.

While many courses can be delivered by staff in the home university, there is much to be gained by sharing courses between the various schools/departments across Ireland. This is especially the case for specialist courses, where the number of interested students in a particular University may be small. One approach to effective delivery of such courses is video-conferencing (as has been successfully achieved within SUPA). Another is through the organisation of workshops or multi-day summer schools. These allow the participation of invited international experts, as well as local academics or industrialists, and have already been successfully run within the Dublin Regional Higher Education Alliance. Consideration should be given to organising these master-classes/workshops as 'satellite' events to annual all-Ireland postgraduate meetings.

WHAT IS THE ROLE OF INDUSTRY?

Many research areas in chemistry and physics involve industry, either directly or indirectly, and many PhD supervisors in chemistry and physics have good connections to industry. Physics (and engineering) industry in Ireland are increasingly involved in the IRCSET Enterprise PhD funding scheme, and currently about 60 physics/engineering PhD students are involved in IRCSET collaborative industry projects. In contrast, there are relatively few chemistry PhD students (about 20) engaged in such schemes. This issue needs to be urgently addressed by chemistry schools/departments and the chemistry-based industry in Ireland: there is a clear benefit both for industry and researchers in such interaction. The importance of the IRCSET Enterprise Scheme was also highlighted in the recent report by the Advisory Council for Science, Technology and Innovation (ACSTI): 'The Role of PhDs in the Smart Economy'.

Industry might also be a source of guest lecturers, both for research and business topics.

⁴ ECTS = European Credit Transfer System



OTHER ISSUES

Given the specialist nature of advanced PhD-level courses and the widely-distributed community of potential participants, it was strongly recommended that video-conferencing be used to deliver many of the formal courses, in addition to intensive schools and workshops. Both would help to create a sense of community amongst PhD students in each discipline in Ireland. The SUPA Graduate School in Scotland uses video-conferencing regularly and this is regarded as very successful. The key issue here (apart from the initial set-up cost) is that it is *essential* to have dedicated technical support to ensure the VC facility works seamlessly, so that the lecturer and students can focus on the science. There is also a scheduling issue that requires administrative support.

The issue of current PhD oral examination procedures was also raised. Whilst the private, in-depth oral exam is still preferred, many participants strongly recommended preceding this with a public talk, as is already done at some universities.

WHAT ARE THE SUPPORT AND FUNDING IMPLICATIONS?

It is accepted that Irish PhD graduates in chemistry and physics are well-regarded internationally, and that the quality of research apprenticeship offered is high. Maintaining and enhancing this high-quality training for a four year structured PhD will require significant support. There was considerable concern expressed over the possibility that the adoption of a structured PhD programme without adequate funding, in particular for high-level academic courses, would damage our international reputation and be a disservice to future PhD students. Graduate courses need to be properly resourced, bearing in mind that the smaller numbers of students for these courses (even with the pooling of students via video-conferencing) requires a larger staff-to-student ratio than for undergraduate courses. The issue of staff resources was felt to be the main barrier to the success of structured PhD programmes: a structured PhD programme based on volunteer effort from a few dedicated PhD supervisors is not sustainable in the longer term.

A second resource issue is the provision, and more importantly the maintenance, of video-conference facilities at each university/loT. Experience from the SUPA Graduate School shows that it is essential to have dedicated technical support at each site, so that lecturers and participants can focus on the learning process rather than getting bogged down in technical/communication problems.

A third essential resource for structured PhDs is the need for high-level, subject-specific, administrative support, not only to maintain proper records and provide coordination services (e.g. VC scheduling) but also to provide a collegiate focus and accessible advice service for PhD students. An indicative staffing appointment of one high-level administrator for every one hundred PhD students was suggested.

The above requirements are of course additional to the extra funding needed to provide a minimum of four years support (stipends and fees) for PhD students. At present, only SFI has committed to the provision of four-year support, with IRCSET retrenching to three-year support in 2009/2010.

CONCLUSIONS

All schools/departments of chemistry and physics involved in PhD education in Ireland should establish a structured PhD programme for all their students. They should engage their University Management (including Deans of Graduate Studies) to ensure that adequate resources are made available and to ascertain that internationally recognised standards are achieved and maintained. The sharing of specialist academic courses using video-conferencing and joint intensive schools is encouraged.

ACKNOWLEDGEMENTS

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VENUE
ROYAL IRISH ACADEMY, 19 DAWSON STREET, DUBLIN 2

THE FUTURE OF GRADUATE EDUCATION IN CHEMISTRY AND PHYSICS

Wednesday 18th November 2009

10:00

ARRIVAL (Coffee)

10:30

INTRODUCTION AND WELCOME

10:45

EXAMPLES OF GRADUATE SCHOOLS

Dublin Chemistry;
Dr Susan Quinn, University College Dublin
SUPA* Grad School in Physics;
Dr John Jeffers, University of Strathclyde
INSPIRE Grad School;
Dr Jim Greer, Tyndall National Institute

12:00

BREAKOUT SESSIONS

- A. Chemistry Core
- B. Physics Core
- C. Professional & generic skills, links to industry
- D. Funding, management and resources

13:00

LUNCH (in-house)

14:00

DISCUSSION FORUM

Reports by spokespersons
of breakout groups
Open discussion

15.45

CLOSE

AGENDA

* SUPA: Scottish Universities Physics Alliance

DAVID BARR	Royal Society of Chemistry, UK
STEPHEN BELL	Queen's University Belfast
ENDA BERGIN	Trinity College Dublin
CARMEL BRESLIN	National University of Ireland, Maynooth
NOEL BUCKLEY	University of Limerick
EAMONN CASHELL	Cork Institute of Technology
JOHN CASSIDY	Dublin Institute of Technology
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AP DESILVA	Queen's University Belfast
JOHN DONEGAN	Trinity College Dublin
JOHN DORAN	Dublin Institute of Technology
PETER DUFFY	University College Dublin
PATRICIA ENNIS	Dublin Institute of Technology
ANDREA ERXLEBEN	National University of Ireland, Galway
STEPHEN FAHY	University College Cork
NICK FLETCHER	Queen's University Belfast
WESTLEY FORSYTH	Irish Universities Association
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SHEILA GILHEANY	Institute of Physics in Ireland
DAVID GRAYSON	Trinity College Dublin
JIM GREER	Tyndall National Institute
AUISON HACKETT	Institute of Physics in Ireland
FRANK HEGARTY	University College Dublin
GRAEME HORLEY	Science Foundation Ireland
JOHN JEFFERS	University of Strathclyde
LEIGH JONES	National University of Ireland, Galway
EAMON JUDGE	Eli Lilly
JOHN KELLY	Trinity College Dublin
TIA KEYES	Dublin City University
MARTIN LEAHY	University of Limerick
DONAL LEECH	National University of Ireland, Galway
LUIS LEON	University College Dublin
CONOR LONG	Dublin City University
LIAM McDONNELL	Cork Institute of Technology
MICHAEL MCGUINCHY	University College Dublin
JOHN MCINERNEY	University College Cork
EILISH MCLOUGHLIN	Dublin City University (Director of CASTel)
TERRY McMASTER	Bristol Centre for Functional Nanomaterials
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JOHN WOOD	Cork Institute of Technology

PARTICIPANTS LIST