International Conference on Developments in Doctoral Education & Training

Conference Proceedings

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Reprint of contribution from

Mulvany MJ, Jonsson R, Lackovic Z

European PhD education - a tale of two cultures.

2014

pp 43-53
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Abstract

Although the PhD was traditionally the route to an academic career, the situation has changed dramatically over the past 10-20 years. In many countries, governments and other funding bodies have invested massively in PhD education, and now most professors have several PhD students. Thus relatively few PhD graduates find permanent employment in academic research. Yet, the PhD remains a research degree, and indeed institutions have become heavily dependent on PhD students for their research output. In institutions in some countries, including many UK institutions, this challenge, at least in biomedicine and health sciences, has been met by maintaining the traditional concept of the PhD as a degree of individual scientific excellence, but setting it in a structured environment with the offer of courses in generic skills. On the European Continent, consistent with the Salzburg principles, institutions in many countries have placed substantial emphasis on the responsibility of the institution for their PhD programmes, with compulsory time for generic skills development, and for enhancing the employability of their PhD graduates outside academia. This has created, to some extent, two cultures. The aim of this article is to discuss these two cultures, stressing the large areas of agreement, but also the areas where there is disagreement. Finally, the moves to consensus are described. Although the article is concerned primarily with biomedical and health related PhD education, the area in which the authors have experience, most of the points are probably relevant for the majority of scientific fields.

Introduction

The concept that researchers should have a professional training was a European idea, first introduced by the far-sighted Wilhelm von Humboldt at the Humboldt University in Berlin following its founding 1810. His vision was to strengthen research by ensuring training for research under supervision, successful students being awarded the doctor of philosophy degree. Some decades later the concept

Acknowledgements

The authors thank Dr. Johnny Laursen, Department of Culture and Society, Aarhus University for helpful comments on a draft of this article.
spread to the USA, where the first US PhD student was famously Arthur William Wright at Yale in 1862. During the First World War, the UK government decided to develop national research training, and the first UK PhD student was enrolled at Oxford in 1917. Since then the PhD degree (sometimes referred to in the UK as DPhil. while in other European countries other titles such as ‘drsci’ are sometimes used) spread throughout the rest of Europe. In some countries, notably in Scandinavia, influenced by a strong German tradition there was reluctance to introduce the PhD, since these countries already had a more advanced research degree given to established researchers. However, even where the PhD has been accepted, the PhD being officially introduced for example in Denmark in 1989. Also outside of Europe, the PhD has become widespread, with almost all developed countries now having PhD programmes [1,2,3]. The PhD is thus an internationally recognized qualification, but there are significant differences within Europe in the structure and content of PhD programmes and the outcomes needed to obtain a PhD degree. The aim of this article is to discuss these differences, with emphasis on similarities and differences between UK and the programmes dominant in Continental Europe (hereafter referred to as the “Continent”) that follow the Salzburg and EC procedures – both in the UK and on the Continent, and the article is based on our personal experiences gained over many years from our experience within ORPHEUS and our experience as heads of our respective graduate schools. ORPHEUS is an organization founded in 2004 committed to safeguarding the reputation of the PhD as a research degree and strengthening career opportunities for PhD graduates. The organization has nearly 100 members from almost all European countries and several countries outside Europe. The article is based primarily on PhD education in the field of biomedicine and health sciences, although many of the points will also be relevant for other fields. The article is a development of a previously published article [4].

Development of the traditional PhD

The traditional PhD developed in Europe followed the apprenticeship model – in keeping with the Humboldt tradition. As discussed previously [4], students would usually enter their PhD programmes as a result of personal contact with a professor. The relationship was informal, the university often only becoming involved when the student submitted his or her thesis. Later, the traditional model was modified at many universities, so that PhD students were registered, but otherwise it was often entirely up to the professor to supervise the student. The training was unstructured but was concluded when sufficient experiments had been made, and the PhD student wrote up the results of the experiments in the classic PhD thesis, a monograph. The monograph was evaluated either with a public examination (usually following a written review), or with a viva.

This traditional approach provided solid training in scientific method, hands-on understanding of methodology, and critical analysis of the data. A PhD graduate was recognized as a trained researcher, a member of the academic community and in principle qualified to contribute independently to scientific literature and scientific meetings. A successful PhD was the route to an academic career. Current procedures for PhD training in most institutions in the UK, but also in several other European countries, are generally speaking still heavily based on the traditional approach, but with important developments. Thus PhD programmes are generally structured with strict rules about admission, supervision, the content of the programme, and the final examination; and with quality control throughout. Increasingly, there is emphasis on the development of generic skills. In the UK, several bodies such as the Quality Assurance Agency (QAA) provide frameworks for ensuring the excellence of the PhD education being provided.

The Salzburg PhD

The development of PhD programmes on the Continent in the past decade has been greatly influenced by decisions made at a meeting of the European Union’s Conference of Ministers responsible for Higher Education in Berlin, September 2003, where it was decided to extend the Bologna process from two cycles (bachelor and master) to include a third doctoral cycle. The ministers emphasised the importance of research and research training, and the need for PhD graduates to build the ‘knowledge society’ that will enable Europe to compete with other economies of the future. This implied a significant move away from PhD education being primarily a training for an academic career, towards one where PhD education should provide PhD graduates with the competences needed for a wide variety of non-academic jobs. This raised the possibility of a reduction in the research quality of a PhD degree, and the European Universities Association (EUA) responded by holding a conference in Salzburg 2005. Here it was emphasised as the first of ten points that ‘The core component of the third cycle is the advancement of knowledge through original research’ [6]. Amongst other points, the conference document from the 2005 Salzburg meeting also emphasised the importance of having structured PhD programmes. Thus it was recommended that institutions should have structures (e.g. graduate schools) which had the responsibility for enrolment, for approving the PhD project, for arranging courses, for monitoring student progress, and for ensuring competent supervision and assessment [6]. To emphasise the importance attached to doctoral education, the EUA set up a Council for Doctoral Education (EUA-CDE) which in a second 2010 Salzburg (‘Salzburg II’) document [7] provided more details about how the ten points could best be achieved.

More recently, the European Commission has published a set of ‘Principles of innovative doctoral training’ [8]. This emphasised the need for excellence as the basis for all doctoral training and the need for interdisciplinarity. It indicated that PhD students should have competences within their PhD field(s) and through other relevant employment sectors during their training. International networking was also advocated. Importantly, PhD programmes should also include training in generic (transferable) skills. The overall aim of the document was to describe the conditions that can ensure that PhD education makes a valuable contribution to the European society. The document also stressed that while maintaining the quality of the essential research component. Other organizations such as the League of European Research Universities (LERU), Ca’Foscari and ORPHEUS (specifically in biomedicine and health sciences) have also prepared documents describing the main features of PhD education. In many countries these initiatives were followed by increased financial support for PhD education with government support for more PhD stipends and for the establishment of structured PhD education.

Across Europe there is widespread support amongst policy makers and heads of graduate schools for the principles enunciated in the Salzburg and EC documents. In particular as regards the need for structured PhD programmes with a content that provides competences that are appropriate for PhD graduates regardless of whether they choose careers within or outside of academia. In Scandinavia, the PhD programmes followed are almost universally consistent with the principles. In other countries, such as Spain, national regulations were changed so that the traditional open-ended PhD programmes were replaced with structured PhD education, with programmes limited to three years full-time (‘exceptionally’ four years). Portugal is following suit. However, despite official support for the Salzburg principles, support on the ground is not so widespread. In Germany, although Graduiertenkolleg has been established to provide structured PhD education, these exist alongside traditional apprenticeship programmes, students having the choice about which to choose. In many other European institutions, despite official support for structured PhD programmes, the traditional apprenticeship form of PhD education still survives, in some cases due to lack of funds for a structured programme. However, it is our experience that this is again due to opposition from supervisors who have a strongly held belief that the classical apprenticeship model provides the highest quality with its focus on individually acquired scientific skills and competences. There is, however, perhaps also an underlying view that PhD students should provide pro quo provide laboratory assistance in return for the training they receive, and not participate in other activities dictated by a graduate school.

Comparison of traditional and Salzburg procedures

European diversity is reflected in the diversity of approaches to PhD education. However, it has been the authors’ experience through their work with ORPHEUS® that there is a surprising degree of agreement (see Table 1), at least in biomedicine and health sciences. Thus the principles of PhD education introduced by von Humboldt are in general followed throughout Europe (including the UK), and there is increasing agreement that the research excellence is the sine qua non of PhD education. The crucial role of supervision is recognized, successful supervision being a two-way process, with responsibilities on both sides. Formal contracts are made in many graduate schools between supervisor and PhD student upon enrolment, underscoring the need for qualified supervision with relevant courses for supervisors, and also students [9]. Increasingly there is also agreement about the need for interdisciplinarity, and in some instances giving PhD students career development opportunities through being exposed to industry and other relevant employment sectors during their training. There is agreement that the thesis is the primary basis for determining whether a PhD degree is awarded, the decision being made on the recommendation of an independent assessment committee. There is growing agreement that PhD students should be involved in the leadership of the graduate school.

There are, however, significant differences, Table 1. Thus according to the Salzburg principles, entry to a PhD programme is usually a master’s degree (which is the traditional final degree on the Continent before possibly moving on to a PhD), whereas for more traditional programmes, such as the UK, a good 3-year bachelor degree has normally been sufficient. As discussed further below, this difference is becoming less clear-cut. For example, 5-6 year medical degree programmes are widely accepted as qualification for enrolment for a PhD programme. Another difference concerns generic skills, where according to the Salzburg principles, the emphasis on the development...
of generic skills (or ‘personal development’ as recommended by Vitae) is greater, with about 6 months being set aside for activities not directly related to the PhD project. Where these activities are courses, they are held at PhD level, not master’s level. In more traditional programmes, it is our impression from conversations with UK colleagues that considerably less time is devoted to these activities in most institutions. As regards the thesis, it is now common in programmes following the Salzburg principles for this to be based on articles/publishable manuscripts together with a ‘review’, whereas in more traditional programmes the monograph is normally retained. Finally, concerning the examination of the thesis, in institutions following the Salzburg principles, the oral examination is a public examination following a written assessment of the thesis, in contrast to the closed viva still used in some countries.

**International PhD programmes**

Outside of Europe, PhD programmes are based typically either on the traditional model (especially in those countries that were part of the British Empire), or on the US tradition. In the US, enrolment is on the basis of a bachelor degree but the first two years of the programme are spent following advanced learning courses and in choosing and preparing for the research project to be pursued. Entry to the PhD project usually requires passing a qualifying exam. The research project is performed in a structured environment, but in practice it is often open-ended such that PhD programmes can last 6 or more years (indeed much longer in some cases). Generic courses are usually available, but not normally compulsory. Countries following the UK tradition are in some countries also beginning to emphasise the development of generic skills, where for example Monash University has introduced the ‘new Monash PhD’ and 200 hours are set aside for activities not directly related to the PhD project (courses, seminars, participation in conferences, etc.).

**Structural considerations**

In comparing European PhD programmes, account needs to be taken of structural differences, where in particular UK structures differ significantly from those generally found on the Continent. Thus, while it is probably generally recognised in UK that research experience would be an advantage before enrolment in a PhD programme, a requirement for a master’s degree would impose a financial burden on the student, since fees for a master’s course have to be paid by the student up front. Some UK foundations are dealing with this challenge by extending PhD stipends to four years, but this is not general. Furthermore, for PhD students coming from outside of the EU, who pay a substantial annual fee, an additional year would have considerable financial implications. Students from the UK and EU normally receive a stipend at the level of £1500-2000 per month (non-taxable); for those coming from outside of the EU, stipends may be available, but students may choose to pay their own way. Full-time PhD students normally retain student status in the UK, this has certain advantages (e.g. non-taxable stipends, student housing), but they do not have the employment conditions of academic staff.

On the Continent, in most Western countries at least, there is no fee for PhD education for nationals (or EU nationals). Furthermore, master’s programmes are an integrated state-financed continuation of bachelor programmes, and normally include a 6-12 month research project. However, the stipends which PhD students receive vary widely from the substantial Scandinavian stipend (e.g. €3000-4000 per month, but taxable) to other countries where few stipends are available, and even these are low. PhD students coming from outside of the EU may in some countries have to pay an annual fee, while in others (as in Scandinavia) this is not the case. Stipends may be financed by the state (in Scandinavia this is typically the case for about one third of the stipends), by foundations or by the supervisor’s grant money. In Scandinavia (and in several other countries), PhD students have appointments as junior academic staff. The seemingly generous remuneration of PhD students in some countries, and good employment conditions, should be set against their research production which typically in biomedicine and health sciences is three articles; the sizeable stipend also implies commitment from the student. Although hard statistics are lacking, the research output of PhD students probably amounts to 30-50% of the institution’s publications. And since publications are often part of the algorithm by which universities are funded (at least in Scandinavia), and for obtaining external resources, this production provides funding for the institution.

Taken together, and to put it crudely, in some countries (in particular the UK and some Eastern European countries) PhD students, especially those from outside of the EU, are a direct source of income. While elsewhere, in those institutions where state funding is dependent on publication output, a major part of the income is indirect through the publications that the students produce. Inevitably, these considerations have influence on the PhD education provided.

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**Demographic considerations**

As long as it was only some professors who occasionally had a PhD student, and as long as there was a modest increase in the number of academic positions, the system was sustainable: there was space in academia for the successful PhD students. However, now that most professors have several PhD students, the number of PhD students worldwide has increased rapidly. In Europe, there has been a 50% increase over the past 10 years [10]. In the USA there has been a doubling in biomedical PhDs over the past decade [11]. In some countries, such as Denmark, the rate has been even greater with more than a doubling over 10 years. In China, the number of PhD students increased almost four-fold between 1999 and 2007 [12]. Thus the careers followed by PhD graduates has changed radically. In the UK, for example, according to a Royal Society 2010 report [13], around 50 per cent of PhD graduates go immediately to non-research positions outside of academia, 30% to postdoctoral positions, and around 17% to non-university research positions. Of those who move to postdoctoral positions, only around 4 per cent find permanent academic research posts, the majority of the remainder going to non-research positions. Thus, only about 25% of PhD graduates use their talents in research activities (Figure 1). The statistical basis for this report has been questioned, but the general trend is accepted. This is supported by a firmly based survey in Norway, where using a national register it was found that in 2009 of all Norwegians who had received a PhD between 1970 and 2009 only 18% had a research position [14]. A report in Nature showed similar figures across the world [15]. On the other hand, a survey covering most of the member states of the European Union (EU), of EFTA as well as some of the most important other members of the OECD, such as the United States and Australia indicated that around 50% of PhD graduates are in research positions [16]. This was also a recent finding of Vitae [17], who found that after 3 years 30-50% of PhD graduates were in research positions (either academic or non-academic). Some of the discrepancies may be due to the definition of ‘research positions’ and the time window being examined. However, overall, the data suggest that only a minority of PhD graduates find permanent employment in conventional research positions and, with the current enrolment rates, even fewer are likely to do so in the future.

A possible solution to the demographic challenge would be to cut the number of PhD students, so that there was a better balance between the number of PhD students trained and the number of research positions available. However, as indicated above, developments over the past years have resulted in perhaps up to half the research output of biomedical institutions being performed by PhD students. Cutting enrolment of PhD students to a level consistent with the number of academic positions available would therefore greatly affect the research output of institutions, and is not therefore seen as an option. Thus, it is generally accepted that a large proportion of PhD graduates will go to non-academic positions or indeed non-research positions. This emphasises the importance of ensuring that PhD training is also relevant for such employment.

A corollary of the demographic challenge posed by Figure 1 is that it is not only PhD students who are competing for jobs. Universities have now to a great extent to compete for the best PhD graduates to carry their research forward providing a natural incentive to ensure the excellence of their PhD programmes.

**Criticism of the PhD**

Perhaps because of the continuation of traditional approaches in some institutions, PhD training has received substantial criticism. The Economist [18] suggested that doing a PhD was often a ‘waste of time’ and that ‘dissatisfaction’ among PhD students was widespread. This view was opposed, but a few months later Nature had a series of articles outlining current problems with PhD training [19,19-22]. It was, for example, intimated by a distinguished US author that ‘most doctoral programmes conform to a model defined in the middle age’ [18]. The criticism has continued in 2012 [23,24]. To a large extent, the criticism has been directed at the more traditional forms of PhD programmes, and not to the more modern forms of PhD training that have been developed in UK and the Continent. However such criticism is not conducive to enhancing the image of PhD training. If the PhD is to maintain its historical reputation as a degree of excellence, and if PhD training is to remain attractive to the brightest and best, some action is needed. As we have suggested recently, it should be ensured that ‘PhD students remain a mainstay of current scientific research, the source of our future scientists, and a basis for providing persons with the skills needed to build knowledge societies’ [23].

**Standards for PhD education**

Most European countries have more or less detailed regulations and guidelines for their PhD programmes and most emphasise the need for quality assurance. The European Commission’s ‘Principles of innovative doctoral training’ referred to above [8] also emphasises that quality assurance procedures are essential to ensure that the principles enunciated in the document are implemented. Similar comments are found in the EUA-CDE Salzburg II document [7]. Such procedures can either become very detailed if all regulations are to be fulfilled, or
Doing all this within the framework of a 3-4 year PhD programme is not easy. However, by viewing PhD students as managers of a project, who are able to enlist the expertise of other colleagues and technicians it is our experience that the scientific level is at least as good as for programmes where PhD students do all the work. To allow PhD students time to do all the suggested activities not directly related to the PhD project, in our view, the PhD students should not themselves necessarily do all the work presented in their thesis. Such a view is still considered anathema by some, but one needs to consider whether the requirements for a PhD in the new demographic situation do not make this unavoidable [28]. Fortunately for the less convinced supervisors, experience shows that provision of structured PhD education that gives PhD students not only research proficiencies, but also generic skills, improves the research performance and allows PhD programmes to be completed successfully on time.

Under all circumstances, whether PhD graduates find employment in academia or in other fields, they should take heed of the recent statement from NIH Director Francis Collins: ‘I worry that a number of them are receiving the message that if they don’t get a tenure-track position, they have failed. The good news is that nearly all (PhD graduates) are likely to be employed in interesting positions, but many will not travel a narrow academic path.’ [29]

Towards a consensus

When viewing UK (and other institutions following more traditional PhD programmes) and Salzburg (especially Scandinavian) PhD programmes, the similarities far outweigh the differences. Significant differences do, however, remain as indicated above, Table 1. Some such as enrolment requirements (bachelor v. master’s) are structural, while others like the need for courses and the format of the oral examination are within the remit of the graduate schools.

As regards enrolment, from the discussions that have taken place between ORPHEUS and colleagues in UK, it seems that increasingly 4-year PhD programmes are being introduced, with the first year being set aside for advanced studies, research and preparation for the PhD project with entry to the PhD project being based on a qualifying exam. On the Continent, e.g. in Denmark, ‘3+5’ models are being introduced, where students can enter a combined 5-year master’s and PhD programme directly from bachelor. The extra cost has to be set against the extra research output (and thus benefit for the institution).

As regards the inclusion of activities not directly related to the PhD project (Table 3), these are usually optional in UK programmes but compulsory in programmes following the Salzburg principles. Here there seems to be increasing recognition, as recommended by e.g. QAA and Vitae, that these activities not only prepare for subsequent employment, but can also improve research performance. Conversely, in institutions following Salzburg principles, it is our impression that there is a movement away from set academic courses towards other activities such as short courses in generic skills, making presentations at conferences, attending seminars, teaching (Table 3). Here, therefore, there appears to be a convergence of views.

A third difference concerns the thesis that traditionally is a ca. 80,000-word monograph, but which in institutions following Salzburg principles consists of a number of published papers or e.g. postgraduate theses together with a review. Howevetih, in the UK there seems to be a move towards including papers/manuscripts as chapters in the thesis. Concerned, in institutions following Salzburg principles, there appears to be growing agreement that the ‘review’ consists of a broad introduction including an extensive review of the literature, critical analysis of the methods used, possible inclusion of data not in the accompanying papers/manuscripts and discussion of the results of the project in the context of the literature, broader than in the accompanying papers/manuscripts. Here again there appears to be a convergence of views.

A fourth difference concerns the final oral examination. The traditional viva is a tough exam, and perhaps tougher than the public examinations in some institutions following Salzburg principles, at least in biomedicine and health sciences. On the other hand, the viva does not test ability to give a public lecture and to stand up to scrutiny in a public environment, both essential features of being a scientist. Additionally, in some smaller scientific communities in Europe it would not be easy to organise because the number of independent and competent peers is limited, and national regulations and/or tradition are against involvement of foreign experts. Thus in such countries the public examination and published international papers is at present the best safeguard for quality. At the 2013 ORPHEUS conference in Prague 8 was emphasised that for theses containing papers, the assessment should be based not only on the accompanying papers/manuscripts, but also – and perhaps particularly – on the other parts of the thesis as described above. Furthermore, the oral examination should be detailed enough to ensure that the thesis has been written by the candidate, that the candidate understands the methodology, and that the candidate is able to put the results into scientific context. Thus either of this should be done in a separate session before the public examination, or else the public examination should be considerably more detailed than is often the case at present, certainly in biomedicine and health sciences, where the public examination can in some countries have ceremonial character. The ORPHEUS standards, therefore, indicate that there should be a real possibility of failing the public defence (with possibility for a new defence later).

5 http://www.vitae.ac.uk/researchers/1927371/Evidence-of-your-skills.html

T Consensus documents available on www.orpheus-med.org
The chances of failure will be greatly reduced if the development of the thesis is regularly monitored during the PhD programme by the supervisor(s) with a formative feedback to prevent not properly prepared students reaching the stage of the thesis defence.

Conclusion

Worldwide, as in Europe, PhD education is grappling with the need to maintain the PhD as a research degree of excellence, while at the same time ensuring that PhD education provides PhD graduates with the competences needed to obtain stimulating employment either within or outside of academia. In general, the UK view (as also seen in many institutions in other European countries) seems to be to that the traditional product of PhD training, the PhD thesis, has an established value as a measure of scientific excellence. Thus our conversations with UK colleagues indicate that the UK has addressed the challenge of subsequent employment by offering some training in generic skills, and by strengthening the structure of the programmes within which the PhD is performed to ensure the quality of the training and the thesis. On the Continent, institutions following the Salzburg principles provide compulsory emphasis on the development of generic skills, with weight being given to e.g. dissemination, project management, networking and teaching. The differences between the two approaches - or cultures - are however becoming less distinct, and with increased interaction between UK and the Continent, both approaches can develop, with the best parts of each approach being adopted by both [30].

References


Table 1. Comparison of some points in more traditional PhD programmes (such as UK) and ORPHEUS-based PhD programmes

Points on which there is agreement

- PhD programmes should be performed in a strong research environment.
- PhD programmes should train for both academic and non-academic employment.
- PhD programmes should be structured and based primarily on a 3-4-year hands-on, original research project.
- PhD students should have qualified and regular supervision.
- There should be arrangements to allow PhD students to have time at another laboratory.
- The PhD thesis should be evaluated by an assessment committee consisting of active scientists, who should be independent of the student and the supervisor.
- PhD students should interact with the leadership of the graduate school regarding the management of PhD programmes.
Table 3. Suggested items that could be included in a portfolio for PhD graduates

- Presentation
- Articles, reviews, abstracts
- International conferences: participation, posters, lectures
- Local meetings, department, national
- Lectures to non-scientific audiences
- Patents
- Courses
- project related
- generic skills
- Team management
- Grants received
- Time in other laboratories, time abroad, time in industry or job placement
- Networks established
- Teaching

The table lists some of the scientific activities that a PhD student could cover during his/her PhD programme in addition to the work on the PhD project. It has been suggested that documentation for this portfolio (by some called a ‘diploma supplement’) should be provided to the assessment committee, and that these activities could also form part of the decision by the assessment committee as to whether a PhD degree should be awarded.

Figure 1

![Careers in and outside science]

Legend to Figure 1

Careers in and outside science in the UK. The diagram illustrates the transition points in typical careers following a PhD and shows the flow of scientifically-trained people into other sectors. It is a simplified snapshot based on recent data from Higher Education Funding Council for England [33], the Research Base Funders Forum [34] and from the Higher Education Statistics Agency’s annual Destinations of Leavers from Higher Education (DLHE) survey. It also draws on Vitae’s analysis of the DLHE survey [35]. It does not show career breaks or moves back into academic science from other sectors. Figure based on figure 1.6 in The Scientific Century securing our future prosperity, 2010 Report of the Royal Society, London, 2010 [13]. Reproduced with permission from the Royal Society.