Pipelines or pipe dreams? PhD production and other matters in a South African dental research institute 1954-2006

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This retrospective study documents the Masters and PhD training of 131 Dental Research Institute (DRI) postgraduates (1954-2006) to establish demographics, throughput and research outcomes for future PhD pipeline strategies using the DRI database. Descriptive statistics show four degree-based groups of postgraduates: 18 PhDs; 55 MScs; 42 MDents and 16 dropouts. Postgraduate activity peaked in1981. Pipeline conversion from Masters to PhD was below 20% with MScs more likely to embark on a PhD than MDents. Nearly half of all postgraduates had prior published research experience before embarking on the degree. Acquired skills were predominantly thesis publication, teaching and conference presentation. Higher degrees were done for personal betterment (40%), specialist training (34%) or academic betterment (20%). The DRI intellectual climate and 50-hour research techniques course contributed to the 87% postgraduate completion rate. There is no incentive for DRI clinical researchers to complete a PhD unless on an academic career path.

Keywords: Graduate study, academic persistence, research training, masters study, doctoral study, dentistry, dropout, health education, health sciences, completion rate.

Introduction

The Academy of Science of South Africa (ASSAf) has highlighted the dismal production of PhD graduates in a study drawing on doctoral data from all 23 South African universities (ASSAf, 2010). Alarmingly, Clinical and Public Health produce less than 10% of the country's PhDs, a disturbing statistic since the health sciences, anecdotally, attract the brightest and best of students. The Department of Health (DoH) has long been aware of the consequences of under-capacitation in this area: it stated in 1997 "A culture of research and technology is essential for the future development of the country" (DoH, 1997). Ten years later it called on "universities [to] produce enough researchers, scientists and specialists to contribute significantly to health science education and training" (DoH, 2006).

The low numbers of PhDs in the health sciences has its origins in the late 1970s when the DoH rationalised all health care facilities to its control and prioritised health care and service delivery to the detriment of research activity. A further contributing factor has been the disconnect between Colleges of Medicine of South Africa (CMSA) and University qualification requirements for clinical specialist training, which came into effect in 1974. The University route requires completion of an appropriate Masters degree whereas the CMSA route permits registrable qualification as a clinical specialist on conclusion of the identical University course and examination requirements, but without the time-consuming research module. Consequently, the vast majority of registrars take the simpler CMSA route and abandon the research component of the Masters degree. This is evidenced by Wit's current MMed completion rate which is below 10% (A Rothberg, personal communication). These two factors: an un-conducive research environment exacerbated by high MMed/MDent dropout (ASSAf, 2009:150), have caused a 30-year "haemorrhage" in the PhD pipeline at the Masters level in clinical sciences.

It appears that this haemorrhage is about to be staunched. As from 2011 the Health Professions Council of South Africa (HPCSA) requires the completion of a research component for registration as a clinical specialist in South Africa. Furthermore, the HPCSA has called for protected study time (20% or

eight hours per week) for registrars from their clinical duties (HPCSA, 2010). This call has been heeded by the Gauteng Department of Health (GDH) in a recent memorandum of agreement (GPG, 2008). Such initiatives have opened the floodgates of prospective Masters candidates, potentially restoring the PhD pipeline.

Meanwhile, the question remains: how do the health sciences jumpstart academic PhD study to rear the next generation of scholars when it has lost research culture and accumulated a 30-year capacitation backlog at Masters level? First, historical data is required to provide past postgraduate research performance and a yardstick for future scenario modelling. Unfortunately, such data is lacking: available figures are devoted to recent PhD completion rates, which at best are vague and non-specific. Mouton (2007) has indicated that they are generally low, while ASSAf (2010) points out little information exists on PhD attrition rates. Inappropriately, national Health Sciences data lumps clinical, basic and social scientists together, all of whom are completely different research individuals. Secondly, there is no data on publication outputs or conference presentations from research completed for health sciences higher degrees, either at Masters or doctoral level. This, by extrapolation, could give an indication of the skills acquired during the course of the research study, provide insights into workplace readiness and, importantly, suggest motivations towards further study beyond the Masters phase. Indeed, ASSAf (2010:69) advocate that the Masters is pivotal in the pursuit of a doctoral degree. Thirdly, a better understanding is needed of exactly what "health science research training" (DoH) encompasses. PRES shows that "research environment", "intellectual climate" and research skills development are core elements for British and Australian postgraduate students (Park, 2009), and are heavily shaped by what happens locally at the level of the individual university school or department. Yet, we have little idea of how to optimise these scales, given the sprawling nature of higher degree programmes. Finally, without detracting from the value of such studies, survey data representing headcounts of graduates does not provide "direct evidence on the fundamentally important but mostly ineffable essentials of graduate education [such as] quality and breadth of curricula, exposure to and level of scholarship demanded of them [and] teaching by first-rate faculty members" (Ehrenberg, Zuckerman, Groen & Brucker, 2010:246, 250). Ehrenburg *et al.* propose that intensive case studies of departments and their completion rates should be the "first order of business" towards a better understanding of doctoral education. The Dental Research Institute (DRI) is in a position to provide such understanding.

The extensive DRI database has sufficient records available to permit an intensive case study of its doctoral education through factual, postgraduate-centred data (Grossman, Mogotsi & Cleaton-Jones, 2006). The aim of this article was to extract pertinent detail from the database to:

1. provide a historical record of dental research postgraduate output which can be *applied as a proxy* to other branches of health sciences;
2. present realistic benchmarks for current South African health sciences postgraduate research activities;
3. give insights into the research environment in which the DRI postgraduates obtained their degree;
4. indicate motivations towards further study or reveal areas of pipeline stagnation;
5. illustrate pipeline progress from Masters to doctoral study in a clinical setting;
6. reveal the skills acquired during the course of the higher degree research study;
7. provide insights into workplace readiness, and finally
8. make some recommendations with regard to doctoral production in the changing face of South African academic health care and PhD education.

All the above may contribute towards a better understanding of health sciences research training, suggest a meaningful way forward for doctoral development programmes and thereby the implementation of sound, future PhD strategies.

Background to the study

The DRI was established in 1954 and has had four directors over its 53 years' existence, each promoting an "intellectual climate" and "research environment". Background to each director, their cross-Faculty qualifications and research activity has been documented (Grossman *et al*., 2006). All showed direct evidence of being "first-rate faculty members" and exposing students to the "level of scholarship demanded of them" deemed desirable by Ehrenberg *et al*. (2010) for educating scholars. In addition, the complete record of DRI research outputs (Cleaton-Jones & Grossman, 2004; Grossman *et al*., 2006; Grossman, 2007) has placed the DRI in a unique position to monitor its postgraduate throughput and research-related activities. Pertinent detail was added to the individuals (age, total publications, etc.) to fully exploit the information to hand, thereby providing a 53-year continuum of postgraduate and related outputs from which to gather substantive data. The 50-hour DRI research techniques course, to support postgraduates, was started in 1978 and continued until 2010. The course is University-accredited and is a compulsory requirement for some Masters qualifications and all DRI postgraduates. Course material has changed to suit circumstance and each course topic is assessed anonymously by the participants on a Lickert scale of 1-5 for topic usefulness. Secondly, an accredited Wits course evaluation, monitored by the Centre for Learning and Teaching Development (CLTD), is undertaken for each course. In this way, both topic content and course quality are monitored and adjusted.

Methods and materials

The study

Permission for the study was granted by the Wits Human Research Ethics Committee (Medical), (Clearance number M02-11-14).

The DRI has supervised 132 candidates for a number of qualifications, all of which require an original research component.[1] DRI database specifics can be found elsewhere (Grossman *et al*., 2006) and will not be elaborated on. Eleven of the 132 postgraduates registered for two qualifications, thus there were 121 individuals. For the purposes of this article, this report deals with postgraduates rather than individuals and the term "degree" will cover both degrees and fellowships. Finally, one postgraduate obtained a senior doctoral degree (DSc) which cannot be considered in the same light as a Masters or PhD and is excluded from this report. Simple descriptive statistics have been used throughout the study for factual highlighting and the illustration of trends.

Results

Table 1 shows the numbers of, and background to, the higher degrees achieved by the 1954-2006 cohort either registered in the DRI or officially supervised by DRI staff. To make the results more meaningful, the sample was split into degree types with the eight "non-Wits" or discontinued qualifications grouped according to current Wits requirements for size and research scope of thesis: i.e. PhD, MSc and MDent. The 16 dropouts formed one group, giving the DRI an 87% graduation throughput. Attrition of the dropouts was never related to research problems: 11 candidates left for personal and/or family reasons, with five registrars departing having completed the course work and examination requirements permitting a registrable qualification from the Colleges of Medicine of South Africa (CMSA). Dropout date was difficult to pinpoint, in most cases progress stagnated and the candidate just faded away.

Figure 1 shows that postgraduate activity was low until 1980, peaking in 1981 and since then has fluctuated between 0-8 per year. Postgraduates (Table 2) were mainly South African (120), male (102) and white (107). One hundred and eight had a dental qualification; the other 23 were variously qualified. The

1 The research component can be submitted in the form of a research report for a masters by coursework and research; dissertation for a masters by research only; or thesis for a doctorate. To simplify matters the term "thesis" will cover all three research component types.

non-dentists either worked at the DRI or registered for the higher qualification with the DRI to benefit from its extensive research experience and supervisory skills. All but one (the first PhD) did the degree part-time. All were self-funded, although registrars get a substantial fee remission and staff members obtain various fee reductions of between 30% and 100%. Twenty-six of the MDents were registrars; the others were diploma holders who wished to convert their diplomas to degrees when specialities were established with the introduction of the MDent degree in 1974.

Reasons for doing the qualification were largely degree specific (Table 2): PhDs sought academic betterment; MScs did the degree out of interest or personal marketability; MDents focused on specialist training. The reasons for dropouts embarking on the degree were largely unknown except for the five obtaining specialist qualifications. Overall, 40% of postgraduates did the degree for personal benefit, 34% for specialist training and a mere 20% for academic betterment. Unknowns made up the remainder of the total.

Pipeline DRI conversions from Masters to PhDs can be estimated in one of two ways (Figure 3). Number of PhDs (18) per completed Masters (55+42) would give a DRI conversion rate of 19%. Alternatively PhD conversion can be calculated on all individuals who completed a Masters with the DRI (97) and then went on to complete a PhD either with the DRI (four individuals) or elsewhere (seven individuals). This gives a pipeline conversion rate of 11%. There is a difference between the propensity of the two Masters groups to embark on a PhD, with DRI MDent specialist practitioners (5%) falling behind those doing the more general Masters (15%). It is important to note that only two of the eight DRI MSc group going on to do a PhD had a dental qualification.

Table 3 details publication, presentation and teaching activities of the 131 postgraduates. Of note is the number of prior publishers within the subsets, indicating that nearly half of all postgraduates had some research know-how before embarking on the degree. PhDs were the most experienced researchers having published an average of 15.1 (range 0-49) papers as a group prior to obtaining the degree; MScs had published 2.3 papers (range 0-20) before qualifying; MDents 1.2 (0-6), and dropouts 2.1 (0-12). Mean prior papers for dropouts is relatively high due to one PhD candidate (a Head of Department), who had not completed the degree by 2006, despite being registered for 17 years. The figures for dropouts should be viewed with caution because the year of dropout was an estimate and this data is given for completeness. The relationship between first publication and graduation has changed with time. DRI PhDs are dedicated researchers as evidenced by the distance between cumulated years of first publication and graduation (Figure 2a). A similar, but less marked trend is shown by the MScs (Figure 2b). Prior publication was a feature with MDents until 1981, those who converted diplomas to specialist degrees being the main publishers (Figure 2c). More recent MDents publish their first journal paper post-qualification, and in contrast to the MSc and PhDs, the papers are exclusively from their theses. The graph for dropouts is given for comparative purposes (Figure 2d).

The percentage of qualifying postgraduates publishing their research results and the mean number of publications arising from the thesis increased stepwise with the size of the thesis: 57% of MDents published with 0.6 publications generated per thesis. Equivalent figures for MScs are 74% (1.3) and 94% (5.4) PhDs. Despite not obtaining the qualification, five dropouts (31%) published the results of research done toward their registered degree. In total 164 publications arose from the research of the 131 postgraduates: 98 (60%) were published in journals outside South Africa and 66 (40%) in local South African journals.

Numbers of postgraduates doing oral presentations are similar to those who publish their research, with the exception of dropouts who are more prolific conference presenters (50%) than research publishers (31%). PhD oral presentation output is low (3.7 presentations per thesis) because PhD candidates often attend conferences other than the SA IADR, both locally and overseas, to gain exposure in the wider scientific forum. Overall 49% of postgraduates both published and presented their degree research. Figure 4 illustrates that oral presentations are a pre-graduation activity, with most candidates presenting at conferences in the year prior to qualifying. Publication is a post-graduation activity with the highest number of publications appearing two years after thesis acceptance.

Teaching during postgraduate student years can vary from formal academic courses taught by DRI PhDs who were senior faculty at the time, to a weekly two-hour session by a MSc candidate who is a clinician in private practice, assisting undergraduate students in the clinic (Table 3). Teaching is lowest among MScs (36%) which is probably linked to their private clinical practice commitments. MDents have the highest teaching load (98%) because they are required to teach as part of their clinical specialist training. DRI PhDs are mainly within the academic setting, where teaching is fundamental to research and education (67%).

Table 4 compares the research and academic output of the first (1957-1981) and final (1997-2006) postgraduate cohort. Although postgraduate numbers per year are higher in the final cohort, there are fewer PhDs and reduced research publication outputs. Data on the reduction of oral presentations is not given as this has been published elsewhere (Grossman & Cleaton-Jones, 2005; Grossman, 2007, 2008).

Discussion

This unique 53-year record is the first to show demographics, research and teaching activities associated with postgraduate students whilst registered at a small, academically based South African dental research entity. We have been unable to find any other similar study with which to compare our findings; however, the Graduate Education Initiative (GEI) on doctoral education in the humanities has some interesting parallels (Ehrenberg *et al.,* 2010). What lessons can be learnt from our study to assist Faculties of Health Science struggling to up their doctoral student numbers and meet the demands for high level skills in an emerging economy? In order to answer this, we need to reflect on the demographics of our postgraduates, the research environment they encountered during their studies, and the skills they have demonstrated, and then draw qualified conclusions.

Who were our postgraduates?

DRI postgraduates were largely from a dental background with demographics as to gender, race and nationality reflecting South Africa's past history. Part-time, self-funded study was the mode in this cohort: elsewhere the majority of medical/veterinary and allied medical PhD students are reportedly in full-time, funded study (HEFCE, 2005). Qualified DRI PhDs are mainly dentists, who undertook their study for academic betterment. More recently, DRI "pipeline" PhDs are drawn from the general Masters group and were predominantly non-clinicians. This should not detract from the achievements of the DRI: heterogeneity of scientific disciplines is regarded as a strength in European doctoral dental training (Kersten, Bearn, Gundersen, Holbrook, Kotsanos, Radnai & Virtan, 2010). However, clinician scientists are desperately required to meet the health needs of the country and the prospects of the dental profession, specifically, and health sciences as a whole appear bleak if more clinicians do not come to the fore to take up doctoral studies. A rapid turnaround of the *status quo* seems unlikely, given that only 10% of the DRI masters cohort obtained the higher degree for academic motives. This is further borne out by the DRI conversion rate of masters students to doctoral study, which is well below the national norm of 37% (ASSAf, 2010:70). Allied to this is the absence of experienced or trained clinical health sciences supervisors who are eligible to supervise at the doctoral level.

The environment in which the postgraduates studied

Long before the term came into vogue, the DRI mission statement has been to create "life-long learners" of postgraduates by making their initial encounter with research as positive as possible. Key in this regard is good supervision: students are significantly more likely to complete their higher degrees where positive student-supervisor relationships exist (Bair & Haworth, 1999). The 87% success rate of DRI postgraduates, acceptable by international standards, denotes good supervision. Future planners have identified the provision of good supervision as a major constraint on the country producing increased numbers of doctorates it badly needs.

Equally important is a nurturing environment and intellectual stimulation highlighted in PRES (Park, 2009). The impressive research output and publication record of the DRI (Grossman *et al*., 2006) confirms its rightly held place at the centre of South African dental research (Grossman, 2007). Postgraduates were further integrated into the DRI community and wider dental research community, by being encouraged, coached and sponsored to present their research at the SA IADR. Finally, the research techniques course has undoubtedly helped us achieve our high postgraduate completion percentage, although such courses are not regarded as a universal panacea to individual research self-efficacy. Faghighi, Rakow & Ethington (1999) maintain that formal, course-based research training relies on three issues for success: what knowledge is acquired, how it is acquired and finally how the knowledge is used in an achievement setting. This latter point we have used to our advantage being both supervisors of, and course presenters to, DRI postgraduates. First, this enabled us to develop effective research practice upon the learned theory presented in the research techniques course. Secondly, we encounter first-hand problems experienced by postgraduates and are able to tailor the content of subsequent research techniques courses accordingly. Finally, we ensure quality and relevance by evaluating and monitoring every course and each presentation.

Skills gained during the postgraduate experience

Skills gained by postgraduates went beyond simply obtaining the degree. Two thirds of the cohort achieved conference presentation skills and publishing skills, the majority of which was in international journals. In doing so, students learned to translate research produced in thesis format to oral presentations and journal publications. Elsewhere it is reported that few theses ever make it to the public domain (Heyman & Cronin, 2005), with publication being higher among candidates with a PhD and/or those with prior research experience (Gordon & Dionne, 2007). Ehrenberg *et al.* (2010:218) are more specific: on average 0.8 publication occurred during graduate school and 1.7 publications within three years post graduation. The DRI postgraduate outputs equal or better these figures. Teaching skills were developed in 63% of DRI postgraduates. Whether this teaching occurred in a clinical or research setting is fairly immaterial as we feel strongly that effective teaching cannot take place in a research vacuum and *vice versa*. Whatever the case, elements of research ethos and evidence-based principles are passed to the next generation through subsequent DRI teacher interactions, thereby passing on research skills and knowledge. Finally, although 13% of the cohort dropped out and did not complete their degree, many of them obtained and utilised the same skills their graduating classmates acquired.

The evidence presented in this study shows that DRI PhDs are largely within an academic environment, research ready when they embark on their degrees by virtue of wide publication and enthusiastically embrace conference presentation and teaching. Measurable outcomes indicate that our PhDs are well above achievement thresholds cited within the literature. Equally, DRI MSc postgraduates have attained research outcomes on a par with PhDs elsewhere. Admittedly, measurable research outcomes have dropped dramatically within the final cohort 1997-2006, but even then the parameters still fall well within GEI ranges (Ehrenberg *et al.,* 2010:206). Only time will tell whether our final cohort's lack of research experience will cut their future research activity compared to that demonstrated by earlier registrants (Grossman & Cleaton-Jones, 2008).

Where do the results of this study leave the perplexed planners of future scenarios for PhD education in the health sciences and how can it guide them? Is a PhD necessary for a career in clinical research? To seek an answer to the question we need to examine the advantages and disadvantages confronting the prospective clinician PhD when contemplating the doctoral pipeline.

PhDs for clinicians, *pro et contra?*

It has become a national imperative to escalate the production of doctoral graduates, but the reason for this ambition is not entirely clear: is it about creating new knowledge or is it a numbers game? When taking into account the former case for creating new knowledge and using the DRI study specifically, a quality argument comes to the fore. Our study shows that DRI MSc postgraduates appear to have learned all the skills required to produce new knowledge without the benefit of doctoral education. The good grounding

in research techniques, a stimulating intellectual climate and discipline heterogeneity permit our students to achieve research targets on a par with PhDs elsewhere. The high percentage of postgraduates who embarked on the degree for personal betterment, high completion rate and high research outputs confirm the passion with which they embraced research.

On the other hand, if the national imperative to escalate the production of doctoral graduates is to increase numbers of PhDs per million population, the quantity argument predominates. In this case, DRI (and health sciences) PhD conversion rates are well below average. It then becomes necessary to examine incentives, recognition and career paths available to clinician PhDs in South Africa. ASSAf (2010:87) results show that outside academia and to a very minor extent government, there is no employment market for the clinician PhD. This is confirmed by our cohort where most DRI PhDs were confined to an academic track where the defined career path makes such a qualification essential (Grossman & Cleaton-Jones, 2008). There is little incentive for clinicians outside academia to train in a taxing doctoral programme when their research curiosity can be satisfied with skills gained at Masters level. In addition, ASSAf (2009:230) lists five barriers hindering clinical research in South Africa and highlights the minimal credit given to clinical doctoral graduates in other sectors of the public health system, industry and professional bodies (ASSAf, 2009:146). Accordingly, it is understandable why the majority of our postgraduates find a PhD superfluous for their careers and only "life-long learners" and academics will consider doctoral study.

The answer to the question "Is a PhD necessary for a career in clinical research?" is currently "No, unless on an academic track". In this the clinical health sciences is unique as it does not follow other "professional" disciplines such as engineering where there is a demand for PhDs in industry and the private sector. Equally, in science and the humanities, a PhD is regarded as only the starting point for diverse career paths, rich in opportunity, in private, public and not-for-profit sectors, industry and self-employment in addition to University life (ASSAf, 2010:87). It may be that the health sciences PhD numbers South Africa so sorely desires will be achieved once a market is created for clinician PhDs, tangible credit for the degree is acknowledged and barriers to doctoral studies are removed.

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