A systematic analysis of doctoral publication trends in South Africa

It is incumbent upon doctoral students that their work makes a substantive contribution to the field within which it is conducted. Dissemination of this work beyond the dissertation, whether whilst studying or after graduation, is necessary to ensure that the contribution does not remain largely dormant. While dissemination can take many forms, peer-reviewed journal articles are the key medium by which knowledge is shared. We aimed to establish the proportion of doctoral theses that results in journal publications by linking South African doctoral thesis metadata to journal articles authored by doctoral candidates. To effect this matching, a customised data set was created that comprised two large databases: the South African Theses Database (SATD), which documented all doctoral degrees awarded in South Africa (2005–2014), and the South African Knowledgebase (SAK), which listed all publications submitted for subsidy to the South African Department of Higher Education and Training (2005–2017). The process followed several iterations of matching and verification, including manual inspection of the data, in order to isolate only those records for which the link was established beyond doubt. Over the period under review, 47.6% of graduates, representing 22 of the 26 higher education institutions, published at least one journal article. Results further indicate increasingly higher publication rates over time. To explore whether the journal article identified was a direct product of the study, a similarity index was developed. Over 75% of records demonstrated high similarity. While the trend towards increasing publications by graduates is promising, work in this area should be ongoing.

Significance:
• In spite of increasing trends in publications by graduates, many are not disseminating their work, suggesting that significant bodies of research are potentially not being shared with the academic community and are therefore not contributing to the relevant discipline or field.
• This study provides baseline data from which a number of further investigations can be launched, such as exploring the extent to which doctoral candidates who are also academics are publishing their work; the factors that enable or constrain publication; the other avenues of dissemination used; and whether publishing or not publishing can serve as a proxy for the quality of the doctoral work.

Introduction
The South African Higher Education Qualifications Sub-Framework describes doctoral studies as needing to ‘make a significant and original academic contribution especially at the frontiers of a discipline or field’. Knowledge creation is an unconditional expectation of doctoral work.1,2,3 However, this knowledge contribution will remain largely dormant and ‘invisible’ if the work is not disseminated beyond the student, the supervisor and the examiners, limiting the opportunity for sharing the academic contribution with others.4 While institutional e-repositories have made access to dissertations easier than before, most of the work documented in the thesis will require additional forms of dissemination if it is indeed to contribute to the frontiers of the relevant discipline or field. One could even argue that there is a moral obligation on doctoral graduates to ensure that their research is readily accessible to other researchers. Doctoral study is the most highly subsidised higher education qualification and taxpayers have a right to benefit from the potential value and contributions of such research. Implicit in conducting research at postgraduate level, therefore, is the notion of dissemination, typically through publication in an academic journal or similar artefact.5 While dissemination may take many forms – such as patents, community workshops, news articles and so on – accredited conference proceedings and journal articles remain the key means by which knowledge is shared and thereby cumulatively built.

The South African Higher Education Qualifications Sub-Framework further indicates that the doctorate should ‘satisfy peer review and merit publication’.1 Thus, the expectation of publishing some aspect of one’s research more widely, is not only for ensuring dissemination of the knowledge, but also could be used as an additional measure of the quality of the thesis. Having a reliable estimate of the number of publications emanating from the doctorate over an extended time frame provides a proxy for understanding the extent to which the doctoral graduate translated their work into more accessible publication outlets as well as continued a specific line of research or not.

It has been argued that the African continent needs ‘tens of thousands more PhDs’.6 In South Africa, there is a national mandate to significantly increase the number of PhD graduates to 100 per million of the population by 2030.7 In various policy documents – the National Research and Development Strategy of 20028 and the Ten-Year Innovation Plan of 20089 – the target is 5000 PhDs per year by 2030. In a recent report by SciTIP10 on The State of the South African Research Enterprise, it is shown that this target is in fact achievable under certain conditions, and given the current upward trajectory. Data show that slightly over 3300 students graduated with a doctoral degree in 2018, a sharp increase from the 1420 graduates in 2010 and 973 in 2000.11

Debates about the quality of a doctorate play out quite differently from one country to the next. In many Global North countries, the PhD agenda has become one of employability and relevance for industry as the number of PhDs produced far exceeds the number required by academia.12,13 But, in South Africa, a significant proportion of doctoral candidates (around 35%) are in fact academics5 who pursue doctoral studies as part of their ‘training for an academic career’. The demand for academics to obtain a doctoral degree is emphasised when one keeps in mind that...
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2018–2019 Department of Higher Education and Training data indicate that only 45% of permanent academic staff in South Africa have PhDs while the National Development Plan goal is for 75% of academics to have doctorates by 2030.

As alluded to above, South Africa has witnessed a steady and, since 2008, rapid growth in the number of both doctoral enrolments and doctoral graduates. There probably are a number of different drivers for this growth, including the significant subsidy paid to institutions by the DHET for doctoral study both in terms of teaching input (enrolment) and research output (graduates). The extent of the increase in the numbers of doctoral graduates and the commensurate increase in the subsidy amounts paid since the promulgation of the 2005 funding formula are evident in Table 1.

Table 1: Subsidies generated through graduation of doctorates in South Africa (2005–2017)

| Academic year | Number of doctoral graduates | Subsidy amount (ZAR) |
|---------------|-----------------------------|----------------------|
| 2005          | 1189                        | 303 287 742          |
| 2006          | 1100                        | 281 779 400          |
| 2007          | 1274                        | 392 148 666          |
| 2008          | 1182                        | 415 392 624          |
| 2009          | 1380                        | 528 421 320          |
| 2010          | 1421                        | 508 708 053          |
| 2011          | 1576                        | 562 759 656          |
| 2012          | 1878                        | 648 202 968          |
| 2013          | 2051                        | 696 421 152          |
| 2014          | 2258                        | 736 286 382          |
| 2015          | 2530                        | 813 814 980          |
| 2016          | 2782                        | 923 610 090          |
| 2017          | 3040                        | 1 111 463 520        |

Source: Table compiled from data provided by the South African Department of Higher Education and Training (DHET)

Other drivers for increasing doctoral numbers could include the setting of national targets, and the restructuring of higher education institutions in South Africa that has seen, for example, universities of technology mount multiple initiatives to encourage academic staff to obtain their doctorates. Either way, the rapid increase since 2005 (compound average growth rate of 7.7%) has been accompanied by growing concerns about the quality of our doctoral graduates and their theses. The increase in the quantum of doctoral enrolments has placed strain on the capacity of the system to supervise such students as the ratio of enrolled students to staff with PhDs increased to 2.5 to 1 (22 572 students that could potentially be supervised by 9032 staff with doctoral degrees). It is worth pointing out that this ratio is an average across all fields and universities. Because doctoral enrolments are not evenly distributed, but concentrated in certain fields and especially concentrated in the more research-intensive universities, this ratio in some cases is much higher. This means that the “burden” of doctoral supervision6 has increased significantly over the past decade. Together with a commensurate increase in the burden of master’s supervision, it is not surprising that concerns over quality have arisen.

While measures such as external examination are meant to ensure that the doctoral graduates the country produces are of the appropriate standard, anecdotal evidence suggests that quality in doctoral education is already being compromised in some instances. In the first round of institutional audits undertaken by the Council on Higher Education between 2005 and 2012, for example, concerns were raised about supervisors being used as examiners and about the incidence of repeated use of a very small pool of examiners for numerous theses. This has led to many universities improving their quality assurance procedures in order to ensure that good practice in the appointment of examiners is followed. The current national review of the doctrine by the Council on Higher Education suggests that the quality of the doctorate remains an area of concern and requires scrutiny.12

The obvious approach to assess the quality of doctoral education in a system would be to review examiners’ reports, the names and reputations of examiners as well as the records of the decisions of higher degree committees when awarding doctoral degrees. However, as far as we know, no such study has been done in South Africa and access to examiner reports is extremely difficult to obtain. Instead we analysed the links between doctoral graduation and publication. We report on the first part of this investigation here. Our aims were modest – namely to attempt to estimate what proportion of doctoral theses result in journal publications. Specifically, we focused on doctoral students who graduated between 2005 and 2014 and who published the results of their studies in any of the publications appearing on the lists of journals as accredited by the Department of Higher Education and Training (DHET) between 2005 and 2017. As far as we are aware, this is the first systematic and comprehensive study aimed at establishing what proportion of ‘materials’ contained in South African doctoral theses eventually found their way into peer-reviewed journals. Our research questions address whether this proportion has increased over time, and whether there are significant differences in these proportions by university and gender of graduate. In the next phase of the investigation we intend to do further analyses around the different types of dissemination strategies related to such journal outputs as well as the quality of the journals in which articles appear.

Methodology

The single biggest methodological challenge of our study was to link South African doctoral thesis metadata to journal articles authored by the doctoral candidates. As there is no national database that contains these data, we had to create a customised data set for the analysis by linking two databases housed at the Centre for Research on Evaluation, Science and Technology (CREST) at Stellenbosch University: the South African Theses Database (SATD) and South African Knowledgebase (SAK).

Over the past 5 years, CREST has been building the SATD. It is a dedicated bibliographic database of doctoral dissertations submitted at South African universities since 2000. The data have been extracted from institutional repositories and the South African National Research Foundation (NRF) database of theses and dissertations. Fields captured within the SATD are:

• Thesis title
• Doctoral candidate: surname, initials and first name
• Granting university and year of thesis
• Supervisor(s): surname, initials and first name
• Field of study (not always possible/often only department)
• Abstract (full abstract where available)
• URL (handle) to the actual depository address where the thesis is stored

At the time of conducting our analysis, the SATD included metadata on 23 547 doctoral theses for the period 2000 to 2017. This figure represented a 92.7% coverage of the 25 390 doctoral degrees awarded by South African universities over this period.13

The second database, the SAK, is CREST’s proprietary database of scientific publications authored by South African academics and scholars. SAK is unique in several respects. Firstly, SAK contains metadata on all scientific articles that earned subsidy for South African universities under the DHET Funding Framework. This means that it includes published articles that appear not only in the Web of Science (WoS), but also in other indexes and lists, including the DHET list of South African journals (not indexed in the WoS), the Proquest International Bibliography of the Social Sciences (IBSS) list, the Norwegian list and Scopus. As a result, we are able to augment the bibliometric analyses with more detailed analyses of output in different indexes as well as to compare the numbers of outputs in national versus international journals.

Specifically, SAK includes:

• Title of the document (article/proceedings/book/chapter)
• Author(s) (surname, initial and first name)
• Source information (journal/publisher/publication year)
Although the coverage for each of these variables is not equally good, we deem it to be sufficient to present general trends for each of the variables. Our coverage of these variables in all cases varies between 80% and 90% depending on the variable, allowing us to draw relatively robust conclusions from these analyses. The current version of SAK comprises 426 496 authorships made up of journal articles (82%), conference proceedings (13%), and books and book chapters (5%) that were submitted for subsidy to the DHET for the period 2005 to 2017.

Preparing the two databases for analysis required intensive work over a significant period of time as researchers at CREST spent many months ‘cleaning’ the data, and seeking to fill in missing information – a process that continued into the matching period as ongoing engagement with the data identified anomalies and gaps that needed to be addressed.

Ultimately, we decided to confine our analysis to doctoral theses granted by South African universities between 2005 and 2014 and these were then compared to all journal articles in SAK for the period 2005 to 2017. This allowed for the counting of publications for a period of between 12 years (for the 2005 graduates) and 3 years (for the 2014 graduates) after the date of graduation.

Matching records in the SATD and the SAK

Our process of matching the data in the two databases was as follows. The first step was to match the records of doctoral theses to the journal articles based on the surnames of graduates and first authors, and on the similarity between the graduating institution (in SATD) and the institution that submitted the request for publication subsidy (in SAK). Once this process had been completed, we needed to establish whether the thesis author (in SATD) and the article author (in SAK) were indeed the same person (this verification was required because of the many instances of the same surnames – especially very common surnames – in both databases). In order to establish a more verifiable link between the records in the two databases, we wrote an algorithm that assigned a similarity score between the thesis titles and the article titles (see Table 2 and Figure 1). This programmatic process was followed by a manual inspection of the results in order to isolate only those records for which the identity of the thesis author and article author had been established beyond doubt.

Despite this systematic and rigorous process, we should note two limitations. First, the likelihood of matching the records beyond reasonable doubt was reduced where graduates changed surnames (as a result, for example, of either marriage or divorce) or used a different surname, or even order of names, in their publications versus the full names provided on the cover of the theses. Second, using the university (graduating and submitting) as one identifier in the matching process could have excluded graduates who soon after graduation moved to another institution or were indeed already working at another institution at the time of graduation, and then published articles under the name of a university other than that from which they graduated. We do not view either of these issues as major weaknesses in our methodology. Given the size of the sample of theses and publications analysed, the impact of these limitations would be minimal and would simply mean that our estimates are (to a small degree) lower than the actual figures.

Our focus in this study is on doctoral graduates who published the findings or results of their doctoral studies in journals. We are well aware of the different publication practices across different fields. In the humanities and social sciences, for example, publications in books are deemed to be important. Fields such as the computer sciences, as well as certain subfields of engineering sciences, mathematics and economics, view conference proceedings as essential publication outlets. In the next phase of our investigation, we intend to investigate some of these other modes of publication as well. In some contexts, the dissemination of the knowledge takes place outside of academic fields altogether, through creative outputs, community workshops, policy briefs, patents and more. This is a limitation of the extent to which we can claim that publications in journals represent dissemination of knowledge developed through the doctorate, but the dominance of journal articles as the means of knowledge communication and the study’s large sample size mitigate this limitation.

Results

At the time of conducting the analyses for this study, SATD contained information on 13 962 doctoral theses of students who graduated between 2005 and 2014, representing 22 of the 26 higher education institutions in South Africa (Figure 1). The matching algorithm (Step 1) identified 51 864 possible authorships in SAK that could be linked to 7069 of these theses. The distribution of the similarity scores of these are summarised in Table 2.

The next step was to undertake a visual inspection of the 51 864 records and check whether the author of each publication (in SAK) was in fact the same person as the author of the doctoral thesis (the graduate listed in SAT). This process resulted in a reduced number of 44 073 records that could be definitively matched to a thesis author. The 44 073
It is important that we emphasise that the results presented in Table 3 refer to any publication that we could accurately link to a specific doctoral graduate (thesis). Whether the publication (journal article) was a direct product of the doctoral study and clearly based on the doctoral thesis is a second question which needs to be addressed.

Table 2: Breakdown of similarity index

| Range of similarity score | Count of records | Share |
|--------------------------|------------------|-------|
| 1                        | 66               | 0.13% |
| 0.00 to 0.1              | 24 658           | 47.54%|
| 0.1 to 0.2               | 14 211           | 27.40%|
| 0.2 to 0.3               | 6747             | 13.01%|
| 0.3 to 0.4               | 3248             | 6.28% |
| 0.4 to 0.5               | 1510             | 2.91% |
| 0.5 to 0.6               | 757              | 1.46% |
| 0.6 to 0.7               | 331              | 0.64% |
| 0.7 to 0.8               | 185              | 0.36% |
| 0.8 to 0.9               | 110              | 0.21% |
| 0.9 to 1                 | 41               | 0.08% |
| Grand total              | 51 864           | 100.00%|

Table 3: Proportion of doctoral graduates linked to journal articles by year (2005–2014)

| Year     | Number of graduates (total) | Number of published graduates | Published graduates as a percentage of all graduates |
|----------|----------------------------|-------------------------------|--------------------------------------------------|
| 2005     | 1118                       | 389                           | 34.8%                                            |
| 2006     | 1088                       | 433                           | 39.8%                                            |
| 2007     | 1313                       | 512                           | 39.0%                                            |
| 2008     | 1289                       | 614                           | 47.6%                                            |
| 2009     | 1317                       | 600                           | 45.6%                                            |
| 2010     | 1382                       | 701                           | 50.7%                                            |
| 2011     | 1425                       | 752                           | 52.8%                                            |
| 2012     | 1570                       | 836                           | 53.2%                                            |
| 2013     | 1683                       | 927                           | 55.1%                                            |
| 2014     | 1777                       | 886                           | 49.9%                                            |
| Total    | 13 962                     | 6650                          | 47.6%                                            |

Table 4: Linked journal articles according to publication date

| Thesis publication year | Number of linked theses | Number of published articles | % Before | % During | % After |
|-------------------------|-------------------------|------------------------------|----------|----------|--------|
|                         | Before                  | During                       | After    | Total    |        |
| 2008–2011               | 2667                    | 545                          | 5128     | 12 575   | 18 248 |
|                         | 3%                      | 28%                          | 69%      |          |        |
| 2009–2012               | 2889                    | 987                          | 5763     | 11 918   | 18 668 |
|                         | 5%                      | 31%                          | 64%      |          |        |
| 2010–2013               | 3216                    | 1440                         | 6781     | 11 232   | 19 453 |
|                         | 7%                      | 35%                          | 58%      |          |        |
| 2011–2014               | 3401                    | 1771                         | 7489     | 10 006   | 19 266 |
|                         | 9%                      | 39%                          | 52%      |          |        |

Table 5: Ratio of articles to theses (2008–2014)

| Year       | Published graduates | Articles published (during) | Ratio of article to theses (during) | Articles published (during and after) | Ratio of articles to theses (during and after) |
|------------|---------------------|-----------------------------|-------------------------------------|--------------------------------------|------------------------------------------------|
| 2008       | 614                 | 1242                        | 2.02                                | 2624                                 | 4.27                                           |
| 2009       | 600                 | 1088                        | 1.81                                | 2424                                 | 4.04                                           |
| 2010       | 701                 | 1277                        | 1.82                                | 2676                                 | 3.82                                           |
| 2011       | 752                 | 1521                        | 2.02                                | 3212                                 | 4.27                                           |
| 2012       | 836                 | 1877                        | 2.25                                | 3916                                 | 4.68                                           |
| 2013       | 927                 | 2106                        | 2.27                                | 4179                                 | 4.51                                           |
| 2014       | 886                 | 1985                        | 2.24                                | 3667                                 | 4.14                                           |
| Total      | 6650                | 11 096                      | 2.09                                | 26 905                               | 4.05                                           |
Although Table 4 shows that an increasing number of doctoral graduates publish from their thesis (the ‘during’ category), we were also interested to establish whether this finding meant that the average number of articles per thesis had increased over this time period. Table 5 presents the results of these analyses. It is interesting that the results show no significant increase in the average number of articles per thesis over this period: whether one focuses on only those articles that appeared during the generation of the thesis (average number of articles of just over 2.1) or on those articles which were published both ‘during’ and ‘after’ (up to 3 years after the graduate date, average of 4.1). This finding is interesting because it shows that although there has been an increase in the recent past of doctoral students publishing from their theses (Table 3), this increase does not mean that the average student who publishes from their thesis is generating more articles from their thesis than before. Stated differently: the increase in the number of articles that we have recorded linked to doctoral theses is due not to doctoral students on average becoming more productive, but simply that a larger proportion of doctoral students is in fact publishing from their theses.

The general trends observed above hide large differences in the publication practices of our sample. We give two examples below to illustrate this point. In both examples we have authors who have published before, during and after the completion of their theses.

The first example (Figure 2) is the profile of a student who published at least five journal articles in the period preceding the study years (2005 to 2009); five during the thesis years (2010–2013) and three subsequent to the completion of the thesis. The three articles highlighted in blue are seemingly not directly related to the thesis topic (although this is subject to further validation). The remaining articles – before, during and after – form a clearly cohesive collection of papers with a similar specialisation.

The second example (Figure 3) is the profile of a person whose thesis was published in 2012. This is also an example (similar to the example above) in which the candidate had published articles in a specific field before completion of the thesis. In fact, inspection of the actual thesis and the publication profile as illustrated below, shows the typical profile of a doctoral student who conducted a PhD by publication. All the titles highlighted in green appear as chapters in the thesis. This is clearly the profile of a scholar who had published in their field of specialisation for some time before writing up the thesis as well as continued to disseminate the results of the thesis after the degree was awarded. This is very often the profile of scientists in the natural and life sciences where the knowledge and insights produced over an extended period is cumulative in nature.

These two examples show how the profiles of publishing doctoral graduates can differ. Our very basic classification of articles (‘before’, ‘during’ and ‘after’) clearly hides deeper issues around differences in publication practices. We currently are investigating a more comprehensive typology of these variants.

In the remainder of the article we disaggregate our general findings further. In all of these analyses we revert to the total sample of articles linked to theses irrespective of whether these appeared before, during or after the thesis publication year. Including the ‘before’ category (which is the smallest category of publications) is justified for our focus now shifts away from the question of whether we have seen a clear increase in doctoral publication productivity (which has been sufficiently demonstrated above) to questions related to different publication practices at the institutional level (breakdown by university below) and at the individual level (breakdown by productivity and gender).

We have excluded Walter Sisulu University (5 of their 7 doctoral graduates published articles), Sefako Makgatho University (3 of their 5 graduates...
published) and Vaal University of Technology (6 of their 11 graduates published) from these tables as the numbers are too small for sensible percentages to be generated.

We first present a breakdown of the percentage of doctoral graduates who published before, during or after their doctorate by university (Table 6). Given the large range in the distributions by universities, we have split the table into two to distinguish between those universities with larger samples of publishing graduates (more than 200) and those with much smaller samples of graduates (between 30 and 200).

Table 6: Percentage of doctoral graduates per institution who have published (2005–2017)

| University (2005–2014) | Number of graduates | Number of graduates who have published | Percentage of graduates who have published (in descending order) |
|------------------------|---------------------|----------------------------------------|---------------------------------------------------------------|
| n = 200+               |                     |                                        |                                                               |
| Rhodes University      | 455                 | 266                                    | 58.46%                                                        |
| Stellenbosch University| 1565                | 876                                    | 55.97%                                                        |
| University of Cape Town| 1645                | 892                                    | 54.22%                                                        |
| University of KwaZulu-Natal | 1426            | 762                                    | 53.44%                                                        |
| University of the Witwatersrand | 1355          | 702                                    | 51.81%                                                        |
| North-West University  | 1146                | 579                                    | 50.52%                                                        |
| University of Pretoria | 1900                | 864                                    | 45.47%                                                        |
| University of the Free State | 682         | 295                                    | 43.26%                                                        |
| University of the Western Cape | 518      | 217                                    | 41.89%                                                        |
| University of Johannesburg | 731        | 299                                    | 40.90%                                                        |
| Nelson Mandela University | 539          | 207                                    | 38.40%                                                        |
| University of South Africa | 1056        | 295                                    | 27.94%                                                        |
| n < 200                |                     |                                        |                                                               |
| Tshwane University of Technology | 151      | 93                                     | 61.59%                                                        |
| Cape Peninsula University of Technology | 132    | 72                                     | 54.55%                                                        |
| University of Fort Hare | 183                 | 78                                     | 42.62%                                                        |
| University of Venda    | 45                  | 19                                     | 42.22%                                                        |
| Central University of Technology | 68      | 25                                     | 36.76%                                                        |
| Durban University of Technology | 82      | 30                                     | 36.59%                                                        |
| University of Limpopo  | 99                  | 34                                     | 34.34%                                                        |
| University of Zululand | 150                 | 31                                     | 20.67%                                                        |

The results (excluding the three universities with too small an output), reveal two interesting trends:

- The proportion of publishing graduates is typically highest at the traditional universities (higher than the average of 46% for the system).
- It is generally the case that doctoral graduates at the universities of technology publish from their PhDs at much lower rates (Tshwane and Cape Peninsula Universities of Technology being the exceptions).

Publication rates thus vary significantly by institution. Analysis at the level of the individual graduate also shows variance (Table 7), with 25% of graduates publishing only one article, and a significant group (41.66%) publishing from two to five articles. At the other end of the scale is a small group of 16 significant outliers who published more than 100 articles each. All of these 16 were, at the time of conducting this analysis, full-time academics who were affiliated with nine different universities; five were women, seven were black researchers, ten worked in medicine and the health sciences, only one came from the social sciences and none came from the humanities. It needs to be emphasised that the numbers in Table 7 relate only to the 6650 graduates to whom we could link publications.

Table 7: Publication rates per published graduate (before, during or after graduation within the 10-year period)

| Number of articles | Number of published graduates | Percentage of published graduates |
|--------------------|-------------------------------|----------------------------------|
| 100+               | 18                            | 0.27%                            |
| 51–100             | 47                            | 0.71%                            |
| 31–50              | 127                           | 1.91%                            |
| 21–30              | 190                           | 2.86%                            |
| 11–20              | 676                           | 10.18%                           |
| 6–10               | 1112                          | 16.74%                           |
| 2–5                | 2779                          | 41.84%                           |
| 1                  | 1692                          | 25.47%                           |

Further analyses of those doctoral graduates who have highlighted the trends in terms of gender (Figure 4) and journal index (Figure 5). The disaggregation by gender shows that there is no significant difference between the proportion of articles authored by men and that authored by women in comparison to the gender distribution of all doctoral graduates for the same year.
76% in 2005 to 82% in 2017. This finding is important as it suggests that published in journals in the WOS or Scopus citation databases: from (Figure 5) shows a small and steady increase in the proportion of articles and beyond 16,17, would lead academics and, by implication, also our characterises many higher education institutions, both in South Africa There has been some speculation that the pressure to publish that • Articles that appeared only in local DHET-accredited journals (and not in any other journal databases) were coded as ‘SA DHET’. • Articles that appeared only in the ProQuest IBSS list of journals (and not in any other journal databases) were coded as ‘IBSS’. • Articles that appeared in either the Web of Science and/or Scopus citation databases (and not in any other journal databases) were coded as ‘WOS/Scopus’. There has been some speculation that the pressure to publish that characterises many higher education institutions, both in South Africa and beyond16,17, would lead academics and, by implication, also our doctoral students or graduates to publish more in local journals (DHET) or IBSS journals rather than in journals that are indexed in the two citation databases (Web of Science or Scopus). However, the evidence (Figure 5) shows a small and steady increase in the proportion of articles published in journals in the WOS or Scopus citation databases: from 76% in 2005 to 82% in 2017. This finding is important as it suggests that the increase in the rate of publications from PhD theses did not occur at the expense of publishing in more visible international journals.

Discussion

We present an analysis of journal article publications by doctoral graduates in South Africa across a specific time frame to provide a picture of the publication rates of these graduates and, in so doing, consider what this picture might indicate about the quality of doctoral work. While we found that approximately 52.2% of doctoral graduates could not be linked to any DHET-accredited publication, there is evidence of a trend toward increasing publication by graduates over the period under scrutiny, which is promising, particularly given the increase in WOS/Scopus-indexed outputs. It is important, however, to consider what lies behind these findings, the context within which they occurred, and to reflect on what they mean for doctoral education going forward. As mentioned earlier, this paper presents the first level investigation and it is clear that work in this area should be ongoing, with many aspects requiring further investigation.

We have already alluded to the issue of subsidy generation for universities, and the concomitant pressure that institutions then place on supervisors and students to ‘produce’. We have also emphasised the role that the ‘PhD by publication’ model may have played in increasing doctoral outputs. There could, of course, be several other factors that our data cannot expose. In their work on enhancing postgraduate supervision, for example, Nulty et al.19 identified strengthening supervisor capacity, particularly at research-intensive universities, as a mechanism to grow postgraduate publication outputs. Over the past 10 years in South Africa, initiatives such as the Strengthening Postgraduate Supervision (www.postgraduatesupervision.com) and the Enhancing Postgraduate Environments (www.postgradenvironments.com) have intentionally focused on postgraduate supervision, possibly also contributing to the increase in outputs that we now observe. On the other hand, there may be supervisors who discourage publication during doctoral studies as it may distract the student from doctoral work4, or alternatively coerce students into publication for their own gain19. Clearly silent in this study are the individual student voices which could inform us about what motivates towards publication, what might enable or constrain it.

There are also a number of caveats that need to be considered. For example, what percentage of doctoral graduates leaves the academic environment after graduation and in so doing moves away from any work-related expectation that they should publish? Graduates may be publishing in journals that are not DHET accredited, but that are specific to their areas of interest. Differentiation also plays out across the representation of fields in the publishing arena. Some fields are more difficult to publish in than others,20 and some prefer different outputs such as music scores, books and portfolios – our study has not accounted for these. At a more detailed level, there is evidence of unevenness across the system as the issue of institutional histories that characterise the South African higher education system manifests here. While some universities have such low numbers of doctoral graduates that using publications as a proxy for the quality of the doctorate is highly problematic, there are universities with more than 100 doctoral graduations over this period where very few manage to publish. Two institutions stand out in Table 6. At University of Zululand, only 20.7% of their 150 PhD graduates could be matched to any publications. At Unisa, only 27.8% of their 1056 PhD graduates could be matched to any publications. Overall, the institutional data need to be read with care and interpreted through the lens of our country’s complex past.

There is also the issue of academics pursuing doctoral studies. For example, we know that approximately 35% of doctoral candidates are academics. For many academics, the doctorate represents a logical next step in their academic careers5, undertaken against the backdrop of the ‘publish or perish’ narrative that has become pervasive in academic circles16,17. Further analysis is needed to establish how many of the country’s doctoral graduates who have published are indeed academics, what factors have enabled or constrained their participation in publishing, and how some of these statistics might be shifted further upwards. Knowledge production and dissemination are central to the identity of an academic, as well as being key for promotion and for successfully securing grants that will fund future work.18 Focusing specifically on the outputs of doctoral graduates who are in an academic role is also important given that these graduates are expected to take on the supervision of future doctoral students. How does one take on the mantle of research mentor if one is not actively involved in the publication of research?

Finally, Figure 5 provides a breakdown of the publications by doctoral graduates according to the journal indexes and lists in which the relevant journals feature. For the purposes of this analysis, all articles were coded into three categories:

- Articles that appeared only in local DHET-accredited journals (and not in any other journal databases) were coded as ‘SA DHET’.
- Articles that appeared only in the ProQuest IBSS list of journals (and not in any other journal databases) were coded as ‘IBSS’.
- Articles that appeared in either the Web of Science and/or Scopus citation databases (and not in any other journal databases) were coded as ‘WOS/Scopus’.

![Figure 5: Articles disaggregated by journal index.](image)
As far as gender of the publishing doctorates is concerned, no significant difference was found between this cohort and the gender of all doctoral graduates. To put it differently: those doctoral graduates who published were in the same proportion of the gender distribution of all doctoral graduates over the same period. Further analysis by age of the graduate and scientific discipline may reveal deeper differences.

This analysis of doctoral publication outputs has provided a stratified overview of an extremely complex issue. We acknowledge that analysing ‘publications’ as a collective downplays the significant variance across the publication industry in terms of quality, reach, focus, and the like. Our data do not identify those graduates who could have in fact published in non-accredited or even predatory journals. Recent work in the area of predatory publishing has identified this as a significant area of concern, with 3.4% of articles published by South African authors in the period 2005 – 2014 being identified as having been published in such journals. It can be assumed that doctoral graduates are included in this number.

At a practical level, this study highlights the need for better tracking of publications given that graduates change their names and institutional affiliations. Many journals now require authors to include their ORCID. It is clear that encouraging the use of ORCID on all theses would greatly facilitate future work in this area, and indeed many universities are already implementing this as a requirement for the master’s and doctoral graduates as of 2019.

Ultimately, the study provides evidence of Lotka’s Law whereby most of the research publications in a system or institution are typically produced by a relatively small group of highly active academics (see also Kamler). Given that 75% of those doctoral graduates who do publish manage to publish two or more articles (Table 7), this study also suggests that if graduates can ‘crack the code’ and obtain one publication, they are likely to move on to more. Supporting doctoral candidates and new graduates to disseminate their work through publication seems to be an important endeavour, and yet it appears that mentorship to support doctoral publication is not common practice, particularly in the social sciences.

Given the enormity of responsibilities associated with supervision and the ‘burden of supervision’ in a context of scarce resources, some may argue that it is unfair to expect doctoral supervisors to take on the work of inducting graduates into the processes of writing for publication. However, as we have shown, the description of the doctorate in the Higher Education Qualifications Sub-Framework makes it clear that this is indeed central to doctoral education as ‘training for an academic career’ through the production of knowledge that should ‘merit publication’.

The study has opened up several avenues for further research, including more qualitative work, as suggested above. Further analysis of the data will also allow us to interrogate collaborations between doctoral scholars and their supervisors through co-authorships – an approach that has been identified as being enabling and generative for doctoral publication. Such work could expose the ‘back story’ that further qualitative studies could illuminate. For example, there may be cases where the supervisor undertook extensive mentoring with regard to publication, but chose not to take co-authorship, or where the supervisor wrote the article on their own without any such mentorship and included the student as co-author in recognition for their generation and/or analysis of the data; and so forth. These issues all influence the publication landscape, directly impact on the lives of many academics and students, and therefore warrant our attention.

Finally, it should be noted that the findings from this study are not necessarily out of kilter with work conducted in other countries. In 2008, Lee and Kamler observed similar trends in countries such as the UK, the USA and Australia. At the time, however, they called for doctoral programmes to be more intentionally structured to enable the dissemination of doctoral work, emphasising pedagogic practices that facilitate the graduate’s entry into the disciplinary community such as co-authorship, and other writing related initiatives. As South Africa continues to strive towards strengthening research work at doctoral level, institutions should be encouraged to build support for publication throughout the doctoral journey across the initial years and beyond. Much can be learned from those fields, particularly in the natural sciences, where there is a tradition of such collaborative endeavours.

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Authors’ contributions

S.v.S., S.M. and J.M. contributed to the conceptualisation of the study. S.v.S. led the writing process, and S.M. and J.M. contributed to the development of the manuscript from draft to finalisation. H.R. was responsible for data analysis and curation.

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