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What we can learn from elite academic staff publication portfolios: a social network analysis

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Abstract

Purpose: To construct an understanding of *professional academic writing* network structures to inform organisational strategic investment in academic staff development.

Design: Longitudinal social network analysis is used to examine the personal-networks evident in the publication portfolios of a purposive sample of four international academics across each quartile of the SCOPUS defined area of *General Nursing's* Top 100 authors.

Findings: Trends in the publication portfolios of elite academics across gender, sector and geographic location are presented. In the first years of successful writing for publication authors collaborate within a single highly connected co-author network. This network will typically expand to include new co-authors, before additional separate co-author collaborations emerge (three- to four- years). Authors experience steady growth in co-author numbers four- to seven- years from first co-authored publication. After a period of rapid expansion, these collaborations coalesce into a smaller number of highly connected groups (eight- to ten- years). Most collaborations occur within the higher education sector and across multiple disciplines including medicine, social sciences and psychology. Male co-authors are disproportionately represented in what is a predominantly female profession.

Practical implications: The development of extended co-author networks, locally, internationally, and across the higher education sector, enable authors to attain the marker of achievement required by universities and government funding bodies, namely sustained output of academic publications. Identified trends support the inclusion of investment in academic time and resources in higher education institutions' strategic and operational plans to enable academic staff to develop interdisciplinary professional networks. In focusing this investment on gender equality, female academics will experience parity of opportunity in achieving their organisational and personal goals relating to *professional academic writing*. Medium term investment may be required before the impact of that investment becomes apparent.

Originality/value: This is the first example of social network analysis used to determine characteristics of *professional academic writing* portfolios over time. Findings inform the type and range of investment required to facilitate academic staff writing activities, specifically those publishing in the area of *General Nursing*.

Background

Writing for publication is core to academic life and is used as a marker of achievement by universities and government funding bodies to inform the selective allocation of research funding (Australian Research Council, 2015, Research Excellence Framework, 2020a),

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academic staff review (McKiernan et al., 2019), promotion (University of Manchester, 2019) or tenure (McKiernan et al., 2019). While much has been written about supporting academic writing in students (Adler-Kassner and Wardle, 2015), there is an assumption that because staff can support students writing for assessment they are naturally equipped to write for publication (Grant et al., 2010).

Libraries have long supported writing within higher education, with initiatives ranging from writing centres located in library services in the early noughties (Rader, 2001) to contemporary narratives of libraries assisting staff in identifying journals that authors may wish to publish in, editing manuscripts and creating bibliographies (Akers, 2019). At this juncture it is important to distinguish between *academic writing* and *professional academic writing*. Writing centres have typically focused on *academic writing*, defined as writing by students in academic settings relating to assignments and theses for assessment. Broader library services having focused on supporting the *professional academic writing* of higher education staff for publication.

Responding to the findings of their systematic review exploring the "publish or perish" culture of universities and research institutes, Guraya et al (2016) suggest that universities have an obligation to train staff in sound scientific writing. The most effective forms of writing skills training in particular contexts remains unknown (Stylianou et al., 2017), though a lack of confidence in their writing ability can preclude an academic's decision to attend a writing interventions (Noone and Young, 2019). Sword (2017) found that only 15% of academic staff in their mixed methods study acquired *professional academic writing* skills through accredited writing courses or institutional sponsored mentoring programmes; for the majority of academics, skills development was achieved through reading books or attending occasional academic development workshops (38%), or ad hoc, opportunistic, and noninstitutionalised processes (47%). Multiple writing interventions exist to support academic staff on their journey to published author including writing groups (Grant et al., 2010), promoting motivation (Smith and Deane, 2014) through peer-formativity interviews (Murray and Thow, 2014), the use of specific software packages to provide an underlying structure for a piece of academic writing (Smith and Deane, 2014), writing retreats (Dwyer et al., 2015), how-to-guides (Belcher, 2019), and publisher provided author resources (Elsevier, 2020c, Taylor & Francis, 2020, Wiley, 2020a) and webinars (Wiley, 2020b). Evaluation of these techniques are typically drawn on anecdotal accounts or based on single case studies; although programmes of this type can facilitate research outputs, their impact and sustainability are generally limited (Kempenaara and Murray, 2018) suggesting that an alternative approach to supporting the *professional academic writing* of university staff may be required.

Recent estimates for the 2021 Research Excellence Framework suggest there will be a 43.8% increase in the number of full-time equivalent staff included in Panel A: Medicine, Health and

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Life Sciences, from 13,611 full-time equivalent members of staff in 2014 to 19,573 full-time equivalent members of staff (Research Excellence Framework, 2020c). The projected increase partly reflects a move from a selective staff inclusion in 2014 (Stern, 2016) to submitting all staff with 20% or more of their role being assigned to research in the 2021 census. These full-time equivalents are projected to be 73 per cent of the total eligible population of 26,812 estimated by the Higher Education Statistics Agency (Higher Education Statistics Agency, 2019). It is unclear what proportion of 11,095 full-time equivalent nursing and allied professionals academics' employed in the United Kingdom higher education sector in 2018/2019 (Higher Education Statistics Agency, 2019) will contribute to Panel A assessment (see Table 1), though given the research intensity of disciplines such as medicine and neuroscience also represented (Research Excellence Framework, 2020b) it seems unlikely that publications from all full-time equivalent nursing academics will be assessed. Although professional associations promoting excellence in higher education have called for the processes, policies and practice of achievement markers to be refined (Advance HE, 2017), publishing research papers remains a key marker of academic success. The question of what facilitated *professional academic writing* is a complex one worthy of exploration.

Originating in sociology, social network analysis facilitates the mapping of relationships and information flows between people and information/knowledge entities (Borgatti et al., 2018a). For example, Leonard and Bob are friends and they both work in the intensive care units. Social network analysis enables researchers to integrate quantitative data with qualitative and graphical data to construct a rich analysis of phenomena (Scott, 2017). Social network analysis uncovers trends of interaction and determines the conditions under which those trends arose (Quatman and Chelladurai, 2008).

In the absence of an accepted framework of how academics acquire writing skills (Murray and Thow, 2014), this study responds to the call for time series analysis to develop longitudinal perspectives of academic community research outputs (Kumar, 2015). A network can be understood as a web of relationships such as, in this instance, co-author relationships. Personal-networks, commonly referred to as ego-nets, are constructed from a purposively selected group of elite authors with the intention of exploring social structures between co-authors, facilitating representations of relationships between co-authors. Designed with the aim of understanding the social environment of individuals (Borgatti et al., 2018b), by constructing and reflecting upon several personal-network cases it is possible to identify general types of network structure including similarities and differences across individual cases, to produce general theories (Crossley et al., 2015), achieving what Borgatti et al. (2018b) propose is richer, more detailed data.

In the absence of contemporary studies exploring why nursing research is not published (Flanagan et al., 2016), it has been suggested that academic's writing activity is often informed by a desire to enable positive change in care provision through publication in practice-based

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journals (Clark and Thompson, 2015). A focus on publishing in practice-based journals is in tension with organisational expectations to publish in high impact journals, achieve high citation rates and achieve a high *h*-index (Clark and Thompson, 2018). Disparity in writing aspirations coupled with expectations of competence and a lack of a support system to encourage, develop, and support writers (McGrail et al., 2006) can result in the process of learning to write for publication being a demanding and stressful experience (Smith and Deane, 2014). It can be difficult for inexperienced academic writers to know how to start writing (Grant et al., 2010), their inexperience being a named barrier to writing for publication (Dhakal and Tornwal, 2020); as a consequence, many seek to acquire writing skills through a time consuming process of trial and error (Galipeaua et al., 2015).

This study moves beyond anecdotal accounts of initiatives to support for *professional academic writing* to examine the characteristics of the *professional academic writing* portfolios of academics publishing in the area of *General Nursing*. It seeks to determine whether there are identifiable trends in publication profiles that can be used to inform organisational strategic investment in the support provided to future academic staff seeking to write for publication in *General Nursing*. Analysis is made of co-authors relationships, co-author employer, country of co-author collaboration and gender.

Design

Social network analysis was used to identify and consider the significance of trends of co-author collaboration on writing productivity and impact. Data were acquired from SciVal. SciVal is an online bibliometric resource containing data on the research performances of worldwide research institutions, disciplines and individuals, using the abstract and citation database Scopus as its data source (Elsevier, 2020b). Authors were purposively sampled (Williamson, 2017), one from each quartile of SciVal's Top 100 authors of the Scopus defined area of *General Nursing* (Elsevier, 2020a). A full record of each author's publication history, herein defined as a portfolio, provided an information-rich case for in-depth study.

Inclusion criterion were that each author's employment included a minimum 50% in a higher education institution within the last five years. Portfolios were purposively selected to cover both qualitative and quantitative research projects. This acknowledged the inherent differences in writing styles of narrative based qualitative studies (American Psychological Association, 2020a) compared with the more routine and minimally burdensome reporting of quantitative studies (American Psychological Association, 2020b). Longitudinal comparisons

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were made of changes in author collaboration trends from first publication to latest available data to identify trends of central importance in the development of a *professional academic writing* portfolio.

Social network visualisations were generated to forefront network characteristics and trends of interactions of potential significance (Quatman and Chelladurai, 2008). Acknowledging the challenges inherent in drawing conclusions from large network visualisations, quantification of network properties (Quatman and Chelladurai, 2008), including network size and composition, was used to facilitate more precise interpretation and greater conceptual understanding of network trends.

Name ambiguity is a key consideration in the compilation of networks (Kumar, 2015), particularly in analyses of publication portfolios where authors may have used multiple versions of their name over the course of their writing career. To ensure the network analysis in this study created a true representation of co-author relations, instances of co-author name ambiguity *e.g. Grant, Maria J., Grant, MJ, Grant, M.J., Grant, Maria.,* were cross-checked in terms of an author's previous, current and latter organisational affiliations, contact details and recurring co-author collaboration. Disambiguated co-author details were merged to create a single entity for an author prior to the inclusion of each publication in the network analysis.

Network compositions were analysed using categorical data for number of co-authors, co-author employer, country of co-author collaboration and gender.

This study received ethical approval from the Liverpool John Moores University Nursing and Allied Health Research Ethics Committee on 12th June 2017: 17/NAH/018.

Findings

There were two male and two female authors entered in this analysis. Authors were drawn from across the globe including Europe, North America and South East Asia and had *h*-indexes ranging from 10 to 42; see Table 2. Portfolios included publications which contained a combination of qualitative and quantitative publication. Portfolios ranged in size from 57 to 360 outputs published over periods between 12 and 18 years.

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A breakdown of additional areas in which outputs were published included medicine; social sciences; biochemistry, genetics and molecular biology; and psychology (see Table 3). Network size and gender differences were analysed for the full data set. For other analyses the first 12 years from first co-authored paper were assessed for equivalence based on the publication period of the least published author.

Network Size

In the first years of successful writing for publication authors publish within a single highly connected co-author network. This network will typically expand to include new co-authors, before additional separate co-author collaborations emerge after three- to four- years. Authors experience a steady growth in co-author numbers between four- to seven- years from first co-authored publication. A rapid expansion in network size occurs eight- to twelve- years from first co-authored publication, increasing from between nine and 45 co-authored publications in Year Seven of a portfolio to between 40 and 96 co-authored publications in Year Nine; see Figure 1. Twelve years into their publication portfolios, the maximum number of years for the least published author, the size of collaborative writing networks had increased to between 106 and 151 co-authors.

Component Analysis

In social network analysis, components are maximally connected portions of a network disconnected from others (Borgatti et al., 2018a, Tsvetovat and Kouznetsov, 2011). Within the present study, components represent groups of co-authors connected only by the author of the portfolio under analysis. Figures 2-5 present the growth of co-author networks with each box representing a year of publication. Viewed from left to right, top to bottom, each author begins their co-author *professional academic writing* in a single group of co-authors.

Taking Q1_h42_M as an example, Year 1 of their publication record sees six co-authors in a single highly connected component. Year 4 sees new co-authors joining the writing group and increasing the component size. Year 6 sees the formation of a new co-author collaboration, with both components increasing in size over the next two years. In Year 9, the two writing collaborations join into a single entity and continue to expand in the next two years. From Year 12 of Q1_h42_M's writing career, smaller but highly connected writing groups also establish and grow.

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After a period of steady growth in their co-author networks, the portfolios in this analysis experience a period in which the number of writing groups collaborations coalesce into a smaller number of larger entities; see Figures 2-5. In three quarters of portfolios the consolidation is followed by development of new components. Twelve years into their publication portfolios those authors with the highest and lowest *h*-index worked with fewest components; see Figure 6.

Co-Author Location

Co-author relations within an author's higher education institution provided a starting point for the majority of authors (mean 72%; range 33%-100%;) but decreased over time (Year 12 - mean 34%; range 28%-43%); see Figure 7.

Levels of collaborations within the higher education sector remain higher (Year 1 - 53%-100%), at 12 years into a publication career the majority of author collaborations measured between 61% and 66%; see Figure 8. Q2_h28_M is anomalous with 94% of their co-author collaborations occurring within the higher education sector.

Country

For most authors initial co-authors relationships are built within their host country (83%-100%); see Table 4. After 12 years, authors with higher *h*-indexes have smaller numbers of host country co-authors and, inversely, larger numbers of international collaborators: Q1_h42_M had 46% host country co-authors and 54% of international co-authors compared with Q4_h10_F who had 86% host country co-authors and 14% international co-authors.

In this sample, Q2_h28_M and Q3_h12_F relocated to another country during their *professional academic writing* career after three and six years respectively. After 12 years publishing, Q3_h12_F's collaborations occurred in 61% of their host and previous host country compared with 56% in host country alone; Q2_h28_M's collaborations in their host and previous host country accounted for in 77% of co-author collaborations compared with 64% in host country alone; see Table 5.

Gender

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The male authors in this analysis began publishing earlier than the females, in 2003 compared with 2006 and 2007, publishing either exclusively or with 50% of male colleagues. In comparison, female authors began their publishing career co-authoring up to 100% of their papers with other females; see Table 6. To account for changes in gender related policies over time, data were analysed by year of publication rather than number of years into a writing career; see Table 7. In these data there is remains a strong correlation of female authors publishing with other female authors (mean 66%; range 61%-69%), male authors demonstrating a more even split (mean 49%; range 46%-55%).

Author Position

Except for Q4_h10_F, authors began their career as first authors. As time progressed there was an even split between first and final author position; see Table 8.

Discussion

Representing an important marker of professional and institutional achievement, writing for publication is a core element in the contemporary university setting. This study examined the personal-network characteristics of the *professional academic writing* portfolios of four elite academics publishing in the area of *General Nursing*. The study identifies trends to inform the organisational strategic investment required in the support provided to those wishing to write for publication as part of their academic life. Central in the *General Nursing* portfolios analysed was the development of co-author networks, with a noticeably shift in the number of co-authors around four years, and again at seven years, from first co-authored publication. Preferential attachment theory states that when seeking a collaborator to join one's network, in this instance a co-author, a determining factor is to connect with someone who has already established a positive reputation and, by association, is highly connected with access to the resources (Wagner and Leydesdorff, 2005). Such successes have been shown to perpetuate success with authors who have published before being more likely to publish again, and papers which attract citations are more likely to be cited again (de Solla Price, 1976). Preferential attachment has been linked with international co-author collaborations, noting that highly connected individuals increase their number of collaborations faster than their less connected colleagues (Wagner and Leydesdorff, 2005). In seeking to build collaborative networks, Wagner and Leydesdorff (2005) note that junior researchers may not be able to leverage the advantage of preferential attachment, sometimes referred to as cumulative advantage, because they have not yet established themselves as potentially attractive co-workers. The concept of preferential attachment is consistent with the marked increase in the number of co-author collaborations noted at four and seven years from first co-authored publication as junior researchers begin to establish their reputations as professional academic authors. To support employees in achieving elevated status, some organisations have

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proposed a range of measures to facilitate the building of networks and research collaborations including time for continuing professional development activities, sabbatical and visiting fellowships (Leydesdorff et al., 2013, Farajollahi et al., 2013).

Within the portfolios analysed a diversity of research areas are evident, in addition to the inclusion criterion of *General Nursing*. In a study of academic collaborations within and across disciplines it was noted that research tends to be organised around epistemological rather than ontological dimensions, that is, methods of investigation rather than topics of research (Bellotti et al., 2016). Notwithstanding, disciplinary areas are known to experience large variations in citation patterns (Aksnes et al., 2019). Ontologically, authors in the first two quartiles both published more frequently in the field of *Medicine* compared to *General Nursing* which may account for the difference in the quantity of citations received and subsequent elevated *h*-index. Adopting an epistemological approach to collaboration , shared methods of investigation may account for the range of disciplines, including medicine, social sciences and psychology, rather than the topic of research (Bellotti et al., 2016); see Table 3. Further analysis of the trends of methods, funding and topics under investigation within portfolios is proposed.

A marked change in the geographic location of co-authors within this analysis is evident between six- to nine- years into their publication portfolios (see Table 4). When accounting for the relocation of authors (see Table 5) a noticeable decrease in the dominance of co-authors based in an author's host or previous country remains evident as the percentage of international co-authors increases. The consistent and growing proportion of internationally co-authored papers (Leydesdorff et al., 2013) may, in part, be accounted for by technological advances that have mitigated the need for researchers to work in close geographical proximity (Hoekman et al., 2010). Initiatives by national governments (Kwon et al., 2011) and programmes such as the European Framework (European Commission, 2020), purposefully established to stimulate international research collaboration (Adams and Gurney, 2016) may also be a factor. Elsewhere, evaluation frameworks such as the Research Excellence Framework in the United Kingdom (Research Excellence Framework, 2020a) and the Excellence in Research for Australia (Australian Research Council, 2015) continue to influence what, how and for whom academics write (Murray and Thow, 2014). Previously dominated by research-intensive western Europe and the USA, an analysis of a sub-set of Science Citation-Index Expanded (SCI-E) journals, identified that all nations are now collaborating in co-authored papers across geographical boundaries (Leydesdorff et al., 2013). For some established economies the total research output since the mid-1980's has more than doubled (Adams and Gurney, 2016). However, while domestic research output levels have not increased (United Kingdom – 47,5000 papers per year), international collaborations have increased more than ten-fold (Adams and Gurney, 2016). The true import of these explanatory frameworks on writing behaviour are worthy of additional examination.

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Male authors were disproportionately represented in all the portfolios analysed: 31%-53% of co-authors in the portfolios analysed were male; see Table 6. Women typically co-authored with other women 20% more than men with women; male co-author relationships presenting closer to a 50-50 split. Male authors wrote with female co-authors a maximum of 58% of the time; range 43%-53%. A recent ranking of the world's top 100 universities (Times Higher Education, 2020) included analysis of organisational commitments to gender equality, including the recruitment and promotion of women, as informed by the United Nation Sustainable Development Goals (United Nations, 2020b). Sustainable Development Goal 5 calls for the adoption of sound policies to empower all women and girls at all levels (United Nations, 2020a). Within this context gender differences evident in the portfolios is of particular significance given the latest available data indicating that nursing is a highly gendered profession with a consistent 89% to 11% female-to-male ratio of nurses on the Nursing and Midwifery Council register since 2013 (Nursing and Midwifery Council, 2014, Nursing and Midwifery Council, 2015, Nursing and Midwifery Council, 2016, Nursing and Midwifery Council, 2017, Nursing and Midwifery Council, 2018, Nursing and Midwifery Council, 2019). Academic nursing departments also have a high female-to-male staff ratio of 75% female to 25% male (Higher Education Statistics Agency, 2019). These findings firmly indicate gender inequality beneficial to male authors in the *General Nursing* portfolios analysed.

Clear longitudinal trends are apparent across this study of portfolios containing *General Nursing* outputs, with most authors beginning their co-authored *professional academic writing* career as first authors; see Table 8. The technical definition of authorship encompasses not only the person who undertakes the writing of a manuscript, but also those who have made a substantial contribution to a study, whether in formulating the problem, structuring the design, conducting statistical analysis, or interpreting the results (American Psychological Association, 2019). Authorship conventions differ among disciplines and can prove challenging to negotiate when writing as part of a multidisciplinary team (National Academy of Sciences et al., 2009). Nonetheless, the convention of placing the principle investigator last in an author list has become an accepted standard across most research areas, signalling intellectual input or supervision of the work reported rather than actively conducting the research or writing the manuscript (American Psychological Association, 2019). In nursing the first author has typically contributed the most to the development of a manuscript with the assignment of subsequent authors reflecting their relative contribution (Oermann and Hays, 2016), as is apparent at the start of co-author relationships represented in this analysis. However, in contrast with the anticipated shift towards final author placement of the female authors, male authors continued to be named as first author more than a decade after first publication. Whether first author male authors attributions persist because they maintain a higher level of project involvement or, contrary to guidance (American

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Psychological Association, 2019), have been assigned the position of first author due to relative status is unclear.

Although some academic staff appear to spontaneously succeed in *professional academic writing* the assumption that all writers have similar capacity to flourish is too simplistic (Hyland, 2016). The findings of this study highlight consistent trends in the publication portfolios of elite academics publishing in *General Nursing*, particularly the significance of expansive professional networks in producing sustained *professional academic writing* outputs. To enable all academic staff to thrive in achieving their personal and organisational publishing goals, the implementation of institution-wide strategies facilitating continuing professional development are recommended. These development activities should focus on fostering opportunities to build the interdisciplinary professional networks necessary to make academics wishing to publish in the area of *General Nursing* attractive as collaborators and co-authors.

While university Vice Chancellors act as Chief Executives responsible for authorising strategic decisions within their institution their decisions are informed by the work of executive committees. Also known as strategic management teams, executive committees are in charge of devising policies in key areas of university business including developing strategic and operational plans with associated budget allocations. Based on this research, it is recommended that higher education institution executive committees build medium-term investment into their strategic and operational plans for time, resources and facilitation of academic staff development in relation to writing for publication. Acknowledging the role of the university library in assisting academics with their publishing endeavours (Akers, 2019), targeted investment in library services to support *professional academic writing* should be represented as part of these organisational plans. Within the context of gender differences evident in *General Nursing* portfolios, it is recommended that strategic and operational plans particularly focus on the continuing professional development of female academics. In focusing on gender equality (Times Higher Education, 2020, United Nations, 2020a), the female academics who comprise the majority of the nursing practice and academic communities will experience parity of opportunity in achieving this key marker of achievement used by university in promotion, tenure and academic review, *professional academic writing*.

Limitations

Like bibliometric and social network analysis studies before, this study has relied upon quantification of network characteristics without the opportunity to explore qualitatively the meanings of those characteristics. The *h*-index is used by SCOPUS to compile a list of the Top

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100 authors in a specialism and provided a useful starting point to purposively select publication portfolios for analysis in this study. However, it is reasonable to conclude that all the authors of these portfolios should be considered elite authors given the latest available World Health Organisation statistics that there are 20.7 million nurses and midwives in the world (World Health Organisation, 2016); a premise borne out by Hirsch (2005), creator of the *h*-index, estimation that after 20 years a "successful scientist" would have an *h*-index of 20, an "outstanding scientist" an *h*-index of 40, and a "truly unique" individual an h-index of 60. the portfolios within the analysis were consistent with this definition, *h*-indexes ranging from 10 to 42, even accounting for the variation of *h*-indexes between fields (Hirsch, 2005). The analysis presented illustrates the *professional academic writing* networks of an elite cohort of academic writers publishing in *General Nursing* and may therefore differ from the portfolios of other disciplines.

While whole-network designed social network analysis which assume that the full data set is available (Borgatti et al., 2018b), or studies which combine whole-networks with the quantitative analysis of written documents (Waltman and Noyons, 2018) that is bibliometric or citation analysis (Yu-Wei, 2011, Mangas-Vega et al., 2016, Lining et al., 2019, Ardanuy et al., 2009), this study has focused on personal-networks of a select group of elite authors. While other techniques can provide statistical generalisations of an area, the case studies presented have enabled analytic generalisations to be made (Yin, 2018). The findings within this study demonstrate correlations between co-author network size, employing organisation, geographic location and gender, though further investigation is required to determine the cause of these relationships.

Conclusion

This research presents insight into consistent publication trends across gender, sector and geographic location in the portfolios of academics publishing in the area of *General Nursing.* University executive committees can use the trends evident in these descriptive data to support the development of, and investment in, institutional-wide strategic and operational plans to support academics writing for publication; these plans should include targeted investment in academic staff time and resources to foster interdisciplinary connections, nationally and internationally, through continuing professional development activities. Strategic investment in staff development over a medium- to long- term may be required before the impact of that investment becomes apparent.

Further research is underway to develop insight into the qualitative experiences of how staff negotiate the *professional academic writing* landscape, from developing research skills,

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building support structures and interdisciplinary networks, securing adequate resources, and negotiating the publishing process.

Practical Implications

The development of extended co-author networks, locally, internationally, and across the higher education sector, enable authors to attain the marker of achievement required by universities and government funding bodies, namely sustained output of *professional academic writing* for publication. Identified trends support strategic investment in academic time and resources to build professional networks across disciplines. Medium- to long- term investment may be required before the impact of that investment becomes apparent.

Using social network analysis techniques to interrogate personal-networks, this information science based doctoral research demonstrates that by aligning to the needs of our stakeholders, as advocated by our professional associations (Chartered Institute of Library and Information Professionals, 2019, Medical Library Association, 2020), we can generate evidence to help inform strategic investment in staff time and resources.

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Table 1: Research Excellence Framework – Panel A

Panel A of the Research Excellence Framework includes the following disciplines:
Agriculture; Allied Health Professions; Biological Sciences; Clinical Medicine; Dentistry; Food; Health Services; Neuroscience; Nursing; Pharmacy; Primary Care; Psychiatry; Psychology; Public Health; and Veterinary Sciences.

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Table 2: Author Profiles of Selected *General Nursing* Portfolios

Q1_h42_M: Professor at a higher education institution in Western Europe. He has a background in health sciences and has studied to PhD level. He has received international awards recognising the quality of his research, was a founding member of an international research network, and holds advisory positions with national and international organisations and journals.

Q2_h28_M: Professor and Associate Dean (Research) at a higher education institution in North America. He is a Registered Nurse and has studied to PhD level. Having worked as a Post-Doctoral Researcher, he relocated from the United Kingdom to an Associate Professor position in North America. He has received international awards recognising the quality of his research, held leading roles on international nursing organisations, and holds an editorial position with an international ISI listed journal.

Q3_h12_F: Associate Professor at a higher education institution in South East Asia. She has a background in clinical medicine. Her Masters' in Nursing and PhD-level studies were completed in Europe before returning to South East Asia to take up her position as Associate Professor.

Q4_h10_F: Professor at a higher education institution in Southern Europe. She is a Registered Nurse, held leading roles in European regulatory bodies, was a founding member of national research network, and is a leading member of her national nursing association.

Note: Authors are defined by Quartile_h-Index_Gender e.g. Quartile1_h-index=42_Male reads Q1_h42_M

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Table 3: Subject Composition of Publication Portfolios

	Biochemistry, Genetics and Molecular Biology	General Nursing	Medicine	Psychology	Social Sciences	Others
Q1_h42_M	7%	18%	63%	3%	3%	6% *Including agricultural and biological sciences*
Q2_h28_M	-	32%	46%	2%	14%	6% *Including health professions, & arts and humanities*
Q3_h12_F	-	67%	33%	-	-	-
Q4_h10_F	-	57%	29%	-	7%	7% *Including mathematics*

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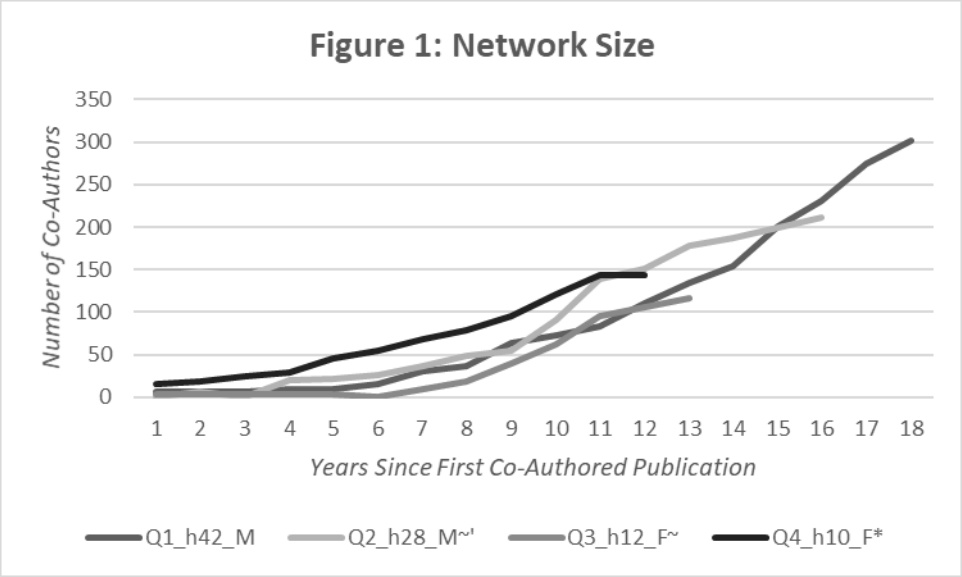

~ Moved countries: Q2_h28_M in Year 3 & Q3_h12_F in Year 6

' Published single authored papers in the preceding four years

** Partial data for final year*

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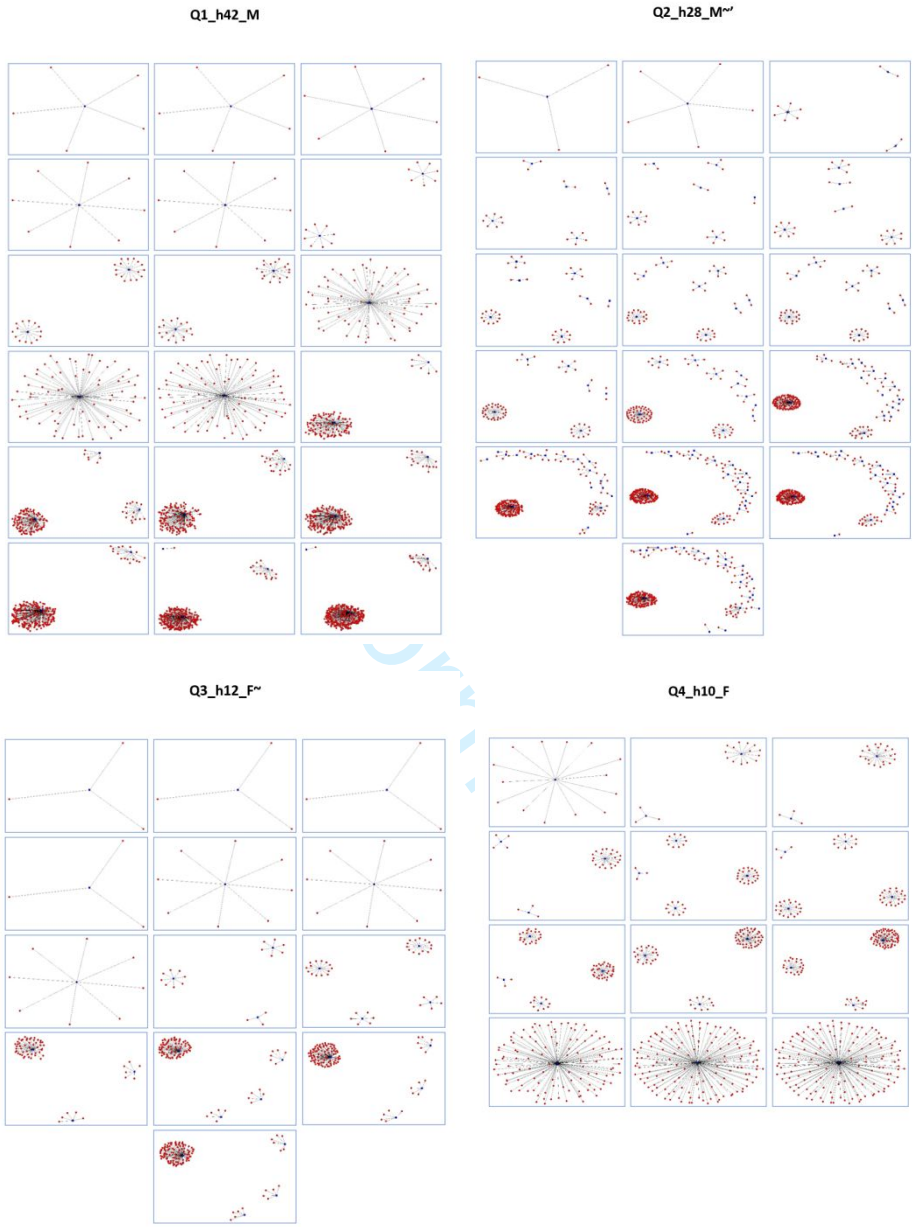
Figures 2-5: Co-Author Collaborations of up to 18 Years

From First Co-Authored Publication



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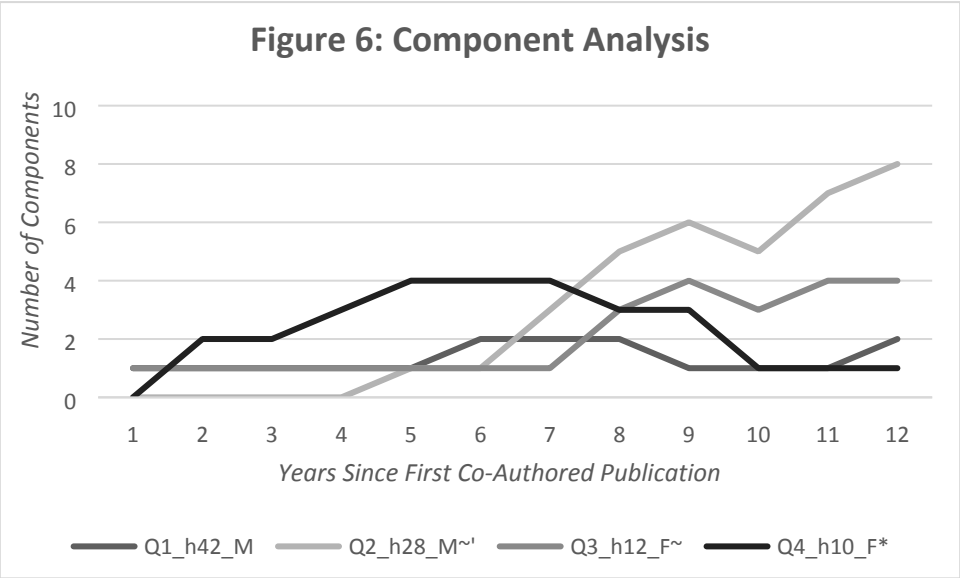

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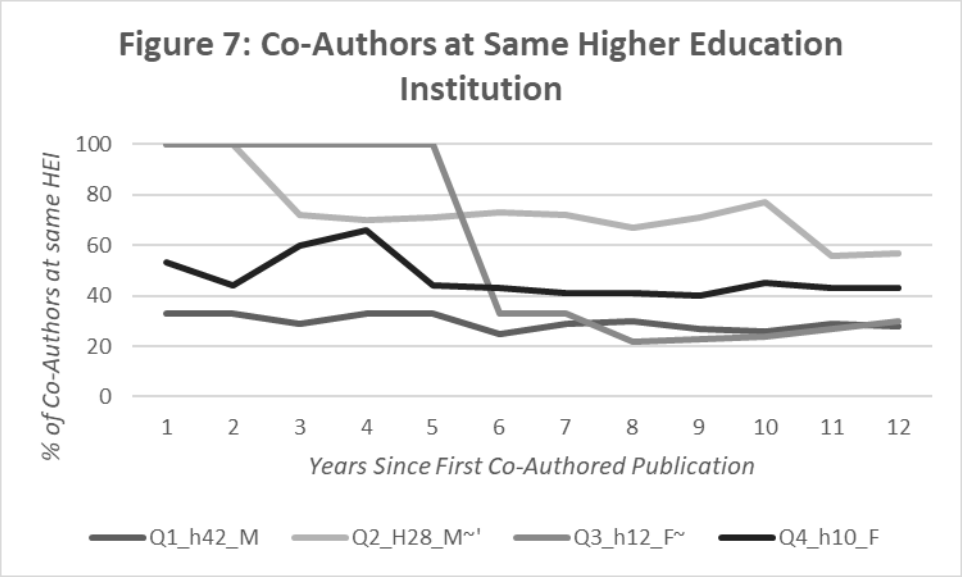

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' Published single authored papers in the preceding four years

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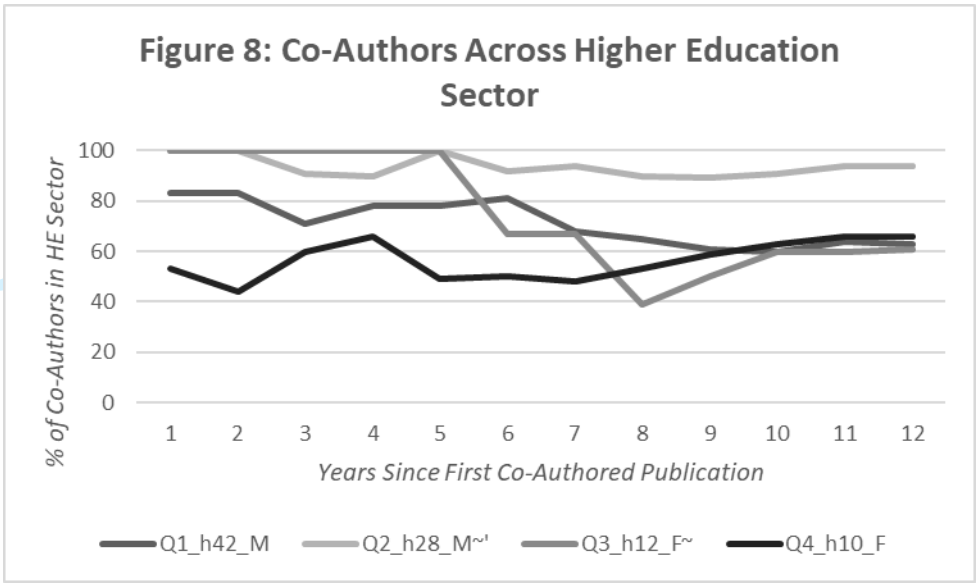

~ Moved countries: Q2_h28_M in Year 3 & Q3_h12_F in Year 6

' Published single authored papers in the preceding four years

** Partial data for final year*

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Table 4: Percentage of Co-Author Collaborations in Host Country

	Years of Publishing											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Q1_h42_M	83%	83%	86%	89%	89%	56%	45%	49%	44%	44%	44%	46%
Q2_h38_M'	100%	100%	27%~	35%	48%	46%	50%	60%	64%	53%	63%	64%
Q3_h12_F	100%	100%	100%	100%	100%	67%~	67%	50%	45%	45%	52%	56%
Q4_h10_F	100%	94%	96%	97%	98%	97%	97%	96%	90%	90%	86%	86%*

' Published single authored papers in the preceding four years

~ Moved countries

** Partial data*

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Table 5: Percentage of Collaborations in Host Country or Previous Host Country

	Years of Publishing											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Q1_h42_M	83%	83%	86%	89%	89%	56%	45%	49%	44%	44%	44%	46%
Q2_h28_M'	100%	100%	100%~	95%	95%	92%	92%	90%	91%	71%	77%	76%
Q3_h12_F	100%	100%	100%	100%	100%	100%~	100%	67%	48%	50%	42%	61%
Q4_h10_F	100%	94%	96%	97%	98%	97%	97%	96%	90%	90%	86%	86%*

' Published single authored papers in the preceding four years

~ Moved countries

** Partial data*

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Table 6: Percentage of Collaborations with Female Authors by Year of Publication

	Years of Publishing															
Gender	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Q1_h42_M	0%	0%	0%	19%	29%	38%	40%	42%	43%	47%	55%	52%	50%	50%	48%	47%
Q2_h38_M’	50%'	50%	54%~	50%	52%	46%	58%	53%	56%	50%	55%	56%	47%	47%	46%	46%
Q3_h12_F	-	-	-	100%	100%	100%	100%	100%	78%~	78%	61%	63%	68%	62%	64%	68%
Q4_h10_F	-	-	-	-	27%^	20%^	18%^	36%^	57%^	64%^	64%^	62%^	66%^	68%^	69%^	69%*^

‘ Published single authored papers in the preceding four years

~ Moved countries

^Contained instances where co-author gender was not possible to determine; these data were excluded from the analysis

** Partial data*

Table 7: Aggregated Percentage of Collaboration with Female Authors

	2004-2008	2009-2013	2014-2018
Q1_h42_M	17%	45%	49%
Q2_h38_M'	50%~	54%	48%
Q3_h12_F	100%	83%~	65%
Q4_h10_F	24%^	48%^	67%^

' Published single authored papers in the preceding four years

~ Moved countries

^Contained instances where co-author gender was not possible to determine; these data were excluded from the analysis

** Partial data*

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Table 8: Position in List of Authors

	Start of Writing Career			Twelve Years into Writing Career			Eighteen Years into Writing Career		
Q1_h42_M	First	Middle	Final	First	Middle	Final	Final	Middle	First
Q2_h28_M	First	Middle	Final	First	Final	Middle	First	Final	Middle
Q3_h12_F	First	Final	Middle	Final	Middle	First	-	-	-
Q4_h10_F	Middle	First	Final	Final	First	Middle	-	-	-

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Abstract

Purpose: To ~~identify publication trends by successful academic authors to~~ construct an understanding of *professional academic writing* network structures to inform organisational strategic ~~development~~investment in academic staff development.

Design: Longitudinal social network analysis is used to examine the personal-networks evident in the publication portfolios of a purposive sample of four international academics ~~within~~ across each quartile of the SCOPUS defined area of *General Nursing's* Top 100 authors.

Findings: ~~Unique insight is presented of trends~~ Trends in the publication portfolios of elite academics across gender, sector and geographic location are presented. In the first years of successful writing for publication authors collaborate within a single highly connected co-author network. This network will typically expand to include new co-authors, before additional separate co-author collaborations emerge (three- to four- years). Authors experience steady growth in co-author numbers four- to seven- years from first co-authored publication. After a period of rapid expansion, these collaborations coalesce into a smaller number of highly connected groups (eight- to ten- years). Most collaborations occur within the higher education sector and across multiple disciplines including medicine, social sciences and psychology. Male co-authors are disproportionately represented in what is a predominantly female profession.

Practical implications: The development of extended co-author networks, locally, internationally, and across the higher education sector, enable authors to attain the marker of achievement required by universities and government funding bodies, namely sustained output of ~~high-quality~~ academic publications. Identified trends support the inclusion of ~~strategic~~ investment in academic time and resources in higher education institutions' strategic and operational plans to enable academic staff to develop interdisciplinary ~~build~~ professional networks ~~across disciplines~~. In focusing this investment on gender equality, female academics will experience parity of opportunity in achieving their organisational and personal goals relating to *professional academic writing*. Medium term investment may be required before the impact of that investment becomes apparent.

Originality/value: This is the first example of social network analysis used to determine characteristics of *professional academic writing* portfolios over time. Findings inform the type and range of investment required to facilitate academic staff writing activities, specifically those publishing in the area of *General Nursing*.

Background

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Writing for publication is core to academic life and is used as a marker of achievement~~, with~~ by universities ~~(University of Manchester, 2019)~~ and government funding bodies to inform the selective allocation of research funding (Australian Research Council, 2015, Research Excellence Framework, 2020a), ~~requiring sustained outputs of high-quality publications. These high quality publications were recently defined by 40% of 129 research intensive higher education institutions with reference to a journal's impact factor (McKiernan et al., 2019). Reservations about the use of journal impact factors as a mark of quality for research publications are well rehearsed, from unaccounted differences between disciplines and insufficient citation windows, through to the skewing of underlying citation distributions (Larivière and Sugimoto, 2019). Although professional associations promoting excellence in higher education have called for the processes, policies and practice of achievement markers to be refined (Advance HE, 2017), high quality publications continue to be used to inform university criteria for~~ academic staff review (McKiernan et al., 2019), promotion (University of Manchester, 2019) or tenure (McKiernan et al., 2019).

While much has been written about supporting academic writing in students (Adler-Kassner and Wardle, 2015), there is an assumption that because staff can support students writing for assessment they are naturally equipped to write for publication (Grant et al., 2010).

~~This assumption runs counter to findings that one-quarter of academic staff do not publish over a five year period (Harris, 1990), despite 97% of newly qualified staff signalled an intention to write for journals, newsletters and peer-review publications (Bradley, 2008). This supports earlier studies that report that as few as 1% of writing projects are ever translated into published articles (Hicks, 1993, Hicks, 1995). In the absence of contemporary studies exploring why nursing research is not published (Flanagan et al., 2016),(Clark and Thompson, 2015) it is unknown to what extent a lack of writing skills development contributes to these figures, nor the form that writing skills training should take (Stylianou et al., 2017). For the inexperienced academic writer it can be difficult to know how to start writing (Grant et al., 2010) with many seeking to acquire writing skills through a time consuming process of trial and error (Galipeaua et al., 2015). Expectation of competence and a lack of a support system to encourage, develop, and support writers (McGrail et al., 2006) can result in the process of learning to write for publication being a demanding and stressful experience (Smith and Deane, 2014)For the inexperienced academic writer it can be difficult to know how to start writing (Grant et al., 2010) with many seeking to acquire writing skills through a time consuming process of trial and error (Galipeaua et al., 2015). resulting in some academics believing they are not sufficiently capable (Swart et al., 2015).~~

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Libraries have long supported writing within higher education, with initiatives ranging from writing centres located in library services in the early noughties (Rader, 2001) to contemporary narratives of libraries assisting staff in identifying journals that authors may wish to publish in, editing manuscripts and creating bibliographies (Akers, 2019). At this juncture it is important to distinguish between *academic writing* and *professional academic writing*. Writing centres have typically focused on *academic writing*, defined as writing by students in academic settings relating to assignments and theses for assessment. Broader library services having focused on supporting the *professional academic writing* of higher education staff for publication.

Responding to the findings of their systematic review exploring the "publish or perish" culture of universities and research institutes, Guraya et al (2016) suggest that universities have an obligation to train staff in sound scientific writing. The most effective forms of writing skills training in particular contexts remains unknown (Stylianou et al., 2017), though a lack of confidence in their writing ability can preclude an academic's decision to attend a writing interventions (Noone and Young, 2019). Sword (2017) found that only 15% of academic staff in their mixed methods study acquired *professional academic writing* skills through accredited writing courses or institutional sponsored mentoring programmes; for the majority of academics, skills development was achieved through reading books or attending occasional academic development workshops (38%), or ad hoc, opportunistic, and noninstitutionalised processes (47%). Multiple writing interventions exist to support academic staff on their journey to published author including writing groups (Grant et al., 2010), promoting motivation (Smith and Deane, 2014) through peer-formativity interviews (Murray and Thow, 2014), the use of specific software packages to provide an underlying structure for a piece of academic writing (Smith and Deane, 2014), writing retreats (Dwyer et al., 2015), how-to-guides (Belcher, 2019), and publisher provided author resources (Elsevier, 2020c, Taylor & Francis, 2020, Wiley, 2020a) and webinars (Wiley, 2020b). ~~Multiple writing interventions have been identified as supporting academic staff on their journey to published author including how-to-guides (Belcher, 2019), writing groups (Grant et al., 2010), writing retreats (Dwyer et al., 2015), promoting motivation (Smith and Deane, 2014) through peer-formativity interviews (Murray and Thow, 2014), and use of specific software packages to provide an underlying structure for a piece of academic writing (Smith and Deane, 2014).~~ Evaluation of these techniques are typically drawn on anecdotal accounts or based on single case studies~~;~~ ~~, it being noted that~~ although programmes of this type can facilitate research outputs, their impact and sustainability are generally limited (Kempenaara and Murray, 2018) suggesting that an alternative approach to supporting the *professional academic writing* of university staff may be required.

Recent estimates for the 2021 Research Excellence Framework suggest there will be a 43.8% increase in the number of full-time equivalent staff included in Panel A: Medicine, Health and

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Life Sciences, from 13,611 full-time equivalent members of staff in 2014 to 19,573 full-time equivalent members of staff (Research Excellence Framework, 2020c). The projected increase partly reflects a move from a selective staff inclusion in 2014 (Stern, 2016) to submitting all staff with 20% or more of their role being assigned to research in the 2021 census. These full-time equivalents are projected to be 73 per cent of the total eligible population of 26,812 estimated by the Higher Education Statistics Agency (Higher Education Statistics Agency, 2019). It is unclear what proportion of 11,095 full-time equivalent nursing and allied professionals academics' employed in the United Kingdom higher education sector in 2018/2019 (Higher Education Statistics Agency, 2019) will contribute to Panel A assessment (see Table 1), though given the research intensity of disciplines such as medicine and neuroscience also represented (Research Excellence Framework, 2020b) it seems unlikely that publications from all full-time equivalent nursing academics will be assessed. Although professional associations promoting excellence in higher education have called for the processes, policies and practice of achievement markers to be refined (Advance HE, 2017), publishing research papers remains a key marker of academic success. The question of what facilitated *professional academic writing* is a complex one worthy of exploration.

~~This study moves beyond anecdotal accounts of one-to-one library support for *professional academic writing* to examine the characteristics of the *professional academic writing* portfolios of academics. It seeks to determine whether there are identifiable trends in publication profiles that can be used to inform the support provided to future academic staff seeking to write for publication. Analysis is made of co-authors relationships, co-author employer, country of co-author collaboration and gender.~~

Originating in sociology, social network analysis facilitates the mapping of relationships and information flows between people and information/knowledge entities (Borgatti et al., 2018a). For example, Leonard and Bob are friends and they both work in the intensive care units~~music industry~~. Social network analysis enables researchers to integrate quantitative data with qualitative and graphical data to construct a rich analysis of phenomena (Scott, 2017). Social network analysis uncovers trends of interaction and determines the conditions under which those trends arose (Quatman and Chelladurai, 2008).

In the absence of an accepted framework of how academics acquire writing skills (Murray and Thow, 2014), this study responds to the call for time series analysis to develop longitudinal perspectives of academic community research outputs (Kumar, 2015). A network can be understood as a web of relationships such as, in this instance, co-author relationships. Personal-networks, commonly referred to as ego-nets, are constructed from a purposively selected group of elite authors with the intention of exploring social structures between co-authors, facilitating representations of relationships between co-authors. Designed with the aim of understanding the social environment of individuals (Borgatti et al., 2018b), by constructing and reflecting upon several personal-network cases it is possible to identify

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general types of network structure including similarities and differences across individual cases, to produce general theories (Crossley et al., 2015), achieving what Borgatti et al. (2018b) propose is richer, more detailed data.

In the absence of contemporary studies exploring why nursing research is not published (Flanagan et al., 2016), it has been suggested that academic's writing activity is often informed by a desire to enable positive change in care provision through publication in practice-based journals (Clark and Thompson, 2015). A focus on publishing in practice-based journals is in tension with organisational expectations to publish in high impact journals, achieve high citation rates and achieve a high *h*-index (Clark and Thompson, 2018). Disparity in writing aspirations coupled with expectations of competence and a lack of a support system to encourage, develop, and support writers (McGrail et al., 2006) can result in the process of learning to write for publication being a demanding and stressful experience (Smith and Deane, 2014). It can be difficult for inexperienced academic writers to know how to start writing (Grant et al., 2010), their inexperience being a named barrier to writing for publication (Dhakal and Tornwal, 2020); as a consequence, many seek to acquire writing skills through a time consuming process of trial and error (Galipeaua et al., 2015).

~~to the call for time series analysis to develop longitudinal perspectives of academic community research outputs (Kumar, 2015).~~This study moves beyond anecdotal accounts of ~~one-to-one library~~ initiatives to support for *professional academic writing* to examine the characteristics of the *professional academic writing* portfolios of academics publishing in the area of *General Nursing*. It seeks to determine whether there are identifiable trends in publication profiles that can be used to inform organisational strategic investment in the support provided to future academic staff seeking to write for publication in *General Nursing*. Analysis is made of co-authors relationships, co-author employer, country of co-author collaboration and gender.

Design

Social network analysis was used to identify and consider the significance of trends of co-author collaboration on writing productivity and impact. ~~Using the abstract and citation database Scopus as its data source (Elsevier, 2020c),~~ Data were acquired from SciVal. SciVal is ~~is~~ an online bibliometric resource containing data on the research performances of worldwide research institutions, disciplines and individuals, ~~.~~ using the abstract and citation database Scopus as its data source (Elsevier, 2020b). Authors were purposively sampled (Williamson, 2017), one from each quartile of SciVal's Top 100 authors of the Scopus defined

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area of *General Nursing* (Elsevier, 2020a). A full record of each author's publication history, herein defined as a portfolio, provided an information-rich case for in-depth study.

Inclusion criterion were that each author's ~~recent~~ employment included a minimum 50% in a higher education institution within the last five years. Portfolios were purposively selected to cover both qualitative and quantitative research projects. This ~~. Acknowledging~~ acknowledged the inherent differences in writing styles of narrative based qualitative studies (American Psychological Association, 2020a) compared with the more routine and minimally burdensome reporting of quantitative studies (American Psychological Association, 2020b)~~, portfolios were purposively selected to cover both writing styles~~. Longitudinal comparisons were made of changes in author collaboration trends from first publication to latest available data to identify trends of central importance in the development of a *professional academic writing* portfolio.

Social network visualisations were ~~used~~ generated to forefront network characteristics and trends of interactions of potential significance (Quatman and Chelladurai, 2008). Acknowledging the challenges inherent in drawing conclusions from large network visualisations, quantification of network properties (Quatman and Chelladurai, 2008), including network size and composition, was used to facilitate more precise interpretation and greater conceptual understanding of network trends ~~(Quatman and Chelladurai, 2008)~~.

Name ambiguity is a key consideration in the compilation of networks (Kumar, 2015), ~~particular~~ particularly in analyses of publication portfolios where authors may have used multiple versions of their name over the course of their writing career. To ensure the network analysis in this study created a true representation of co-author relations, instances of co-author name ambiguity *e.g. Grant, Maria J., Grant, MJ, Grant, M.J., Grant, Maria.,* were cross-checked in terms of an author's previous, current and latter organisational affiliations, contact details and recurring co-author collaboration. Disambiguated co-author details were merged to create a single entity for an author prior to the inclusion of each publication in the network analysis.

Network compositions were analysed using categorical data for number of co-authors, co-author employer, country of co-author collaboration and gender.

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This study received ethical approval from the Liverpool John Moores University Nursing and Allied Health Research Ethics Committee on 12th June 2017: 17/NAH/018.

Findings

~~The~ There were two male and two female authors entered in this analysis. Authors were drawn from across the globe including Europe, North America and South East Asia and~~.~~ had *h*-indexes ranging from 10 to 42; see Table ~~1~~2. Portfolios included publications which contained a combination of qualitative and quantitative publication. Portfolios ranged in size from 57 to 360 outputs published over periods between 12 and 18 years. ~~There were two male and two female authors. Authors were drawn from across the globe including Europe, North America and South East Asia.~~

A breakdown of additional areas in which outputs were published included medicine; social sciences; biochemistry, genetics and molecular biology; and psychology (see Table ~~2~~3). Network size and gender differences were analysed for the full data set. For other analyses the first 12 years from first co-authored paper were assessed for equivalence based on the publication period of the least published author.

Network Size

In the first years of successful writing for publication authors publish within a single highly connected co-author network. This network will typically expand to include new co-authors, before additional separate co-author collaborations emerge after three- to four- years. Authors experience a steady growth in co-author numbers between four- to seven- years from first co-authored publication. A rapid expansion in ~~co-author collaborations~~ network size occurs ~~in~~ eight- to twelve- years from first co-authored publication~~the subsequent three- to four- years~~, increasing from between nine and 45 co-authored publications in Year Seven of a portfolio to between 40 and 96 co-authored publications in Year Nine; see Figure 1. Twelve years into their publication portfolios, the maximum number of years for the least published author, the size of collaborative writing networks had increased to between 106 and 151 co-authors.

Component Analysis

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In social network analysis, components are maximally connected portions of a network disconnected from others (Borgatti et al., 2018a, Tsvetovat and Kouznetsov, 2011). Within the present study, components represent groups of co-authors connected only by the author of the portfolio under analysis. Figures 2-5 present the growth of co-author networks with each box representing a year of publication. Viewed from left to right, top to bottom, each author begins their co-author *professional academic writing* in a single group of co-authors.

Taking Q1_h42_M as an example, Year 1 of their publication record sees six co-authors in a single highly connected component. Year 4 sees new co-authors joining the writing group and increasing the component size. Year 6 sees the formation of a new co-author collaboration, with both components increasing in size over the next two years. In Year 9, the two writing collaborations join into a single entity and continue to expand in the next two years. From Year 12 of Q1_h42_M's writing career, smaller but highly connected writing groups also establish and grow.

After a period of steady growth in their co-author networks, the portfolios in this analysis experience a period in which the number of writing groups collaborations coalesce into a smaller number of larger entities; see Figures 2-5. In three quarters of portfolios the consolidation is followed by development of new components. Twelve years into their publication portfolios those authors with the highest and lowest *h*-index worked with fewest components; see Figure 6.

Co-Author Location

Co-author relations within an author's higher education institution provided a starting point for the majority of authors (mean 72%; range 33%-100%;) but decreased over time (Year 12 - mean 34%; range 28%-43%); see Figure 7.

Levels of collaborations within the higher education sector remain higher (Year 1 - ~~44~~53%-100%), at 12 years into a publication career the majority of author collaborations measured between 61% and 66%; see Figure 8. Q2_h28_M is anomalous with 94% of their co-author collaborations occurring within the higher education sector.

Country

For most authors initial co-authors relationships are built within their host country (83%-100%); see Table ~~3~~4. After 12 years, authors with higher *h*-indexes have smaller numbers of

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host country co-authors and, inversely, larger numbers of international collaborators: Q1_h42_M had 46% host country co-authors and 54% of international co-authors compared with Q4_h10_F who had 86% host country co-authors and 14% international co-authors.

In this sample, Q2_h28_M and Q3_h12_F relocated to another country during their *professional academic writing* career after three and six years respectively. After 12 years publishing, Q3_h12_F's collaborations occurred in 61% of their host and previous host country compared with 56% in host country alone; Q2_h28_M's collaborations in their host and previous host country accounted for in 77% of co-author collaborations compared with 64% in host country alone; see Table ~~4~~5.

Gender

The male authors in this analysis began publishing earlier than the females, in 2003 compared with 2006 and 2007, publishing either exclusively or with 50% of male colleagues. In comparison, female authors began their publishing career co-authoring up to 100% of their papers with other females; see Table 6. ~~Acknowledging the predominance of females working in nursing practice (89% female / 11% male) (Nursing and Midwifery Council, 2019) and nursing higher education (75% female / 25% male) (Higher Education Statistics Agency, 2019) data were collected on the gender of co-authors to determine whether gender differences existed in co-author networks.~~ To account for ~~possible~~ changes in gender related policies ~~workforce composition~~ over time, data were analysed by year of publication rather than number of years into a writing career; see Table ~~5 and Table 6~~7.

In these data there is remains a strong correlation of female authors publishing with other female authors (mean 66%; range 61%-69%), male authors demonstrating a more even split (mean 49%; range 46%-55%).

Author Position

Except for Q4_h10_F, authors began their career as first authors. As time progressed there was an even split between first and final author position; see Table ~~7~~8.

Discussion

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Representing an important marker of professional and institutional achievement, writing for publication is a core element in the contemporary university setting. This study examined the personal-network characteristics of the *professional academic writing* portfolios of four elite academics publishing in the area of *General Nursing*. The study ~~and~~ identifies trends ~~which can~~to inform the organisational strategic investment required in the support provided to those wishing to write for publication as part of their academic life. Central in the *General Nursing* portfolios analysed was the development of co-author networks, with a noticeably shift in the number of co-authors around four years, and again at seven years, from first co-authored publication. Preferential attachment theory states that when seeking a collaborator to join one's network, in this instance a co-author, a determining factor is to connect with someone who has already established a positive reputation and, by association, is highly connected with access to the resources (Wagner and Leydesdorff, 2005). Such successes have been shown to perpetuate success with authors who have published before being more likely to publish again, and papers which attract citations are more likely to be cited again (de Solla Price, 1976). Preferential attachment has been linked with international co-author collaborations, noting that highly connected individuals increase their number of collaborations faster than their less connected colleagues (Wagner and Leydesdorff, 2005). In seeking to build collaborative networks, Wagner and Leydesdorff (2005) note that junior researchers may not be able to leverage the advantage of preferential attachment, sometimes referred to as cumulative advantage, because they have not yet established themselves as potentially attractive co-workers. The concept of preferential attachment is consistent ~~and~~ with the marked increase in the number of co-author collaborations noted at four and seven years from first co-authored publication as junior researchers begin to establish their reputations as professional academic authors. To support employees in achieving elevated status, some organisations have proposed a range of measures to facilitate the building of networks and research collaborations including time for continuing professional development activities, sabbatical and visiting fellowships (Leydesdorff et al., 2013, Farajollahi et al., 2013).

Within the portfolios analysed a diversity of research areas are evident, in addition to the inclusion criterion of *General Nursing*. In a study of academic collaborations within and across disciplines it was noted that research tends to be organised around epistemological rather than ontological dimensions, that is, methods of investigation rather than topics of research (Bellotti et al., 2016). Notwithstanding, disciplinary areas are known to experience large variations in citation patterns (Aksnes et al., 2019). Ontologically, authors in the first two quartiles both published more frequently in the field of *Medicine* compared to *General Nursing* which may account for the difference in the quantity of citations received and subsequent elevated *h*-index. Adopting an epistemological approach to collaboration , shared methods of investigation may account for the range of disciplines, including medicine, social sciences and psychology, rather than the topic of research (Bellotti et al., 2016); see Table ~~2~~3.

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Further analysis of the trends of methods, funding and topics under investigation within portfolios is ~~recommended~~proposed.

~~The portfolios within this analysis demonstrate a~~ A marked change in the geographic location of co-authors within this analysis is evident ~~at~~ between six- to nine- years into their ~~co-author~~ publication portfolios (see Table 4). ~~; even~~When accounting for the relocation of authors (see Table 5~~4~~) a noticeable decrease in the dominance of co-authors based in an author's host or previous country ~~is~~ remains evident as the ~~number~~ percentage of international co-authors increases. The consistent and growing proportion of internationally co-authored papers (Leydesdorff et al., 2013) may, in part, be accounted for by technological advances that have mitigated the need for researchers to work in close geographical proximity (Hoekman et al., 2010). Initiatives by national governments ~~(Leydesdorff et al., 2013 citing Kwon et al 2012)~~(Kwon et al., 2011) and programmes such as the European Framework (European Commission, 2020), purposefully established to stimulate international research collaboration (Adams and Gurney, 2016) may also be a factor. Elsewhere, evaluation frameworks such as the Research Excellence Framework in the United Kingdom (Research Excellence Framework, 2020a) and the Excellence in Research for Australia (Australian Research Council, 2015) continue to influence what, how and for whom academics write (Murray and Thow, 2014). Previously dominated by research-intensive western Europe and the USA, an analysis of a sub-set of Science Citation-Index Expanded (SCI-E) journals, identified that all nations are now collaborating in co-authored papers across geographical boundaries (Leydesdorff et al., 2013). For some established economies the total research output since the mid-1980's has more than doubled (Adams and Gurney, 2016). However, while domestic research output levels have not increased (~~UK~~ United Kingdom – 47,5000 papers per year), international collaborations have increased more than ten-fold (Adams and Gurney, 2016). The true import of these explanatory frameworks on writing behaviour are worthy of additional examination.

Male authors were disproportionately represented in all the portfolios analysed: 31%-53% of co-authors in the portfolios analysed were male; see Table ~~5~~6. Women typically co-authored with other women 20% more than men with women; male co-author relationships presenting closer to a 50-50 split. Male authors wrote with female co-authors a maximum of 58% of the time; range 43%-53%. A recent ranking of the world's top 100 universities (Times Higher Education, 2020) included analysis of organisational commitments to gender equality, including the recruitment and promotion of women, as informed by the United Nation Sustainable Development Goals (United Nations, 2020b)~~(United Nations, 2020b)~~. Sustainable Development Goal 5 calls for the adoption of sound policies to empower all women and girls at all levels (United Nations, 2020a). Within this context gender ~~Gender~~ differences evident in the portfolios is ~~are~~ of particular significance given the latest available data indicating that nursing is a highly gendered profession with a consistent 89% to 11% female-to-male ratio of nurses on the Nursing and Midwifery Council register since 2013 (Nursing and Midwifery

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Council, 2014, Nursing and Midwifery Council, 2015, Nursing and Midwifery Council, 2016, Nursing and Midwifery Council, 2017, Nursing and Midwifery Council, 2018, Nursing and Midwifery Council, 2019). Academic nursing departments also have a high female-to-male staff ratio of 75% female to 25% male (Higher Education Statistics Agency, 2019). These findings firmly indicate gender inequality beneficial to male authors in the *General Nursing* portfolios analysed. ~~The source of these gender differences, what influences co-author selection, and the practices which result in the corresponding higher representation of men within the portfolios analysed merits closer inquiry.~~

Clear longitudinal trends are apparent across this study of portfolios containing *General Nursing* outputs, with most authors beginning their co-authored *professional academic writing* career as first authors; see Table ~~7~~8. The technical definition of authorship encompasses not only the person who undertakes the writing of a manuscript, but also those who have made a substantial contribution to a study, whether in formulating the problem, structuring the design, conducting statistical analysis, or interpreting the results (American Psychological Association, 2019). Authorship conventions differ among disciplines and can prove challenging to negotiate when writing as part of a multidisciplinary team (National Academy of Sciences et al., 2009). Nonetheless, the convention of placing the principle investigator last in an author list has become an accepted standard across most research areas, signalling intellectual input or supervision of the work reported rather than actively conducting the research or writing the manuscript (American Psychological Association, 2019). In nursing the first author has typically contributed the most to the development of a manuscript with the assignment of subsequent authors reflecting their relative contribution (Oermann and Hays, 2016), as is apparent at the start of co-author relationships represented in this analysis. However, in contrast with the anticipated shift towards final author placement of the female authors, male authors continued to be named as first author more than a decade after first publication. Whether first author male authors attributions persist because they maintain a higher level of project involvement or, contrary to guidance (American Psychological Association, 2019), have been assigned the position of first author due to relative status is ~~a subject of supplementary inquiry~~unclear.

Although some academic staff appear to spontaneously succeed in *professional academic writing* the assumption that all writers have similar capacity to flourish is too simplistic (Hyland, 2016). The findings of this study highlight consistent trends in the publication portfolios of elite academics publishing in *General Nursing*, particularly the significance of expansive professional networks in producing sustained *professional academic writing* outputs. To enable all academic staff to thrive in achieving their personal and organisational publishing goals, the implementation of institution-wide strategies facilitating continuing professional development are recommended. These development activities should focus on fostering opportunities to build the interdisciplinary professional networks necessary to make

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academics wishing to publish in the area of *General Nursing* attractive as collaborators and co-authors.

While university Vice Chancellors act as Chief Executives responsible for authorising strategic decisions within their institution their decisions are informed by the work of executive committees. Also known as strategic management teams, executive committees are in charge of devising policies in key areas of university business including developing strategic and operational plans with associated budget allocations. Based on this research, it is recommended that higher education institution executive committees build medium-term investment into their strategic and operational plans for time, resources and facilitation of academic staff development in relation to writing for publication. Acknowledging the role of the university library in assisting academics with their publishing endeavours (Akers, 2019), targeted investment in library services to support *professional academic writing* should be represented as part of these organisational plans. Within the context of gender differences evident in *General Nursing* portfolios, it is recommended that strategic and operational plans particularly focus on the continuing professional development of female academics. In focusing on gender equality (Times Higher Education, 2020, United Nations, 2020a), the female academics who comprise the majority of the nursing practice and academic communities will experience parity of opportunity in achieving this key marker of achievement used by university in promotion, tenure and academic review, *professional academic writing*.

Limitations

Like bibliometric and social network analysis studies before, this study has relied upon quantification of network characteristics without the opportunity to explore qualitatively ~~explore~~ the meanings of those characteristics. The *h*-index is used by SCOPUS to compile a list of the Top 100 authors in a specialism and provided a useful starting point to purposively select publication portfolios for analysis in this study. However, it is reasonable to conclude that all the authors of these portfolios should be considered elite authors given the latest available World Health Organisation statistics that there are 20.7 million nurses and midwives in the world (World Health Organisation, 2016); a premise borne out by Hirsch (2005), creator of the *h*-index, estimation that after 20 years a "successful scientist" would have an *h*-index of 20, an "outstanding scientist" an *h*-index of 40, and a "truly unique" individual an h-index of 60. the portfolios within the analysis were consistent with this definition, *h*-indexes ranging from 10 to 42, even accounting for the variation of *h*-indexes between fields (Hirsch, 2005). The analysis presented illustrates the *professional academic writing* networks of an elite cohort of academic writers publishing in *General Nursing* and may therefore differ from the portfolios of other disciplines~~to this end presents an aspirational template for others to emulate~~.

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While whole-network designed social network analysis which assume that the full data set is available (Borgatti et al., 2018b), or studies which combine whole-networks with the quantitative analysis of written documents (Waltman and Noyons, 2018) that is bibliometric or citation analysis (Yu-Wei, 2011, Mangas-Vega et al., 2016, Lining et al., 2019, Ardanuy et al., 2009), this study has focused on personal-networks of a select group of elite authors. While other techniques can provide statistical generalisations of an area, the case studies presented have enabled analytic generalisations to be made (Yin, 2018). The findings within this study demonstrate correlations between co-author network size, employing organisation, geographic location and gender, though further investigation is required to determine the cause of these relationships.

Conclusion

~~Although some academic staff appear to spontaneously succeed in *professional academic writing* the assumption that all writers have similar capacity to succeed and merely require right conditions to flourish has been proposed as too simplistic (Hyland, 2016). However, in the absence of an accepted framework of how academics acquire writing skills (Murray and Thow, 2014), this~~ This research presents ~~study provides a preliminary~~ insight into ~~the~~ consistent publication trends ~~consistently present~~ across gender, sector and geographic location in the ~~early publication~~ portfolios of academics publishing in the area of *General Nursing.* University executive committees can use the ~~across gender, sector and geographic location. This study is a response to the call for time series analysis to develop longitudinal perspectives of academic community research outputs (Kumar, 2015). The~~ trends evident in these descriptive data to support the development of, and investment in, institutional-wide strategic and operational plans to support academics writing for publication; these plans should include targeted ~~support an~~ investment in academic staff time and resources to foster ~~build professional~~ interdisciplinary connections ~~across disciplines~~, nationally and internationally, through continuing professional development activities. Strategic investment in staff development over a medium- to long- term may be required before the impact of that investment becomes apparent.

Further research is underway to develop insight into the qualitative experiences of how staff negotiate the *professional academic writing* landscape, from developing research skills, building support structures and interdisciplinary networks, securing adequate resources, and negotiating the publishing process~~the processes of successfully writing and becoming published~~.

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Practical Implications

The development of extended co-author networks, locally, internationally, and across the higher education sector, enable authors to attain the marker of achievement required by universities and government funding bodies, namely sustained output of *professional academic writing* for publication~~high-quality publications~~. Identified trends support strategic investment in academic time and resources to build professional networks across disciplines. Medium- to long- term investment may be required before the impact of that investment becomes apparent.

Using social network analysis techniques to interrogate personal-networks, this information science based doctoral research demonstrates that by aligning to the needs of our stakeholders, as advocated by our professional associations (Chartered Institute of Library and Information Professionals, 2019, Medical Library Association, 2020), we can generate evidence to help inform strategic investment in staff time and resources.

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Table 2: Author Profiles of Selected *General Nursing* Portfolios

Q1_h42_M: Professor at a higher education institution in Western Europe. He has a background in health sciences and has studied to PhD level. He has received international awards recognising the quality of his research, was a founding member of an international research network, and holds advisory positions with national and international organisations and journals.

Q2_h28_M: Professor and Associate Dean (Research) at a higher education institution in North America. He is a Registered Nurse and has studied to PhD level. Having worked as a Post-Doctoral Researcher, he relocated from the United Kingdom to an Associate Professor position in North America. He has received international awards recognising the quality of his research, held leading roles on international nursing organisations, and holds an editorial position with an international ISI listed journal.

Q3_h12_F: Associate Professor at a higher education institution in South East Asia. She has a background in clinical medicine. Her Masters' in Nursing and PhD-level studies were completed in Europe~~, an MSc in Nursing and has studied to PhD level.~~ before returning to South East Asia to take up her position as Associate Professor.

Q4_h10_F: Professor at a higher education institution in Southern Europe. She is a Registered Nurse, held leading roles in European regulatory bodies, was a founding member of national research network, and is a leading member of her national nursing association.

Note: Authors are defined by Quartile_h-Index_Gender e.g. Quartile1_h-index=42_Male reads Q1_h42_M

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