Fostering Connection and Transcending Division: A Peer-led Network for Interdisciplinary Doctoral Researchers

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There is increasing recognition of the need for interdisciplinary approaches to many contemporary global challenges. The work of graduate students has been highlighted as key to increasing interdisciplinary research capacity in universities, however existing literature has not taken doctoral experiences fully into account. A better understanding of the context in which interdisciplinary research takes place is needed, especially at doctoral level. This article adds new insights about interdisciplinary research in practice focusing on the University of Stirling Interdisciplinary Research Network (IRN), an informal network founded and organised by the authors during their doctoral research. The paper presents a network analysis of the IRN based on qualitative survey data, highlighting how connections are fostered within the network that transcend disciplinary divisions. It also explores connections and divisions in relation to key aspects of the authors individual and collective doctoral experiences, namely disciplines and epistemologies, supervision and training, and methodologies. The paper demonstrates the value of the IRN for fostering connectedness and overcoming division which is crucial to the success of interdisciplinary doctoral research.

Introduction

Interdisciplinary research is one of the main ways in which academics are encouraged to connect across disciplinary divisions. The encouragement towards interdisciplinarity is fueled by a recognition that responding to the social-political-ecological crises facing the world today requires interdisciplinary problem-solving. Thus, 'over the last few decades, we have seen a significant upward spike in activities designed to enhance interdisciplinary capacity and learning across borders and boundaries' (Priaulx and Weinel, 2018, p.11). Whilst it has been argued that graduate students and their training programmes are central to increasing interdisciplinary research capacity (Borrego and Newswander, 2010), doctoral and early career experiences in interdisciplinary research are rarely explored (Dooling et al., 2017). To address this gap, the aim of this paper is twofold; firstly, the paper provides a reflective account of the experiences of the authors, who are the co-founders of the University of Stirling Interdisciplinary Research Network (IRN)*, an informal interdisciplinary doctoral student-led network set up in 2018 within one Scottish university to foster connections across disciplines. Secondly, exploration and analysis of the research areas of network members provides novel detail of the connections and divisions that exist across doctoral researchers from different disciplines. The authors of this paper, referred to as 'we' from this point forward, are interdisciplinary in different ways and come to the concept of interdisciplinarity from unique perspectives. Collectively, we work across disciplines including sociology, public health, heritage studies, political ecology, biological, environmental sciences, and climate change in applied settings. By sharing reflections from doctoral research, we aim to generate a better understanding of the context in which interdisciplinary research takes place and the experiences of individuals doing interdisciplinary research at graduate level in one university. This is particularly important given that many who do interdisciplinary research 'may never have reflected very much on what it means to be interdisciplinary' (Szostak, 2012, p.7). The paper

begins by contextualising interdisciplinarity, connections, and divisions, before introducing the IRN. We then present the methods and findings of a simple network analysis of the IRN, designed to explore connections within the network. We then present reflections on our experiences individually and collectively as doctoral researchers and faculty representatives of the network. The paper highlights the ways in which the IRN is fostering connection and transcending divisions, and we discuss the implications of this in relation to wider literature on interdisciplinarity in universities including the concept of 'connective knowledge'.

Interdisciplinarity, Connection, and Division

Interdisciplinary research approaches 'integrate separate disciplinary data, methods, tools, concepts, and theories to create a holistic view or common understanding of a complex issue, question, or problem' (Klein, 2011, p.13). This differs from multidisciplinary and transdisciplinary research which denote different approaches to the production of academic knowledge, the former adopting an 'additive' approach to combining insights from different distinct disciplines, and the latter aiming to transcend disciplinary divisions completely. All three concepts are premised on working across more than one academic discipline while interrogating the nature of academic disciplines themselves. Depending on one's perception of disciplines, divisions are implied, as evident in many of the metaphors used to think about research as domains or fields. Research often happens in parallel among disciplines, and the divisions occur between disciplines as a result of each having their own jargon and culture (Nuijten (2011). However, divisions can be navigated, assuming there exists openness and flexibility among research communities. The extent to which one desires connectedness depends on the individual researcher and reflects the idea of managing boundaries as part of interdisciplinarity (Klein, 1990, 2011). Klein (2011, 2017) highlights the contested discourse of interdisciplinarity, and ultimately the 'political boundary work' involved. For Hinrichs

(2008, p.210) 'boundary work is inherent to interdisciplinarity' and 'can both intensify and reduce divisions' between disciplines. As individual doctoral researchers, we are all doing boundary work, that is, 'conscious efforts to dissolve boundaries and other efforts, sometimes deliberate, sometimes not, to restore or redraw them' (ibid, p.211).

We each approach this differently in our doctoral research and the IRN allows us to unpack what interdisciplinarity means for us in practice and build connections with others doing the same. It operates as a space to negotiate disciplinary divisions and find connections. Hence, whilst interdisciplinarity emphasises connections between disciplines, as participants in a research network, our experiences also add the idea of social connection, 'interrelationship between human beings that helps transcend self-interest and fosters the sense of solidarity' (Mukhopadhyay, 2019, p.35). Thus, throughout the paper, the concept of connection relates both to how we are working across disciplines within our own research areas, and to our participation in a social network bringing us together across disciplinary/faculty boundaries. There is significant diversity in our approaches and experiences of connections across disciplinary divisions, and participation in the IRN is based on a willingness to come together, rather than defined by specific membership criteria. Our discussions often highlight the relationship between different forms of knowledge and ways of knowing the world. The IRN, being member-led, allows us to explore common ground and create spaces for dialogue that are not only about interdisciplinarity itself, but also knowledge of our research topics, methods, and experiences of doctoral research.

The Interdisciplinary Research Network (IRN)

The IRN was set up in 2018 as an informal, face-to-face group of PhD students with the aim of sharing ideas and supporting one another in relation to interdisciplinary research experiences at the University of Stirling. No such space previously existed for researchers to

come together across departments, with opportunities for doctoral researchers to share knowledge confined to specific faculties. The idea for the IRN originated from conversations between researchers from social sciences and natural sciences following a biological and environmental science symposium. Although much of the ongoing research presented was interdisciplinary in nature (situated between the social and natural sciences), there were very few PhD students from social sciences in attendance. This one example of divisions between faculties represents a broader situation where, as interdisciplinary researchers, we were experiencing a general lack of opportunities for formal and informal knowledge sharing across the faculties, which was limiting to our doctoral research. As a result of the experience at the symposium, an initial meeting was held amongst researchers from different faculties to share experiences of divisions and lack of connection across disciplines, and to establish the main aims of the network. It was agreed that the IRN could exist as an informal meeting space - it was not designed to be a specific research project or intervention, nor a formal research group, but a space for social connections to develop that would benefit our individual doctoral research projects.

Operating independently from the university, we have no empirical measures of how our activities may enhance interdisciplinary work within the university. However, this paper is a starting point from which to share our experiences within the IRN as interdisciplinary researchers. The IRN has invited internal and external academics to share their expertise with our members, and has hosted peer-led methods sessions, research seminars, training workshops, and conferences. Members are invited to interact through these planned sessions, as well as through themed discussion boards on the MS Team page. Members often choose to attend the sessions that are most relevant to their research, and although contribution is not compulsory, all members are welcome to suggest sessions, or to run their own sessions. These

activities have successfully brought together doctoral students from across the University of Stirling to support each other and has therefore bridged divisions between disciplines.

Before COVID-19, the IRN trialled the use of MS Teams as a platform to connect, however most members were unfamiliar with the software. As homeworking became commonplace, the network subsequently grew in its online format. Digital space has allowed members to combat the isolation that the pandemic has imposed on doctoral researchers already struggling to connect outside their disciplines. Moreover, it has introduced greater scope for connection, both across the University of Stirling, but also beyond, enabling us to include researchers from across Scotland. Currently, there are 115 members spanning multiple faculties and institutions, although representation remains skewed towards Stirling (see Table 1).

Analysing connections in the IRN

As part of ongoing management of the IRN as faculty representatives, we are interested in understanding the training needs of network members. By surveying our membership, we are able to gain a clearer idea of the composition of researchers and projects, as there is no requirement to provide any information when joining the network. We surveyed members in April 2020, and again in April 2021 as the network had grown in size. The data collected from this survey we have used herein to analyse the connections within the IRN[i]. The survey collection was carried out through email in the first iteration, and subsequently posted in our Teams space. Participation in the survey was voluntary. Members were asked to provide up to five keywords to describe their research topic, methodology, theory, and the disciplines/fields that they worked in. A total of 15 responses were received, and although this is only 10% of IRN members, the sample contains many of the most active members of the group. Our aim

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[i] The analysis was conducted informally by the authors purely for the purposes of better understanding the IRN network membership and should be interpreted as such, rather than as an output from a more formalised research project.

Faculties present	University	No. of Members
Arts & Humanities, Social Sciences, Natural Sciences, Management School, Health Sciences and Sport, Corporate Staff & Services	*Stirling*	89
School of Education and Sport; School of Philosophy, Psychology and Language Sciences;	*Edinburgh*	6
Includes NGOs and independent researchers as well as recently graduated PhD students	*Non-university*	5
School of Education and Social Work and Community Education, Art & Design, Law	*Dundee*	4
School of Modern Languages and Cultures, School of Education, School of Interdisciplinary Studies	*Glasgow*	3
School of Divinity, School of Medicine; School of History	*St Andrews*	3
Business School	*Strathclyde*	1
School of Education and Social Sciences	*West of Scotland*	1
School of Fine Art	*Glasgow School of Art*	1
School of Psychology, Sociology, and Education	*Queen Margaret*	1
School of Energy, Geoscience, Infrastructure and Society	*Heriot Watt*	1

Table 1: IRN membership composition

was to conduct initial exploratory analysis of connections and division, so this subset of active members is a good starting point to generate qualitative insights. Future work could build on this to provide greater insight across the network as a whole.

A qualitative content analysis approach (Tracy, 2019) was used to analyse the responses in NVivo software. Keywords were first coded 'in vivo' and combined in a hierarchical coding scheme before mapping. We note that this mapping reflects the subjective perspectives of the authors, representing how we make sense of the connections in our network. Mapping the connections from the primary (yellow) and secondary (blue) levels of topic coding to individual researchers reveals a high level of connectivity (see Fig. 1). This connectivity can be read in two ways, members of the network are linked through shared research interests, while at the same time, members of the network are themselves points of connection between disciplines and faculties. Many of these connections would not have come to light within the disciplinary silos of the university. For example, *author c* and *author e* are connected through the field of political ecology, in the bottom left. They share many epistemological and research topic interests, but had previously never, and would have been unlikely to cross paths outside of the IRN due to being divided by the boundaries of faculties. The same example also shows that *author e* connects the fields of heritage studies and political ecology and increases the likelihood that *author c* would be exposed to heritage studies by virtue of their interactions with *author e* even though their primary connection was through the field of political ecology. The benefits of being connected across faculties where there are shared fields of interest include being able to discuss familiar concepts and literature and learn about related ones from diverse perspectives. For *author e* for example, political ecology is not necessarily a field commonly discussed in the PhD communities in social science or arts and humanities faculties.
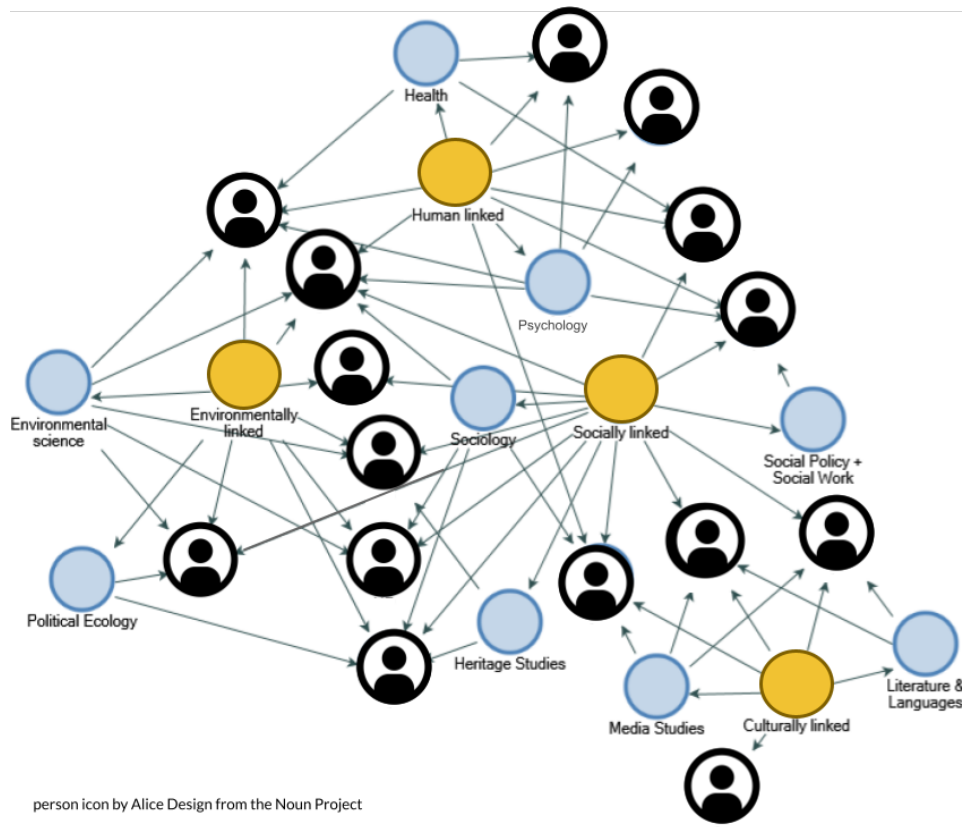
Figure 1: Disciplinary and interpersonal connections in the IRN. Person icons: doctoral researchers, yellow nodes: top level coding, blue nodes: a selection of the most common secondary codes.

Through grouping the secondary codes that represent disciplines into more generalised codes (top level coding in yellow in Figure 1), we get a more synoptic picture of the network. Firstly, there is the centrality of socially linked research. This is frequently the connection point, whether linked to human-centered research in health or psychology, to research in cultural fields (e.g. Literature or Media Studies), or connections to research on 'environments.' There is also a degree of connection evident between environmental and 'human-linked' disciplines. However, this network mapping indicates a lack of connection between respondents working in cultural and environmentally linked fields, as well as between cultural fields and disciplines such as health and psychology. This indicates that some fields are more connected than others, and that perhaps there needs to be more pro-active creation of

opportunities for dialogue between members of weakly linked fields to explore where new connections could be made.

The centrality of social research disciplines and methods in the previous diagram is reinforced by an analysis of the keywords used by members to describe methods and theories used in their research (see Fig. 2).

Figure 2: Word cloud of the methods or theories used by doctoral researchers surveyed.

Interviews, ethnography, discourse: these are qualitative methods most commonly employed in social research disciplines. Despite the social science prevalence, the word cloud also indicates the diversity of the network. Given the small sample size, this is likely to under-represent the diversity of the IRN, based on what we do know about members faculties as shown previously in Table 1. These findings give us a good initial understanding of the network composition, with opportunities to respond to the interests and areas of research of our membership. As an entirely peer-led network, this kind of knowledge about members is crucial to our success at fostering connections and transcending divisions. However, it is a challenge to acquire and maintain such knowledge and moreover to act on it in meaningful ways due to

the informal nature of this voluntary activity we are engaged in as faculty representatives of the IRN alongside our own individual interdisciplinary PhD journeys.

Interdisciplinary research in practice: doctoral researcher reflections

Reflecting on our own PhD journeys, and our participation in the IRN, we can further explore the notion of connections and divisions in relation to interdisciplinarity in the doctoral research experience. We begin this reflective section with a sole author vignette to give a greater sense of what the individual experience of doing interdisciplinary doctoral research in practice entails, and what participation in the network offers. The vignette starts to draw out how key aspects of the doctoral experience can be challenging where they are specifically shaped by interdisciplinarity, and thus where there is a need for a space such as the IRN which rejects disciplinary divisions and aims to foster connection.

My research explores the politics of water infrastructure. With a background in engineering and natural sciences, but a strong interest in critical social research, interdisciplinarity held promise as a way for me to weave together my different intellectual interests. As I work through the third year of my PhD, this vision has not gone exactly to plan. In recent months, two of my supervisors working in natural science disciplines came to realise that they could not adequately supervise my work. This was framed as a failure of my research to be interdisciplinary in the way they had anticipated.

Disciplinary traditions incorporate diverse factors such as methods, ways of conducting analysis, ways of looking at the world, ideas of what the world is, ideas about the role of researchers, and what research should accomplish. Any one of these factors may not be unique to a discipline, but in interdisciplinary work that connects or transcends disciplines there is a chance for a disjuncture across one or more of these factors. In my case, a key challenge was divergent opinions about the aims of the research.

Bringing critical reflexivity to the research was an aim that divided supervisors. My thinking here is inspired by those working in the sub-discipline of Critical Physical Geography. Lave et al (2018) write "both natural and social science are inextricably imbricated in social, cultural, and political-economic relations that affect the questions we ask (or ignore), the way we conduct our research, and even our findings". Frustratingly, my efforts to understand the relations

> underpinning my research frames and concepts were viewed as unnecessarily philosophical.
>
> Following these experiences, I remain committed to research that pushes beyond disciplinary boundaries. In doing so, in contrast to a framing of interdisciplinarity as a method of problem-solving, I explicitly adopt a critical perspective that asks how the world (and our research about the world) could be more oriented towards justice and liberation. I believe that a pragmatic approach can allow research to work through or despite frictions. However, a common aim or sense of purpose is required to sustain this pragmatism. Without a shared aim, boundary objects may come to represent borders, rather than points of connection.
>
> The IRN is a group of people who realise that disciplinary formations don't work for the research that they want to do. Disciplines frame problems in different ways, but what should be clear is that we face interlocking ecological, social and mental crises. Not taking disciplines for granted, but rather reflexively exploring their divisions, limitations and connections is a vital approach, one that the IRN fosters.

Box 1: Author c Vignette on experiences of interdisciplinary research

This experience can be contextualised in our collective reflections on these connections and divisions as they relate to key themes relevant to all authors' research: disciplines and epistemologies, supervision and training, and methodologies.

Disciplines and Epistemologies

Interdisciplinary doctoral researchers are said to be at risk of becoming generalists across multiple disciplines, yet specialists in none (Frodeman and Mitcham, 2007). Despite the interdisciplinary nature of their research, they may neglect one aspect and find interdisciplinary is only in name, and not in practice. It can be easy to rest on one's disciplinary roots, inadvertently side-lining a new area. For example, this has been a challenge for *author e* as a sociologist moving into a new area with heritage studies, for *author d* working across social and natural sciences, and for *author b* as a water practitioner integrating new concepts from sociology and political sciences. Disciplinary arenas in academia can be intimidating, and a disciplinary audience can focus on how your work advances theories and concepts in their

discipline, rather than looking at the work as a whole. As interdisciplinary researchers, we may enter such spaces as inquisitive guests and leave with nothing but feelings of being an imposter. Conversely, we have found the IRN to be a safe place to bring ideas and have them challenged or augmented by researchers with backgrounds in the disciplines that are new to us. Participation is based on a common understanding that network events are a space of learning and sharing, wherein one person's expertise may address another's deficit, and vice-versa. In this setting, input and feedback from students from a range of disciplinary perspectives is a valuable experience and allows the interdisciplinary nature of the work to be front and centre.

When doing interdisciplinary research, differing epistemological standpoints are often regarded as a barrier (Nuijten, 2011). In the experience of *author d*, researching the potential use of greenspace interventions for improving mental health and supporting people with problem substance use, navigating connections and divisions between the social and natural sciences has been central to the research project. Much of the empirical evidence base for greenspace programmes is positivist by nature, predominantly focusing on testing quantitative measures and related physiological processes (Antonelli et al., 2019; Li., 2019; Wen et al., 2019). Conversely, when exploring greenspace programmes within social research, outcomes are frequently explored through qualitative methods including ethnographies, interviews, and participatory methods (Cook, 2020; Martin-Feeney, 2014). Therefore, one of the challenges working in an interdisciplinary way in this field has been identifying which epistemological approach makes it possible to integrate data from research that typically falls at different ends of the epistemological poles. Indeed, as identified by Wendelboe-Nelson et al. (2019), discords between study paradigms makes it difficult to aggregate the evidence effectively. In order to build a connection between the existing research, *author d's* work has drawn on Critical Realism, a post-positivist perspective that attempts to position itself as a model of scientific explanation between the two traditional epistemologies of positivism and relativism (Pawson

and Tilley, 1997). Adopting a realist lens has allowed flexibility in research design, collaborative working from different disciplines with supervisors from both the natural and social sciences, and the integration of different disciplinary perspectives and methods within a single research project.

Working across disciplines and epistemologies also brings with it the challenge of having to learn many new terms and jargon. The IRN provides a space to discuss the differing meanings of certain terms across disciplines and allows exploration of the relevant literature that others are using. Further, discussion across disciplines forces the need to present research in ways that are accessible to those working in different fields. For example, for scholars in the natural sciences it is not standard practice to state the epistemological perspective in which the research is situated. Indeed, *author b* struggled at first to define the 'epistemology' and 'ontology' of their study and, after eventually including these framings in a review, was asked to define these terms to a panel of natural scientists from the faculty. These terms were considered 'imported' and treated with much hesitance – rendering inclusion of these details powerless to provide context to the panel. In contrast, for *author e* in social science and arts and humanities epistemology and ontology is often considered a foundational starting point of research. Hence, the opportunity to discuss one's work across faculties brings differences to the fore, with fruitful learning experiences that may not arise from presenting within, rather than across faculties, the former being a common occurrence, the latter, less so. For all authors, the IRN sessions have been crucial for our interdisciplinary researcher development in this way, providing experience in communicating research across different fields and negotiating the divisions therein. It allows us to connect to and learn from others outside of our own expertise, which can be fruitful for interdisciplinary research projects which transcend the boundaries of any single research approach or discipline.

Supervision and Training

Just as we cannot become experts in every discipline, it is also difficult for a supervisory team to contain the breadth of knowledge and skills across disciplines that an interdisciplinary student will require guidance on throughout their PhD. Supervisors perform an essential role in the support of interdisciplinary research for early career researchers, especially that of PhD students (Golde and Gallagher, 1999; Lyall and Meagher, 2012). Making connections with supervisors individually, and as a team, is vital to the experience of an interdisciplinary PhD. Equally, divisions between doctoral researchers and supervisors can alter or halt the journey (Golde and Gallagher, 1999). Hence, there is a strong argument for ensuring wider connectivity between disciplines and a cohesive research community (Lyall and Meagher, 2012), as well as developing connections with, and through, supervisors. However, supervisors may not be interdisciplinary themselves, instead offering disciplinary perspectives on an interdisciplinary project, meaning knowledge gaps are inevitable. As interdisciplinary researchers, often the authors required methods for PhD research outwith the expertise of our supervisors, and the reach of their networks to connect to this expertise was limited by discipline. In this scenario, the IRN offers a useful space for connections to form with peers who can share learning around such methods as well as relevant literature and experts. Whilst this is positive, it has the unintended consequence of placing supervisors in a position where they can no longer provide guidance on a major area of the research. In this way, relying on connecting across disciplines through peers may create divisions between doctoral students and their supervisors who may not accompany them fully on their interdisciplinary journey. This raises the question of how well supervisors are equipped to support interdisciplinary doctoral projects that stray beyond the confines of their home disciplines and expertise. Despite recognition of the inherently complex and contradictory nature of interdisciplinary research supervision (Hibbert et al. 2014), it is also an area underexplored theoretically in research literature (Vanstone et al. 2013).

Ryser et al. (2009) argue that the training of interdisciplinary students often takes the role of experiential learning, rather than structured institutional learning. The time and quality of learning that interdisciplinary students experience is related to the investment in interdisciplinary research by the supervisor and the supporting faculties. For the authors at the University of Stirling, the fostering of connection across faculties is minimal, and at the doctoral level, the divisions between faculties are difficult to transcend for many practical reasons. Some of these include a general lack of openness about research seminars taking place or opportunities to participate in doctoral conferences hosted by other faculties. Each faculty has their own disciplinary specific training activities, which are not advertised in one central place. Townsend et al. (2013) have shown for another university, that it is these kinds of 'small structures' which can impede the development of interdisciplinarity. The aim of the IRN is to try to make it possible for doctoral researchers to access the wider University community and participate in relevant seminars and conferences. This has been a difficult division to transcend simply due to the bureaucratic structure of the University and the fragmentation of professional staff and communications networks. For the authors, this has meant missing topic-specific seminars that are of relevance to our PhDs, but which took place in a faculty to which we have no connections. It has also inspired feelings of displacement – being invited to participate in many irrelevant, even if interesting, 'host' faculty seminars while missing those in other faculties that would be most useful to furthering our research and connecting with others with shared interests. This is where the IRN has become invaluable, allowing us to build personal and professional connections with those that enhance our experience and ability to conduct valuable research. Moreover, the IRN has facilitated opportunities for training and spaces for discussion on the specifics of interdisciplinary research across many areas not covered anywhere else at the University. Among others, these topics have included managing interdisciplinary supervision teams, interdisciplinary writing, and interdisciplinary

methodologies. These sessions have benefitted the authors, helping them to develop their research relationships and skills beyond the supervisory team and faculty.

Methodologies

Through inhouse and external training, the IRN supports researchers to develop skills regardless of discipline and at no cost to themselves. The opportunity to engage with peers with expertise across many fields is invaluable for interdisciplinary researchers given the potential range of methods that might be available for addressing the research problem, and the high cost of investing in specialist methods training when unsure of their relevance. For example, *author e,* based in sociology, was struggling to find an entry point into using methods more popular in natural science and geography, specifically Geographical Information Systems (GIS) and mapping, which were used in relevant academic literature for the PhD topic area. The IRN provided a space to learn about using GIS from *author a* with experience of the method, and broader knowledge of the applications of this technology. Without the IRN*,* making this connection and overcoming institutional divisions would have been difficult. In another example, *authors c and e* have expertise with NVivo software used for qualitative analysis, popular in the social sciences, and were able to facilitate a session for a group of non-social science network members including *author b*. In both cases, the training around these tools for research were not sufficiently provided by the faculties or supervisory teams of those benefitting from the training. Additionally, the peer-led nature of the skills share was better suited to explorations across disciplinary boundaries than the typical specialist training available, which often takes for granted a prerequisite disciplinary knowledge, emphasising standard rather than more innovative applications of the method. Connecting across disciplines for this kind of support reflects how interdisciplinarians work more generally, where moving beyond disciplinary boundaries is part of 'the topic-driven nature of the interdisciplinary

approach' and where usually there is a 'lack of resources in a single discipline to address the issue of concern' (Woodill et al., 2019, p.118).

However, from the perspective of interdisciplinary doctoral researchers, we are not necessarily aiming to have the same kinds of insider knowledge of each discipline we engage with, rather the aim is 'to muster sufficient competency in relation to [the] topic, so as to make decisions as to which insights to include and which to exclude' (ibid, p.119). Indeed, in *author e's* experience, learning more about the complexities of GIS enabled the decision to exclude it from the methodology, whilst enabling better understanding of when it would be appropriate to utilise it. In this way, the network enables an 'exploratory disposition' (ibid, p.115), which is part of the way interdisciplinarians draw from a wide range of knowledge domains. Interestingly, some methodologies, methods, and approaches are already primed for interdisciplinarity and are useful frameworks or tools for researchers from varying backgrounds. For example, the IRN ran training on the methodology of Social Network Analysis. Initially, this may seem sociology-centric, however, it can be used to organise and analyse a diverse range of types of data across disciplines that researchers can tailor to their own contexts beyond social interactions, ranging from policy analysis to animal behaviour networks. Upcoming sessions for the IRN are based on the needs and request of members, including cross-cutting topics such as decolonizing research and communicating interdisciplinary research with policymakers. These are not specific to any one discipline, but they can be overlooked if one is focused on particular traditions and processes that do not address them specifically.

Discussion

Drawing on our collective experiences as doctoral researchers, and through analysis of the network, we have explored interdisciplinarity within the PGR community of Scottish

universities, and predominantly at the University of Stirling. We have discussed how the IRN plays a vital role in supporting interdisciplinary doctoral students in a way that no other existing research network has been able to. It has been argued that:

> *Successful interdisciplinary research groups invest considerable time in managing differences and creating common ground. Clearly, those able to create a climate that stimulates dialogue within the group have a greater chance of success.* (Oberg, 2009, p.407 cited in Borrego and Newswander, 2010).

Our experiences suggest that this is part of what we do in the IRN, although we have found that we spend more time creating common ground and stimulating dialogue than we do managing differences. This is likely because participation in the IRN is voluntary and those who engage the most do so based on a desire to interact with others. However, managing differences is something that we do as individual doctoral researchers, such as within supervisory teams. One glimpse into our experience of managing differences has been exemplified by the collaborative writing of this paper, where we learned to appreciate how doctoral researchers are trained to write differently, including more or less reflexively which is more common in social sciences. Given that a major barrier to interdisciplinary collaboration can be terms, jargon and communication issues, the ability to work together, explore differences, and find common ground is crucial. Woodill et al. (2019) point to the importance of mentorship and community for interdisciplinarians, the first step for researchers being the discovery that spaces exist to discuss and explore what interdisciplinarity *means*. Similar to experiences of members within our network, they found examples where one might not have thought to identify as interdisciplinary until participating in the community of like-minded researchers (ibid). This reflects the fact that there are no specific concepts, theories, or methods that connect interdisciplinary researchers but 'at the heart of interdisciplinarity... [is] a deep disregard for boundaries' (ibid).

Our experiences individually and within the network also bring to the fore the idea that 'connective knowledge' gleaned about other research projects and researchers across disciplines is of value in and of itself. This is what 'makes connections possible', it is:

the kind of 'basic' knowledge that better assists us to connect, to have a sense of what is out there, to imagine and envision the possibilities and intersecting problems that researchers from other fields are working on. It is this kind of basic knowledge that opens out the possibilities and widens a researcher's horizons at the point of evaluating the kind of expertise that could make a useful contribution to a project's future. (Priaulx and Weinel, 2018, p.13).

Having connective knowledge is no guarantee that connections will be made but is considered vital to enhancing capabilities for *all* researchers, and key to the question of how connections are formed between researchers and domains of expertise (ibid). The IRN offers the opportunity for connections, and the ability to gain basic knowledge from other disciplines was evident in reflections of the authors. In practice however, we can only offer limited opportunities as an informal network run by PhD students. Our ability to draw in a wide variety of researchers from across all disciplines is also inconsistent, and interdisciplinarity and learning from other disciplines is not something that we feel is valued more widely at our university. This feeds into one of the major barriers when doing interdisciplinary research, which are the 'challenges resulting from differences in training and scientific culture' (Tobi and Kampen, 2018, p.1209). For doctoral researchers, such differences and disciplinary divisions are rarely probed and explored, with emphasis placed on becoming an expert in a niche disciplinary area. For interdisciplinary researchers this is problematic, and instead we must seek to negotiate and transcend the disciplinary divisions that exist in order to form connections across multiple disciplines and with other researchers, which we believe the IRN is helping to achieve.

It would be useful for future research to explore this more systematically, including comparison of different approaches to interdisciplinary research in different university settings, where doctoral researchers may be more or less able to connect across faculties and transcend the divisions caused by disciplinary boundaries. Where support for interdisciplinary researchers may be needed, Dooling et al. (2017, p.583) have pinpointed some key areas including opportunities for formal and informal interaction across disciplines. This is important to consider because of the informality of the IRN - when the authors complete their PhDs it is unclear if the network will continue, which highlights the fragility of support in place for interdisciplinary doctoral students at our institution. For now, our network offers informal interaction, which allows us to better understand and promote the value of interdisciplinarity and foster social as well as disciplinary connections. Therefore, we would encourage the integration of the IRN at the university level to allow for more consistent and centralised support for interdisciplinary PhD researchers. Moreover, it has been argued that leadership at the institutional level is vital for interdisciplinary research to thrive (Townsend et al. 2013).

Conclusion

Interdisciplinary research is becoming increasingly recognised as a valuable approach to solving pertinent local and global problems. However, the existing research of interdisciplinarity has failed to give sufficient attention to the experiences of doctoral researchers, who are considered crucial to increasing interdisciplinary research capacity at universities. In this paper, we have therefore shared our experiences of doing interdisciplinary research, exploring the theme of connections and divisions across key aspects of the doctoral research journey: disciplines and epistemologies, supervision and training, and methodologies. We have also reflected on and analysed the work of the IRN, to show the value of interdisciplinarity for fostering connections across divided disciplines. In analysing the IRN,

there are many connections between researchers that would have remained hidden were it not for the work of the IRN in creating a space for interdisciplinary researchers at the University of Stirling and beyond. It is our collective experience that transcending disciplinary divisions has brought us many benefits, along with some challenges.

Furthermore, we argue that the idea of allowing for 'connective knowledge' to develop at universities does not happen naturally across academic disciplines and therefore needs more widespread support. For the authors, the IRN has been crucial for creating more opportunities to foster connections between interdisciplinary researchers and breaking down barriers to open communication and knowledge sharing beyond the confines of disciplinary boundaries. Universities need to institutionalise appropriate platforms to facilitate the kinds of activities that have been made possible through the peer-led IRN, or risk undermining the integrity of interdisciplinary research taking place.

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