

## PhD candidates' engagement in researcher networks and the key learning experiences embedded in them

O envolvimento de candidatos a doutoramento em redes de investigadores/as e as principais experiências de aprendizagem nelas incorporadas

L'implication des candidats au doctorat dans les réseaux de chercheurs et les Principles Experiences d'apprentissage qui y sont intégrées

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### Abstract

Researcher networks are highly important for a positive PhD experience and the future career of PhD candidates in and beyond academia. Our study explores PhD candidates' engagement in researcher networks, ranging from the local to the global sphere, the key learning experiences embedded in them, and how such engagement is associated with their doctoral thesis format, research group status, and the candidate's country of origin. A total of 768 PhD candidates from a research-intensive multidisciplinary Finnish university participated. The data were collected through a doctoral experience survey. The results showed that PhD candidates participate widely in research collaboration activities, especially by presenting at conferences and participating in international summer schools. Most learning experiences were located in local networks. Some differences between the candidates were found related to the thesis format, research group status, and candidates' country of origin. Our study provides a new understanding of PhD candidates' researcher networks, and the results can be used in the development of support systems in doctoral education to enhance PhD candidates' research collaboration locally and globally.

**Keywords:** PhD candidate, researcher network, doctoral education, PhD experience, mixed methods research

### Resumo

As redes de pesquisadores são essenciais para uma experiência positiva de doutoramento e para a futura carreira dos/as candidatos/as na e para além da academia. Este estudo investiga o envolvimento de candidatos/as ao doutoramento em redes de investigadores/as, do local ao global, as suas experiências-chave e a associação com o formato da tese, estatuto do grupo de pesquisa e país de origem. Um total de 768 candidatos de uma universidade finlandesa multidisciplinar participaram no estudo. Os dados foram coletados no âmbito de uma pesquisa de experiência de doutoramento. Os resultados indicam uma ampla participação dos/as candidatos/as em atividades colaborativas, especialmente apresentações em conferências e participação em escolas de verão internacionais. Experiências positivas estavam mais frequentemente ligadas a redes internacionais, enquanto experiências negativas foram associadas a redes locais de pesquisadores/as. Algumas diferenças foram encontradas relacionadas com o formato da tese, estatuto do grupo de pesquisa e país de origem. Este estudo fornece uma nova compreensão das redes de pesquisadores/as de

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candidatos/as ao doutoramento, podendo ser útil ao desenvolvimento de sistemas de apoio para aprimorar a colaboração em pesquisa local e globalmente na educação doutoral.

**Palavras-chave:** candidato/a a doutoramento, rede de investigadores/as, educação doutoral, experiência de doutoramento, investigação com métodos mistos

## Résumé

Les réseaux de chercheurs sont essentiels pour une expérience positive de doctorat et la future carrière des candidats au-delà de l'académie. Cette étude explore l'engagement des candidats au doctorat dans des réseaux de chercheurs, locaux à globaux, et examine les expériences clés qui en résultent, ainsi que leur association avec le format de thèse, le statut du groupe de recherche et le pays d'origine du candidat. Un total de 768 candidats au doctorat d'une université finlandaise multidisciplinaire a participé à cette étude mixte, avec des données collectées via une enquête sur l'expérience doctorale. Les résultats indiquent une participation étendue des candidats à des activités de collaboration en recherche, en particulier par des présentations lors de conférences et des participations à des écoles d'été internationales. Les expériences positives des candidats étaient le plus souvent liées à leurs réseaux internationaux, tandis que les expériences négatives étaient fréquemment associées aux réseaux locaux de chercheurs. Des différences ont été observées entre les candidats en fonction du format de thèse, du statut du groupe de recherche et du pays d'origine. Cette étude fournit une nouvelle compréhension des réseaux de chercheurs des candidats au doctorat, pouvant guider le développement de systèmes de soutien en éducation doctorale pour renforcer la collaboration en recherche des candidats, tant localement que mondialement.

**Mots-clés:** candidat au doctorat, réseau de chercheurs, éducation doctorale, expérience de doctorat, recherche à méthodes mixtes

## Introduction

Researcher networks have been shown to be vitally important for a positive PhD experience (e.g., Cai et al., 2019; Corcelles-Seuba et al., 2023; Douglas, 2023). They provide the primary arena for learning to become a researcher and conducting research. The quality and quantity of interactions within the networks have been shown to contribute to the doctoral experience (Anttila et al., 2023; Cornér et al., 2018; Vekkaila et al., 2018), degree completion (McAlpine & McKinnon, 2013), PhD candidates' wellbeing (Castelló et al., 2017; Peltonen et al., 2017; Rönkkönen et al., 2023), productivity (Villanueva-Felez et al., 2013) as well as employment after earning the PhD (Germain-Alamartine et al., 2021). For instance, early career researchers with more extensive collaborations are found to be more productive (see Kyvik & Reymert, 2017; Vabø et al., 2016). Accordingly, researcher networks allow PhD candidates to surpass themselves intellectually, be more productive and overcome stressful transactions in their studies. In addition, increased competition, specialisation, increasingly complex research designs and career development both within and beyond academia call for research collaborations (see Brechelmacher et al., 2014; Hall et al., 2018; Iglíč et al., 2017; Leydesdorff & Wagner, 2008). Hence, it appears that investing in building researcher networks locally, nationally and internationally can be considered highly appealing from a PhD candidate's perspective. Yet the evidence on engagement by PhD candidates in researcher networks and the quality of experiences embedded in them is somewhat mixed. While some studies highlight the importance of researcher networks (Cai et al., 2019; Douglas, 2023; Mantai, 2019), others have shown that the PhD candidates' networks are

often very limited and that involvement in them does not always result in positive experiences (Kyvik & Reymert, 2017; Stubb et al., 2011; Tikkanen et al., 2021). Our study aimed to extend the literature on PhD candidates' researcher networks by exploring their engagement in the various spheres of researcher networks, the key learning experiences embedded in them and how the engagement is related to the thesis format, research group status, and country of origin.

### **PhD candidates' research networks and their benefits**

Research networks provide a primary learning environment for a PhD candidate (Cai et al., 2019). Networks are complex nested entities, including complementary spheres, ranging from local to national and global networks. Furthermore, they may involve weak or strong, hierarchical or equal and virtual or physically present ties with others (Kyvik & Reymert, 2017).

*The local research networks*, including typically those with which PhD candidates work most frequently, provide a community of practice (Dysthe et al., 2006; Stubb et al., 2012; White & Nonnamaker, 2008). They often include the supervisor, peer candidates, members of their research group, department, faculty and institution. Local networks are often, but not necessarily, characterised by geographical closeness, providing opportunities for both formal and incidental informal encounters. In the early stages of doctoral studies, in particular, access to researcher networks is often heavily mediated by the supervisor(s) (e.g., Lee, 2008; Wisker et al., 2007). In addition, peers play a key role in the doctoral experience, particularly regarding emotional support (e.g., Anttila et al., 2023; Cornér et al., 2018; Pilbeam et al., 2013).

PhD candidates are often also involved in *national* and *international research networks*; A number have been shown to participate in some collaborative projects or partnerships with external organisations during their studies (Bienkowska & Klofsten, 2012). Also, researcher mobility across national borders, particularly among early career researchers, is increasing due to the internationalisation of doctoral education and researcher careers. Furthermore, cross-sectorial networking is increasingly enhanced, and some doctoral programmes involve internships or the PhD candidates are encouraged to get work experience while conducting their doctoral research (see Germain-Alamartine & Moghadam-Saman, 2019).

At their best, research networks provide a grounding for a positive doctoral experience and a launchpad for building and expanding national or international networks. The quality and quantity of interactions within research networks have been shown to contribute to PhD candidates' sense of belonging, overall satisfaction with the doctoral project (Dysthe et al., 2006; Hutchings, 2017) and interest and commitment to their PhD (Jones, 2013; McAlpine & Amundsen, 2012). Furthermore, it has been shown to reduce the risk of dropping out or suffering from burnout and to increase more timely degree completion (e.g., Castelló et al., 2017; McAlpine & McKinnon, 2013; Peltonen et al., 2017; Rönkkönen et al., 2023). Also, productivity and quality of publication have been shown to be higher among researchers who work in research groups

and actively participate in international networks (Kyvik & Reymert, 2017; Villanueva-Felez et al., 2013).

Research networks have also been shown to contribute to doctoral careers after earning the degree. For example, investing in network-building activities, such as mobility, collaboration, and making connections during a doctoral study, has been shown to nearly double one's chances of immediate employment within 12 months of graduation (Jackson & Michelson, 2015). Engagement in research networks, involving researchers from their own institutions as well as those from other universities, has been shown to enhance academic careers (van Rijnsoever et al., 2008). It has been suggested that the development and influence of networks models an inverted U-shape; the networks grow fast at the beginning of the career, whereas their importance starts to decline later (Iglič et al., 2017; van Rijnsoever et al., 2008). After that, researchers probably do not need networks as much due to an accumulated knowledge base. They might have less time to invest in extensive collaborations and already have well-established collaborations with no need to expand them (Iglič et al., 2017). This implies that investing in building research networks is particularly timely when studying for the doctorate.

### **PhD candidates' engagement in research networks**

PhD candidates can invest in building their research networks in multiple ways. Launching and sustaining the networks can involve various forms of research collaborations, such as organising shorter meetings, seeking advice, co-authoring or engaging in long-term intensive collaboration on a research project. PhD candidates can also build their networks through mobility placements to other institutions, attending national and international conferences and research meetings, taking courses or participating in summer schools or organisations, and collaborating with members of external organisations (Bienkowska & Klofsten, 2012; Blackford, 2018; Gruber et al., 2023; Gureyev et al., 2020; Horta et al., 2021). The research network activities can also involve more loosely coupled relationships with a range of stakeholders from industry, funding agencies, and public or para-public organisations (Blackford, 2018; Kyvik & Reymert, 2017). However, having a network itself does not guarantee that it will be used or that it will lead to research collaboration (Horta et al., 2021; Kyvik & Reymert, 2017). PhD candidates have an opportunity to invest in building their networks, but considering the importance of having well-functioning research networks, they quite often lack the initiative to build them (Pyhältö & Keskinen, 2012).

Individual variations in PhD candidates' research networks, their opportunities for building them and activeness in developing them have been shown to occur. For example, those working on a monograph are less likely to write co-authored articles and engage in writing collaborations with other researchers (Pyhältö et al., 2016). On the other hand, international PhD candidates may be more likely to engage in international collaborations compared to domestic candidates (Melkers & Kiopa, 2010). However, there is also contradictory evidence on increased international research collaboration by international PhD holders

(Jiang & Shen, 2019). Furthermore, the structure of the doctoral degree may increase or decrease the possibility of building these networks. In some countries, such as Denmark, researcher exchange is a mandatory part of undertaking a PhD, whereas in Finland and Sweden it is voluntary and, in the latter, only a quarter of the PhD researchers have been found to have experienced mobility outside their home university (Anttila et al., 2021; Bienkowska & Klofsten, 2012; Cornér et al., 2018).

Taken together, PhD candidates' can proactively build their research networks, including local, national, and international networks. There is evidence that engagement in research networks is typically beneficial for PhD candidates' progress, well-being, and employment after graduation. However, differences between PhD candidates can be expected to occur in their engagement in research networks. However, limited research on PhD candidates' research networking activities and differences in them hinder our ability to support all PhD candidates in establishing their own research networks and engaging in them. Our study aimed to extend previous research on research networks by exploring PhD candidates' engagement in researcher networks, key learning experiences embedded in networking activities, as well as differences in such strategies based on the PhD candidates' thesis format, research group status, and country of origin.

### **The aim of the study**

The aim of the study was to understand PhD candidates' engagement in researcher networks, ranging from the local to the global spheres, the key learning experiences embedded in them, and how such engagement is associated with their doctoral thesis format, research group status, and the candidate's country of origin.

The following research questions were addressed:

- 1) How are PhD candidates' experiences of research collaboration related to their 1) thesis format, 2) research group status, and 3) country of origin (international versus native)?
- 2) What key experiences embedded in the local, national, and international researcher networks did the candidates report?

## **Methods**

### **Doctoral Education in the Case University**

The Case University is one of Finland's 13 research-intensive universities. The university has 4900 PhD candidates and approximately 500 PhD degrees are awarded annually. Eligibility criteria for a doctorate require candidates to hold a Finnish second-cycle master's degree or an equivalent foreign degree and

demonstrate proficiency in Finnish, Swedish or English. The application process mandates the submission of a research proposal and a study plan, along with a 'commitment to supervise' letter from one or two supervisors upon acceptance. Typically, at least one of the prospective supervisors will be a full professor with a permanent position. PhD candidates also have an assigned thesis committee consisting of three senior researchers from outside their local network. Their responsibility is to oversee the rights of the candidate and provide support for their progress.

Research begins at the start of the doctorate. A limited amount of complementary coursework (40 ECTS) based on an individualised study plan is included. Doctoral dissertations can be written either as a monograph or a completion of articles, typically featuring three published articles in peer-reviewed journals and a summary. The target duration for completion is four or five years of full-time study, although the average completion time stands at five or six years (Pyhältö et al., 2022). There are no tuition fees and, once admitted, the study right is valid for life. PhD candidates are responsible for meeting their own living expenses.

## **Participants**

A total of 768 PhD candidates, from a research-intensive multidisciplinary Finnish university participated in the study (65% women, 31% men, 4% non-binary or not willing to disclose their gender). The candidates were most typically in the 30–34 age range (31%). The response rate for the survey was 17%. In terms of age distribution, the sample represented the overall population well, but women were slightly overrepresented in the data. Among the participants, 604 were native Finnish speakers, while 152 were international PhD candidates. On average, the PhD candidates anticipated taking 5.8 years to complete their studies, with 43% estimating they would graduate within four years. A significant proportion (61%) were undertaking their doctorate full-time. Seventy-seven per cent reported that they were writing their thesis in the form of a summary of articles, while 21% were working on a monograph. Approximately 30% of the PhD candidates indicated that they were part of a research team, while the majority, 70%, stated that they primarily worked alone.

## **Data**

The data were collected between April and May 2021 with a modified version of the cross-cultural doctoral experience survey (C-DES) validated in previous studies (Pyhältö et al., 2016; see also C-DES manual, Pyhältö et al., 2018). A link to the C-DES online survey was sent to all PhD candidates from a research-intensive multidisciplinary Finnish University via the Doctoral Schools' PhD candidates' mailing lists. The online surveys were available in Finnish, Swedish and English. Information about the study was

provided for the PhD candidates at the beginning of the survey. Participation in the study was voluntary. No identifying information or incentives were used.

In Finland, an ethics review is needed only if the research entails intervention in the physical integrity of research participants, departs from the principle of informed consent, involves participants under the age of 15 without parental consent, exposes participants to unusually intense stimuli, poses a risk of causing prolonged psychological distress beyond the that encountered in normal life; or signifies a security risk to subjects (Finnish National Board on Research Integrity, 2019). None of these conditions applied to the current study.

## **Measurements**

For our study, we used five items to measure PhD candidates' engagement in various national and international research collaboration activities. The scale offered Yes/No response options. The positive and negative key learning experiences were explored with two open-ended questions: Describe the most positive/the negative experience by completing the following sentences: "The most positive/the most negative event or experience from the beginning of my doctoral journey until now was when..."; "This event or experience was important to me because..."; "At that time I felt...". In addition, thesis format (monograph versus article-based dissertation), research group status (working alone versus engaging in research group) and country of origin (Finnish versus international candidate) were addressed. Background variables were also collected: PhD candidates' gender, study status (full-time versus part-time), dissertation format (monograph versus article-based dissertation), enrolment year and estimated graduation year were recorded.

## **The mixed methods analysis**

We applied a mixed methods approach (e.g., Creswell & Plano Clark, 2018). Quantitative analyses were used to examine the differences in PhD candidates' engagement in research collaboration activities based on dissertation format, research group status and country of origin (RQ1). The quantitative analyses comprised fifteen separate crosstabulations and chi-square tests, i.e., separate cross-tabulations and chi-square tests for the differences in engagement in each research collaboration activity (five) based on 1) dissertation format, 2) research group status, and 3) country of origin) and were conducted with IBM SPSS Statistics 28. In addressing missing data, we applied listwise deletion without imputation, ensuring that only complete cases with all available data were utilised in the analyses. In the qualitative analysis, PhD candidates' positive and negative key learning experiences were content analysed (e.g., Drisko & Maschi, 2015) using an abductive strategy (e.g., Chamberlain, 2006). Descriptions related to researcher networks

and researcher community interaction were first coded into two basic categories of negative and positive network experiences. These were then coded into the following three exclusive categories according to the network sphere: 1) *local networks*, including experiences situated in one's own research group, faculty, doctoral school and university, including interaction with local peers and researchers 2) *national networks*, including experiences in other national universities, theses committee, national conferences and summer schools, including interaction with researchers in Finnish academia beyond their own university; and 3) *international networks* including experiences situated abroad such as international conferences, researcher exchange, fieldwork, or interaction with international researchers. The categories derived from the content analysis were validated by the research group at the end of each analysis phase (e.g., Miles & Huberman, 1994).

## Results

The results showed that most PhD candidates (79%) had participated in at least one research collaboration activity. The proportion of candidates reporting that they had been engaged in two or three activities was 43%. About one-fifth of PhD candidates (21%) had not participated in any form of research collaboration. Further investigation showed that the most typical research collaboration activity among PhD candidates was presenting at international conferences (63%) and at national conferences (59%). In addition, 45% of PhD candidates had participated in international courses or summer schools, and a third had co-authored papers with international researchers (see Table 1). Yet, they had rarely taken part in research exchanges (13%).

Differences between the candidates existed in engagement in various research collaboration activities based on thesis format, research group status, and whether they were international or domestic candidates. More specifically, those writing an article-based dissertation had participated in researcher exchange ( $\chi^2(1, N = 736) = 4.54, p < .05$ ) and co-authored articles with international collaborators ( $\chi^2(1, N = 737) = 22.41, p < .001$ ) more often than their peers writing a monograph dissertation. Furthermore, the candidates who reported working at least partly in a research group had co-authored papers more often with international colleagues than those working mainly on their own ( $\chi^2(1, N = 741) = 30.18, p < .001$ ). Moreover, international PhD candidates had participated in international courses or summer schools ( $\chi^2(1, N = 749) = 10.65, p < .01$ ) and researcher exchange ( $\chi^2(1, N = 749) = 21.42, p < .001$ ) more often than their Finnish peers. The international candidates also had co-authored papers with international researchers more often than the Finnish candidates ( $\chi^2(1, N = 750) = 11.86, p < .01$ ).

TABLE 1

## PhD candidates' engagement in various international and national research activities by the background variables

	I have presented at international conferences (f/%)	I have presented at national conferences (f/%)	I have participated in international courses or summer schools (f/%)	I have co-authored papers with international researchers (f/%)	I have participated in researcher exchange during my doctoral studies (f/%)
<b>All</b>	477 (63%)	451 (59%)	348 (45%)	254 (33%)	100 (13%)
<b>Thesis format:</b>					
Monograph	103 (64%)	96 (60%)	70 (44%)	29 (18%)	29 (18%)
Summary of the articles	364 (63%)	345 (60%)	269 (47%)	220 (38%)	68 (12%)
<b>Research group status:</b>					
Working at least partly in a group	142 (63%)	134 (60%)	112 (51%)	106 (48%)	32 (14%)
Working alone	321 (62%)	302 (58%)	223 (43%)	139 (27%)	64 (12%)
<b>Country of origin:</b>					
International	94 (62%)	81 (54%)	86 (58%)	68 (45%)	36 (24%)
Native	376 (63%)	364 (61%)	257 (43%)	183 (31%)	60 (10%)

*f* = frequency

Further analysis revealed that the PhD candidates reported a range of positive and negative key learning experiences embedded in researcher networks. Most experiences were reported as having been positive ( $f=130$ ), however negative experiences were also reported ( $f=67$ ). Involvement in research community interaction, such as working in a research group, peer interaction, and in particular the ability to participate in international conferences and networking with other researchers were reported as sources of positive experiences. In turn, experiencing oneself as an outsider, receiving dismissive or/and negative feedback, a lack of support from others, and destructive friction in the research community such as a competitive or a hostile academic atmosphere and conflicts between candidates and other members of the community, were perceived as being an impediment to progress and sources of distress.

PhD candidates' learning experiences of researcher community interaction were often related to local networks ( $f=90$ ). Negative experiences at the local level ( $f=49$ ) were often related to experiences of being treated unfairly, being dismissed, or being bullied in their own research group by their peers or other researchers at their own university.

A senior researcher in my research group began to disrupt my research and threaten me.

I sometimes felt micro-aggression from other students in the seminar. I am not sure if it is due to my research topic (...) and I have also had disagreements with one mentor with whom I finally had to end my working relationship.

The lack of a friendly research group to be a part of.

Positive experiences in the local networks ( $f=41$ ) emphasised experiences of belonging and being acknowledged by their peers and other researchers in their own university, faculty, doctoral schools, and research groups. In addition, PhD candidates emphasised experiences of both teaching courses themselves and participating in doctoral courses at their university as a source of positive experiences.

I became part of a research project that interested me and received funding through it.

It was suggested that I apply for a doctoral position in a specific project.

We had an introduction event at our doctoral school before the pandemic, got to meet each other and heard about other programmes.

In addition to local-level networks, PhD candidates frequently reported key experiences related to international networks ( $f=56$ ) and were mostly positive ( $f=51$ ). Participation in international conferences, researcher exchange abroad, working as a reviewer and being acknowledged by international colleagues were particularly emphasised as a source of empowerment.

I received support and encouragement at an international conference related to the specific topic of my research.

I received supervision and feedback while on a research exchange in Japan.

I found an international community of researchers in my own field.

Negative experiences of international networks were only seldom described ( $f=5$ ). These experiences included negative experiences at conferences and not being able to travel abroad.

I was at an international conference abroad for the first time and felt like a fish out of water.

The conference trip was cancelled.

PhD candidates rarely described key experiences embedded in their national networks ( $f=11$ ). The few positive ( $f=9$ ) experiences of national networks included participation in national conferences and summer schools, visiting other Finnish universities and meeting with the thesis committee. The negative experiences ( $f=2$ ) were related to collaboration outside of academia and being undermined by national researchers outside of their own university.

[The] best experience was when I received a thesis committee for myself.

I cancelled a very one-sided collaboration, the goal of which was that the company would only get something out of the collaboration, although it was agreed otherwise.

## Discussion

We set out to investigate PhD candidates' engagement in various spheres of researcher networks, key learning experiences embedded in them and how such engagement is related to thesis format, research group status, and country of origin. The results showed that most candidates engaged in a variety of research collaboration activities, the most typical being presenting at international and national conferences and participating in international courses or summer schools. Overall, engagement in research collaboration activities was more common among those writing an article-based dissertation (cf. monograph), those working in a research group (cf. alone), and international (cf. domestic) candidates. The candidates also reported a variety of positive and negative learning experiences embedded in research networks. Most learning experiences were located in local networks. Also, key experiences embedded in international networks were commonly emphasised, while the national level was rarely reported. Offering an original insight into PhD candidates' interaction with others, the results uncover a new understanding of the differences in candidates' opportunities to build their research networks at local, national and international levels.

The results show that engaging in a variety of research collaboration activities was common among PhD candidates. Three out of four candidates reported having experienced some form of research collaboration, which is in line with prior findings (Bienkowska & Klofsten, 2012). Overall, the results imply that most PhD candidates were actively engaging in research collaborations during their doctoral studies. However, the activities differed in terms of how typically they were reported. The candidates most typically reported presenting at international and national conferences, and participating in international courses or summer schools, which is also aligned with previous research evidence (Bienkowska & Klofsten, 2012; Blackford, 2018; Gruber et al., 2023; Gureyev et al., 2020; Horta et al., 2021). However, the candidates reported engaging in a research exchange rarely (13%), especially when compared to their Nordic peers in Sweden or Denmark (Bienkowska & Klofsten, 2012; Cornér et al., 2018), where from 25% to even 100% of candidates participate in such activity. The differences between the countries are most likely due to differences in doctoral education structures: for example, research exchange is a compulsory part of doctoral education in Denmark.

Furthermore, the results showed that the candidates' engagement in research collaboration activities differed according to the thesis format, research group status, and nationality. For example, those working in a research group were more likely to have experience of co-authoring papers with international collaborators compared to those who worked outside research groups. The finding supports earlier results regarding the importance of research group integration when studying for a PhD (see Meschitti & Carassa, 2014; Vabø et al., 2016) by suggesting that working in a research group provides benefits in building researcher networks. Moreover, in line with previous research (Melkers & Kiopa, 2010), the results showed

that international candidates tended to engage in international collaboration, such as international courses or summer schools, researcher exchange and international co-writing processes, more typically than their Finnish peers. Although international PhD candidates have been shown to have a higher risk of experiencing challenges relating to well-being (Pappa et al., 2020), academic isolation (Le & Gardner, 2010) and attrition from doctoral studies (Laufer & Gorup, 2019), our results suggest that being an international PhD candidate is an asset with regard to research collaboration.

Although the results showed active involvement in research collaboration overall, one-fifth of the candidates did not report having participated in any form of research collaboration. Together with the results regarding differences in engagement in research collaboration activities based on thesis format, research group status, and nationality, the results imply that the PhD candidates do not have equal opportunities or aspirations to build their research networks during their doctoral studies.

Further analysis showed that the local sphere provided the primary arena for research network experiences. The majority of key learning experiences described by the PhD candidates were embedded in local researcher networks. An equal distribution of positive and negative experiences was reported. As suggested in the literature, at their best, local research networks can provide a grounding for a positive experience (e.g., Cai et al., 2019; Corcelles-Seuba et al., 2023; Douglas, 2023), yet the negative experiences in the local researcher community, including unfair treatment or even bullying, may compromise PhD candidates' engagement, well-being and potentially lead to attrition (Castelló et al., 2017; Peltonen et al., 2017; Rönkkönen et al., 2023). Furthermore, as local networks may mediate to access international networks (e.g., Lee, 2008; Wisker et al., 2007), negative experiences might also hinder PhD candidates' opportunities for building and extending their researcher networks at an early stage of a career when their positive experiences may sustain them. In turn, positive ones are likely to encourage and open up opportunities for further networking. Consistent with prior research, our results highlight the importance of local networks as sources of learning and well-being – both in positive and negative senses. In addition to local-level networks, the candidates quite often described learning experiences located in international networks, and these experiences were most typically positive. However, the candidates rarely described key learning experiences situated in national networks, but when described, these experiences were typically perceived to be positive. One reason for emphasising international networks over national ones might be that the candidates perceived international networks to be more important for their future careers as research is international by its nature (e.g., publishing in international journals and funding commonly being tied to international collaboration). In particular, in small countries like Finland, international networks are vital for the candidates and may provide more opportunities for their development.

Our findings provide several directions for future research. First, as the results implied that the PhD candidates have unequal opportunities to build their researcher networks, the contextual and invariant factors that contribute to those differences should be explored. More specifically, it is likely that there are

more factors influencing opportunities to network during doctoral studies than those addressed in our study, and such factors might not be the same across all contexts. This calls for comparative studies in multiple doctoral education contexts. Second, longitudinal studies are needed to investigate the importance and long-term effects of various forms of research collaboration during doctoral studies on PhD careers. Such longitudinal evidence would provide a strong basis for the research-based development of doctoral education. Last, as the results suggested that researcher networks at local, national, and international levels provide alternative contexts for Finnish PhD candidates' learning and well-being, there should be an exploration of whether this holds for other doctoral education contexts as well.

### **Methodological reflections**

The study has some methodological strengths and limitations that should be considered. Firstly, the response rate was somewhat low, although in terms of age the PhD candidates were a good representation of the whole PhD candidate population at the case university. Secondly, the study was conducted at one institution only with a cross-sectional design. Hence, longitudinal studies and studies in other socio-cultural contexts are needed to be able to generalise the results and draw causal conclusions. Also, the measures used in the study can be considered valid and reliable, as they have been validated in previous studies (Pyhältö et al., 2016, 2018, 2020). Last, the data has its limitations related to the depth of the doctoral candidates' descriptions of their engagement in researcher networks. More explicitly, we need studies focusing on candidates learning gains in various networks. More in-depth studies are needed in the future.

### **Practical implications**

The results have some practical implications for developing doctoral education. Firstly, it seemed that engaging in research collaboration activities accumulated for some individual candidates, that is, there were candidates with experience in a variety of research collaboration activities and others with no research collaboration experience. Considering the benefits of engaging in research networks, it might be beneficial to encourage candidates to build collaborations and provide structures and resources for it at the institutional level. In particular, candidates writing a monograph, and working outside the research groups may benefit from additional support in building the networks. Secondly, international candidates might need more help in building local networks, especially informal ones (e.g., Adrian-Taylor et al., 2007; Janta et al., 2014), while domestic candidates might benefit from help in international networking (e.g., Yao & Vital, 2016). Peer support might provide a resource for this; for example, by establishing peer mentoring groups, domestic and international candidates can help each other in networking. Moreover, supervisors could provide additional help to those candidates in finding research networks that are relevant to their

learning and development. Thirdly, our results showed that the most negative experiences that the candidates reported were situated at the local level. This cannot be fully avoided, considering that most research interactions take place in the local sphere. However, institutional efforts should be made to address inappropriate behaviours systematically to provide a safe place for PhD candidates to study and grow as researchers. For example, clear guidelines for preventing bullying and inappropriate behaviour within institutions should be in place.

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