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Four Dimensions of Doctoral Expertise: Graduates' Reflections on Learning During Doctoral Studies

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There is an increasing need for advanced expertise in the world to solve complex problems. A high level of education equips both individuals and societies with the expertise required to find solutions. This article examines the nature of expertise developed during doctoral education. The research question is: What kind of expertise is developed following doctoral studies, on the basis of the experience of doctoral graduates? The qualitative data consists of in-depth interviews with nine PhD holders. The data was analysed using an inductive approach. According to the results, theoretical expertise was perceived as the strongest and most self-evident dimension of doctoral education. However, practical, self-regulatory, and socio-cultural dimensions of expertise also emerged as key aspects of doctoral expertise. In particular, competence in networking, project work, and internationalisation were identified as crucial skills within the academic field. Nevertheless, flexibility, hybrid expertise, and broad applicability were recognised as core features of expertise regardless of the field. The study suggests that doctoral studies foster diverse and still largely unrecognised forms of expertise. This differentiated expertise should be more consciously integrated into the doctoral process. Doctoral expertise evolves at the intersections of different contexts, across disciplinary boundaries. Espousing an augmented meta-level awareness of the dimensions and processes of expertise, and engaging in dialogue across different fields, benefits doctoral graduates, doctoral education, and society at large in the development and utilisation of expertise.

Keywords: doctoral education, PhD graduate, academia, university, expertise

Introduction

In Europe, efforts have been made to harmonise and structure doctoral education, while simultaneously aiming to improve the quality of its complementary research activities (Aittola, 2017; Cardoso, 2024). In Finland too, doctoral education has been developed since the 1990s to become more systematic, and doctoral students have increasingly been included in this development process (Aittola, 2017). However, further progress is still needed—for instance, in recognising how doctoral graduates build their careers (Maunula, 2023; Piironen et al., 2025). From 2024 to 2027, Finland is running an educational pilot in which 1,000 doctoral candidates have been enrolled into universities for three years with dedicated government funding (Ministry of Education and Culture, 2023). This pilot scheme aims to develop more efficient and flexible practices in doctoral training.

Significantly, the number of doctoral graduates in OECD countries has doubled over the past two decades, and this trend is accelerating (OECD, 2021). In 2019, the

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average proportion of 25–64-year-olds holding a doctoral degree in OECD countries was approximately 1% (OECD, 2019), and if the trend continues, 2.3% of today's young adults will enter doctoral education (Sarrico, 2022). Globally, doctoral education is facing growing expectations: the knowledge economy, economic growth, and innovation (Cardoso, 2024; Halse & Mowbray, 2011). Doctoral education is expected to efficiently produce an increasingly refined pool of experts with the knowledge, skills, and future-oriented visions required in the digital and global era (McKenna & van Schalkwyk, 2023). At the same time, general understanding of the capabilities of doctoral holders remains limited (Sarrico, 2022), including among doctoral holders themselves, who often lack awareness of the diversity of the doctoral experience (Piironen et al., 2025). This can be seen as an ethical issue within doctoral education (Cardoso, 2024; Roos et al., 2021).

The employment of doctoral graduates across the wider segments of society has become more common, with over half of doctoral holders in OECD countries now working outside academia (OECD, 2015). Often, those working outside academia report that their research skills have been developed to an extent that exceeds the demands of their jobs, while their personal efficiency, leadership, and communication skills fall short of what is needed (Waaijer et al., 2017). As such, they may apparently be both overqualified and underqualified relative to the expectations of various employment sectors (Sarrico, 2022). Given that doctoral education, cannot always be expected to prepare graduates for every type of work (Sarrico, 2022); therefore employers too must equally take responsibility for continuous and sustainable training of their workforce, for example through appropriate coaching, supervision, and mentorship (Cappelli, 2015; Maunula et al., 2024).

The contexts of doctoral graduates vary between countries at systemic, institutional, and individual levels. Labour markets, academic disciplines, and personal circumstances all shape individual career trajectories (Sarrico, 2022). This article focuses on Finnish doctoral education and the experiences of newly graduated or soon-to-graduate PhDs regarding the dimensions of their expertise. Finnish doctoral education has evolved systematically in line with global trends, with an emphasis on increasing efficiency, improving quality, enhancing internationalisation, and the preparation of professional researchers (Ministry of Education and Culture, 2023). These developments have influenced the various actors, practices, and values across the levels of doctoral education (Jauhiainen & Nori, 2017; Piironen et al., 2025). Discussions have also emerged regarding academic knowledge capitalism and its relevance (Hannukainen & Brunila, 2017). On the basis of this given context, the research question of this study could be formulated and posed as: What kind of expertise is developed following doctoral studies, on the basis of the experience of doctoral graduates? This article proceeds by presenting previous research on doctoral education and expertise contextually, followed by a description of the study's methodological options, findings, and then the analytical discussion.

Literature Review

Doctoral education has undergone significant transformation in recent decades, shaped by both global policy agendas and changing expectations of doctoral graduates. In response to societal demands for innovation, interdisciplinarity, and employability, the purpose and structure of doctoral training have expanded beyond traditional academic pathways. This literature review explores prior research on the reform of doctoral education, the evolving expectations placed on doctoral candidates, and the theoretical understanding of expertise as a dynamic, multi-dimensional process. These perspectives form the conceptual foundation and framework for analysing how doctoral expertise is constructed across diverse contexts.

Reforming Doctoral Education

Doctoral education in Europe is subject to high expectations, and the number of PhD scholars being trained continues to grow (Cardoso, 2024; OECD, 2015; 2019; 2021; 2023). At the same time, the criteria for admission into doctoral programmes have become more stringent, with a clearer emphasis on the quality, relevance and feasibility of the research plan, as well as the applicant's demonstrated research skills and activity (Jauhiainen & Nori, 2017). However, higher education systems have been criticised for their weak connexion with the labour market (Roos et al., 2021; Sarrico, 2022), and there is a global call for doctoral education to become more practical, innovative, and connected to the contextually prevailing real-world challenges (e.g. Costley & Lester, 2012). Thune (2009) highlights the importance of shared objectives and ongoing interaction between universities, public authorities, and industry. A bold reorganisation of doctoral education, including broader skills applicable to diverse contexts, is seen as an opportunity amid the transformation of knowledge and work settings (Sarrico, 2022). Already twenty-five (25) years ago, Etzkowitz et al. (2000) argued that doctoral education should focus more on employability, entrepreneurial activities, and collaborative capacities extending beyond academia. Today, such themes are increasingly integrated into traditional doctoral programmes to better align PhD expertise with societal expectations.

At the European continental level, higher education has been harmonised through initiatives such as the Bologna Process and the Lisbon Strategy (Bitusikova, 2009). Nonetheless, international comparisons continue to show country-specific features of the doctoral experience (Auriol, 2007; Sarrico, 2022). From the perspective of European universities, intensified financial pressures and competition are central themes (Enders, 2005; Hannukainen & Brunila, 2017). The doctoral training system is continuously streamlined, with only the most promising candidates being admitted and emphasis placed on supervision, international networking, and funding acquisition skills (Jauhiainen & Nori, 2017). Universities now aim to efficiently produce not only doctoral degrees (e.g. Hannukainen & Brunila, 2017), but also multi-skilled academic researchers and innovative experts attuned to the needs of working life (Gu et al., 2018), especially those capable of engaging in dialogue across different domains (Laalo et al., 2019). Despite this, universities commonly

assume that graduates will pursue academic careers, resulting in insufficient preparation for non-academic pathways (Gardner & Doore, 2020; Jaksztat & Gross, 2024).

As part of the Salzburg Process initiated by the European University Association and the ongoing reform of doctoral education, universities have begun incorporating transferable skills into their doctoral programmes. The goal is to better prepare doctoral candidates for career options outside the academia (Hasgall et al., 2019; Hasgall & Paneoasu, 2022). This reform is significant, as only 32% of doctoral students reported having studied transferable skills during their PhD training (Janger et al., 2020). Supervisors play a key role in presenting various career options, pathways and opportunities (Goldan et al., 2023; Gu et al., 2018). The diversification of doctoral careers can be seen as an opportunity to revise doctoral training and supervision to better reflect new realities (Coates et al., 2020). Transitioning from academia to non-academic work is not always easy, and the cultural differences between institutions can even be a psychogenic shock for some doctoral graduates (Skakni et al., 2021). Piironen et al. (2025) identify how doctoral career paths begin to diverge already during the PhD process and highlight the importance of recognising the individual and systemic boundary conditions shaping these trajectories. Recognising such conditions makes the covert practices of academia more visible and open to development, while enriching the discourse on the doctoral researcher's roles and remits.

Doctoral Education and Expertise Development as a Process

The process of earning a doctorate fosters the development of multiple areas of expertise, both domain-specific and general professional skills. Expertise is multidimensional and evolves through a process (Ericsson et al., 2006; Hakkarainen et al., 2004). These authors define expertise as a mode of practice that consistently produces high-level performance. It entails a dynamic attitude aimed at continual improvement in increasingly complex tasks. Chi et al. (1988) emphasise that expert knowledge integrates seamlessly with existing mental models, thereby reinforcing overall understanding. Bereiter (2002) adds that experts flexibly utilise both formal and informal knowledge, including experiential, intuitive, and self-regulatory dimensions.

A widely accepted view holds that expertise comprises four core dimensions: theoretical, practical and experiential, self-regulatory, and socio-cultural knowledge (Bereiter, 2002; Erault, 2004; Ericsson et al., 2006; Lehtinen et al., 2012; Tynjälä, 2010). Theoretical knowledge can be expressed in text or speech. Practical knowledge is developed through undertaking and experiencing and includes both skills and embedded knowledge. Often tacit, this kind of knowledge is linked to various processes but can be made explicit through reflection. Such reflection gives rise to self-regulatory knowledge, which includes metacognitive and reflective awareness of one’s own work habits, idiosyncrasies, thinking, and learning. When reflection extends beyond the self, expertise becomes situated in broader contexts such as one's professional community. Lehtinen et al. (2012) stress that socio-cultural expertise includes implicit rules, norms, and cultural knowledge, which can only be accessed through participation in community practices. The shift from

individual to collective expertise is gaining pace (Lindén & Annala, 2016). In expert performance, the various components of knowledge merge into a seamless and meaningful whole.

While the components of expertise are presented separately—into theoretical, practical, self-regulatory, and socio-cultural domains—they are in fact deeply interconnected in high-level expertise domains (Bereiter, 2002; Tynjälä, 2008). Earlier understandings of expertise focused on individual cognitive processes such as exceptional abilities in acquiring and processing information. However, this perspective has expanded to include participation and identity development, highlighting the evolving process of expertise and the creation of new knowledge. The development of new practices and innovative knowledge communities relies heavily on the interactive growth of individuals and communities (Hakkarainen et al., 2004).

The development of expertise during doctoral studies requires conscious awareness of these dimensions and their integration (Tynjälä, 2010). Hancock (2019) stresses the importance of early-stage doctoral supervision that recognises the different skill requirements for different career pathways. Doctoral researchers increasingly expect career guidance to reflect broader, non-academic career landscapes and to support the development of versatile expertise (Gu et al., 2018). Expertise thus entails not only mastery of disciplinary practices but also innovation and the ability to adapt and anticipate within changing conditions and circumstances (Ericsson & Pool, 2016; Hakkarainen et al., 2004).

Methodology

This article explores the capital of expertise developed during doctoral education, as experienced by recent doctoral graduates and current doctoral candidates. The research question is: *What kind of expertise is developed following doctoral studies, on the basis of the experience of doctoral graduates?*

The participants (N=9) were recently graduated or soon-to-graduate doctoral researchers. They were interviewed about their experiences of doctoral education and the expertise they felt had emerged during their doctoral journey. For the sake of simplicity, they are referred to throughout this article as doctoral graduates without further qualification.

The data were collected through thematic interviews, with broad themes covering the entire trajectory of their academic and professional lives—doctoral studies, career development, and the formation of expertise. The interviews lasted approximately 60 to 90 minutes. All were audio-recorded and transcribed. The material is confidential and personal and offers a nuanced view of academic practices and doctoral expertise. Participants were affiliated with three different Finnish universities and represented a range of disciplines, including social sciences, education, economics, sport sciences, social policy, psychology, and mathematics.

To answer the research question, the analysis began with a hermeneutic approach, where the researchers first familiarised themselves with the data and engaged in dialogue using researcher triangulation (e.g., Patton, 2002). This was followed by a theory-driven thematic content analysis guided by the four dimensions

of expertise: theoretical, practical, self-regulatory, and socio-cultural expertise (Ericsson et al., 2006). This approach supposedly allows researchers to draw reproducible and valid inferences from the data in relation to their contextual meanings (Patton, 2002). The process entailed a hermeneutic dialogue between researchers, theory, and data, and through abductive reasoning, an overarching understanding was formed. The research material was in the Finnish Language; only the quotations presented in the results section were translated into English.

The validity of this qualitative study is supported through triangulation and critical reflection by the researchers throughout the research process. The article clearly outlines the study's starting points and contextual framework, enabling readers to interpret its significance appropriately. The dataset is extensive and typical in scale for qualitative research. A critical reader was invited to independently interpret the material and reflect on its implications relative to the study's aims.

Limitations of the Study

As with all qualitative research, this study is context-specific and based on the experiences of a relatively small group of participants (N=9) from Finnish universities. While the sample was diverse in terms of disciplines and institutional backgrounds, the findings cannot be generalised to all doctoral graduates or national contexts. The focus on recently completed or nearly completed doctoral candidates may also exclude insights from those who left doctoral education early or who have accumulated further expertise in later career stages. Additionally, the interviews relied on self-reported reflections, which may be biased or shaped by individual perceptions, memory, imaginations, and context. Another limitation concerns the lack of systematic comparison between disciplines or institutional policies, which may influence doctoral experiences and opportunities for expertise development. Despite these limitations, the study could provide valuable insights into the multi-dimensional nature of doctoral expertise and highlights important areas for further research and development within doctoral education.

Findings – Four Dimensions of Doctoral Expertise

This section presents the key findings of the study, which explores how doctoral expertise is experienced and constructed during doctoral education. Based on the analysis, four main dimensions of expertise emerged: theoretical, practical, self-regulatory, and sociocultural. These dimensions reflect the complex and evolving nature of expertise as perceived by the doctoral graduates. Each dimension is discussed in detail below, illustrated with participants' own reflections.

Theoretical Expertise

According to the doctoral graduates, the expertise developed during their doctoral studies consisted of structured and multifaceted knowledge within their academic field. This included a broad theoretical foundation in their discipline as

well as deep, specialised expertise related to their specific research topic. Their expertise was primarily rooted in their dissertation research and had evolved over an extended period of time.

> *"My expertise is based on the fact that I've worked and written a dissertation on a specific topic. I continue to research within the same area, so it is, of course, essential."*

The doctoral graduates emphasised that they were experts in their specific research field, but this did not exclude their ability to manage and contribute to broader, interdisciplinary contexts. At times, they expressed frustration with misconceptions that portray PhDs as narrowly specialised theorists disconnected from practice.

> *"I see that, as an expert, I possess skills that would be valuable to many other organisations beyond universities. I wish there were more of a shift in attitude—so that more organisations besides universities would more readily consider hiring doctoral graduates."*

The process of developing theoretical expertise was described as at times challenging, yet highly motivating. When research did not progress, it led to frustration and self-doubt regarding one's level of expertise. In difficult situations, the doctoral researchers coped by refocusing on the broader picture of their research and breaking it down into smaller, manageable parts. The doctoral degree itself was not considered a sufficient motivator due to the title alone; rather, they were driven by the pursuit of substantive, content-based expertise. The doctoral graduates viewed their published scientific articles as a key indicator of their theoretical development. Theoretical expertise was regarded as important and became a central, almost self-evident, dimension of the doctoral journey.

> *"I have perhaps developed the most expertise in research and research methodology, including the ability to evaluate the quality of international articles and the data they use. I can critically assess research, and these skills have continuously deepened over time—covering a wide range of knowledge related to conducting research, some of which may even feel self-evident by now."*

Practical Expertise

According to the doctoral graduates, practical expertise was closely intertwined with theoretical knowledge in their discipline and could not be separated from it. Practical expertise was framed as general academic skills and competencies. It developed through the practical phases of the dissertation process and across different contexts. Taking part in the practical aspects of research made the multifaceted nature of scholarly work more tangible.

> *"There was so much else to do—you couldn't just write the dissertation. You had to publish other papers and get involved in many other activities too."*

Research was described as a multi-phase process, the progress of which could not be reliably predicted in advance. Doctoral studies had helped them develop a

better understanding of research processes and a readiness to analyse critically—also across disciplinary boundaries. They had also learned to take criticism as a tool for improving the quality of their work. In addition to their critical stance, they described having grown into a culture of critical thinking.

> *"Feedback on my research is helpful—it gives me more and more confidence in critical thinking."*

One of the key practical skills was writing project funding applications, both independently and as part of a team. Many said they had learned from failed applications and gained perseverance needed for the process. The importance of applying for funding was emphasised, as both research activity and employment prospects required proactivity and an entrepreneurial mindset. Some participants had strong capabilities and success in securing funding and were skilled in presenting their research in an engaging and understandable way to non-expert audiences. Others acknowledged that this was an area they needed to improve.

> *"I would say that within the study framework, my project application skills remained poor—they could have improved much more."*
> *"From the very start, I was part of a research group, and we were constantly applying for funding. I've been in a very good training environment from the beginning. Of course, it took time, but this is the kind of skill and knowledge you need when building your research profile."*

The significance of practical project expertise varied. For some, it was one of the most essential skills; others found it frustrating and bureaucratic and did not want it to be part of their future job role. Most participants saw a meaningful and organic connection between the content of their expertise and project work. Working on projects also helped them envision their expertise in more practical professional contexts and contributed to understanding potential career pathways beyond academic research.

Language proficiency was mentioned as a practical skill, enabling international networking, in-depth research collaboration, and publication in international journals. Doctoral education also strengthened the ability to transfer their skills across contexts, learn new things, and grasp complex systems. The nature of academic work was characterised as a continual process of learning new research practices and finding new applications. These abilities were seen as helpful for expanding one's competencies and navigating future work in different contexts.

> *"Working in an international community, I have conducted all tasks and written communication in English, which has strengthened my overall communication skills. My language proficiency has supported successful mobility funding applications, and the resulting research collaborations remain ongoing."*

Practical expertise was also associated with the processes of scientific writing. The ability to write and review academic articles was considered central. Academic productivity and publishing in prestigious journals were seen as indicators of both

theoretical and practical expertise. Doctoral candidates were eager to publish actively to distinguish themselves from their peers. Understanding the logic of publishing and learning from it continuously was viewed as a critical academic skill. The publication process was described as lengthy, demanding, and exhausting, yet instructive and ultimately rewarding.

> *"I read research with interest and can assess reliability, sample size, and those basic elements. In many ways, that foundation has helped me."*

Some doctoral graduates had extended their practical expertise through pedagogical studies, seeing teaching as a possible though not primary career pathway. Doctoral studies had also enhanced their skills for more hands-on work. Those who transitioned from academic degrees into non-academic fields expressed a particular interest in combining research and practical application in their work.

> *"I'd like to combine working life with research. Researchers are often blamed for handing down advice from their ivory towers. Nowadays, research is much more of an everyday tool—and that's what I'd like to promote."*

Self-Regulatory Expertise

According to the doctoral graduates, the process of completing a PhD was highly self-directed and fostered the development of self-regulatory skills. Writing a dissertation required not only intrinsic motivation and curiosity for the subject but also goal orientation and self-discipline. At times, the research progressed smoothly, while at other times, the frameworks collapsed and had to be reconstructed. A key element of self-regulatory expertise was the constant critical self-evaluation in relation to the demands of scientific work, the perceived meaningfulness of the work, personal endurance, and time management pressures. The doctoral research process highlighted the typical expert-like traits of ownership and developing a personal working style.

> *"When there's a lot of information, you quickly learn to find the essentials. These days, it's impossible to read everything—it's unfortunate. Sometimes you just skim articles and extract what you need to keep things moving. You can't go too deep into all the available information."*

The competitive nature of academia and the doctoral graduates' individual responses to it required strong self-regulatory abilities. For example, externally imposed dissertation deadlines were seen both as motivational and as sources of pressure. Many emphasised the importance of avoiding constant stress and maintaining mental balance. Self-regulatory expertise also included valuing rest and recovery through hobbies and free time.

> *"Sometimes I wonder how I'll manage the next 20 years—maybe I work too conscientiously. I should reflect on what value this research has: a) for me, and b) for anyone else."*

Gaining employment within academia and advancing to positions of greater responsibility required doctoral graduates to understand the logic of academic systems, and to plan and anticipate their own activities—in other words, to demonstrate self-regulatory expertise. They also had to accept the possibility of failure in a competitive environment. The ability to plan and forecast their career trajectories varied among participants. Self-regulatory expertise also entailed recognising one's own weaknesses in relation to the nature of expert work. The doctoral graduates described the importance of continuous conscious self-assessment.

> *"My project management skills are still developing. I've grown as a writer and improved my international skills—I can use networks and function as an expert. My administrative competence has also grown as I've taken on more responsibility. Now I'm supervising doctoral students and involved in completely new things."*
> *"My strategy to survive it all is to prioritise. You have to be satisfied with your own decisions—you can't constantly be longing for something else or wondering what you* should *be doing—that's where stress comes from. Of course, I feel I should become more international, but at the same time, I'm happy where I am now."*

A defining feature of their self-regulatory attitude was the understanding that expertise is never complete. They were characterised by inner curiosity, a desire to learn, and a readiness to challenge their own thinking—especially within their area of expertise. Satisfaction and a realistic outlook also reflected their growth process as experts. Their passion for a research-based way of working and a desire to know and understand gave depth to the self-regulatory experience of their doctoral studies. Their sense of growing expertise was strong, and they identified multiple contexts for its development and application. Long-term academic training, practical experience, self-monitoring, critical assessment, and social interaction were all key components of their evolving expertise.

> *"All the things I've been able to do and learn have given me knowledge, skills, competence, and the confidence to know that I can handle this work. And I also know where to go for advice if I don't know something. That gives me a real sense of assurance."*

Sociocultural Expertise

Doctoral graduates became integrated into the working culture of their discipline by actively participating in it. They considered their involvement in different communities to be meaningful primarily within the academic sphere, but also in non-academic work environments. Through their dissertation work, they also connected with disciplinary networks. For some, this meant being part of a prestigious and successful international research team; for others, it involved participation in a regularly meeting local doctoral study group. These groups brought peers together through shared experiences of various phases of the dissertation process. Practical tips, updates on others' research, and the sense of belonging created a sociocultural community. Informal peer support was considered particularly valuable.

> *"It feels really important and is a central space to check in on how things are going. Everyone had very different types of projects, but there were also overlaps, and that was genuinely helpful. We had common ground in terms of methods, findings, and theoretical background—not to mention opportunities to share experiences of the process itself."*
> *"I've done several short research visits abroad in different labs. That's how I've built new networks and gained new expertise."*

The research group was described as the core of research work. Collaborating with others led to continual learning and the development of new research perspectives and topics. Working together, sharing, and being an active member of a community expanded the doctoral graduates' practical and social expertise. It provided opportunities to explore the latest research in their field and to develop sociocultural knowledge. The different dimensions of expertise were deeply interwoven and strongly shaped through social relationships.

> *"I've been in the right place at the right time. There are people who look out for me—people who are aware of my employment situation and advocate for me. The support around me has been strong, the work varied, and I've had many chances to develop myself in different areas. That builds confidence—I know I've given the impression in these networks that I'm a good employee, someone worth hiring."*
> *"I've joined networks through conferences and try to stay in touch with certain people. Now I pitch them ideas and article topics so we can write together."*

Doctoral graduates valued collaboration with colleagues. Engaging in hands-on work, articulating scientific ideas, and collaboratively developing research was highly rewarding. Participation in international research groups also brought insight into theoretical and methodological issues, as well as the collective achievements possible within the scientific community. Some had expanded their collaboration networks and sociocultural expertise beyond academia by working outside the academic community. However, integration into academic communities was sometimes hindered by competitiveness and the uncertainty of employment. Working in academia was not solely a matter of personal ambition or expertise—external factors such as the competitive funding environment set constraints. Opportunities outside academia were appealing, offering more stable and practical job roles. Even short-term positions in non-academic contexts provided chances to network and demonstrate competence.

Engagement in academic communities deepened doctoral graduates' understanding of how academia operates and helped them develop a wide range of skills such as collaboration and tacit knowledge. The career pathways of other experts were seen as examples of different opportunities.

> *"The whole doctoral process is an important journey of growth and development. You learn and grow into expertise during that time. I'd recommend it to anyone who wants to engage in research—even if they don't plan to stay in academia afterward, doctoral studies offer a lot. Some might think it's a narrow specialisation, and yes, you do go deep into one topic. But that doesn't mean your expertise is narrow. You learn to*

search for information, to filter it quickly, to grasp the big picture—these are skills that are undoubtedly useful in all kinds of jobs."

Discussion

This study explored the types of expertise developed during doctoral education, as experienced by doctoral graduates. The research identified that doctoral expertise aligns with the four dimensions outlined by Ericsson et al. (2006): theoretical, practical, self-regulatory, and sociocultural. In addition, doctoral expertise also emerged as integrative and networked (see also Hakkarainen et al., 2002).

According to the participants, theoretical expertise forms the self-evident core of doctoral-level expertise. It is rooted in the content of the dissertation but also extends into broader interdisciplinary themes. Its development is a long, rewarding, and at times challenging process. Practical expertise is tightly connected to theoretical knowledge and is reflected in general academic competencies. It is particularly developed through involvement in the various phases of the dissertation process, such as information processing and publishing activities. Practical skills also include the ability to apply for project funding, which connects doctoral graduates to opportunities beyond the university. Additionally, readiness for continuous learning and language proficiency enables international engagement and adaptation to new contexts.

Self-regulatory expertise develops through the self-directed nature of the doctoral journey, including goal-setting, time management, and efficiency. Understanding research logics and academic competition further strengthens self-regulation. The doctoral process is continuous, and promoting well-being and the ability to detach from research supports sustainability within doctoral education. Sociocultural expertise, on the other hand, grows through participation in disciplinary cultures, networks, and academic and non-academic communities. Research groups and close colleagues form the sociocultural community for the doctoral expert. Social relationships within research contexts facilitate the development of all dimensions of expertise.

Examining doctoral expertise through these dimensions highlights its breadth and, when mirrored against existing research, demonstrates that doctoral graduates possess widely discussed transferrable skills (see Hasgall & Paneoasu, 2022; Hasgall et al., 2019). Expertise evolves into differentiated forms through the process (Sarrico, 2022). Career trajectories vary across disciplines (see also Piironen et al., 2025; Gardner & Doore, 2020; Jaksztat & Gross, 2024; Skakni et al., 2021), and this variation should be acknowledged from the outset of doctoral training. Expertise continues to grow after the doctorate (Cappelli, 2015), which is intrinsic to the nature of expertise (e.g. Ericsson et al., 2006). As doctoral careers progress and contexts change, expertise continuously takes on new dimensions (Waaijer et al., 2017). Mentoring also supports doctoral graduates in terms of career sustainability and lifelong learning (Maunula et al., 2024).

The participants in this study represented a range of disciplines, which reflects the diverse contexts of doctoral education. This diversity in background has also been recognised in previous research, and individual differences cannot be

standardised. Doctoral education should embrace and accommodate individual variation as part of career development. While research has identified key influences on career pathways, these influences are not always sufficiently integrated into doctoral education practices (e.g. Piironen et al., 2025). Although evidence-informed development and leadership should be standard in academia, in practice it often challenges already time-pressed academic staff.

Expanding doctoral training to include information on the development of expertise, disciplinary career pathways, and employment opportunities would strengthen doctoral candidates' self-regulation, agency, and awareness of potential career pathways. Rethinking and clarifying supervisors' roles and profiles—possibly extending beyond academic subject expertise—would also support development. A single professor cannot be expected to master every aspect of the doctoral training process alone.

Wider employment of doctoral graduates across sectors requires both academia and external stakeholders to recognise the breadth of doctoral expertise. As highlighted by the doctoral graduates in this study, they are frustrated by misperceptions of PhDs as overly theoretical and disconnected from practice. Doctoral expertise takes different forms in different contexts. The increasing number of doctoral graduates and their employment outside universities presents a significant challenge to the content and practices of doctoral education (reference missing). While doctoral education cannot be expected to fully equip graduates with all transferrable skills, career guidance should help identify broader career pathways. The responsibility for defining expertise and finding career options should not fall solely on the doctoral researcher. An effective doctoral education system supports graduates in finding roles that benefit society. At the same time, employers must also commit to ongoing learning, offering professional development in collaboration with universities.

This study shows that doctoral education cultivates differentiated forms of expertise that are not yet fully recognised, but which could be valuable across sectors if their development were more consciously guided. Doctoral expertise is shaped and refined at the intersections of different contexts. Raising meta-awareness of the dimensions and processes of expertise, and engaging in dialogue across fields, supports doctoral graduates in developing and applying their expertise more effectively. Public discussion around the nature of expertise may also help clarify expectations of experts across sectors.

The doctoral process builds a diverse, and in some cases yet unrecognised, body of expertise. The skills learned have many potential applications in scientific, professional and even everyday life. However, the fact that these skills learned and honed during doctoral studies are largely hidden limits their potential for exploitation in different contexts. It is essential that one of the starting points for doctoral training is that the expertise of the doctor is broad and could be used and further refined in new and diverse ways in different contexts. The expertise of doctors is built up on an individual basis, and taking this into account is part of sustainable doctoral training for the future.

The implementation value of this research lies in recognising the importance of doctoral graduates' experiences in shaping the development of doctoral education.

The diversification of career pathways can be seen as an opportunity to reform training in response to these realities (Coates et al., 2020). However, we stress the need for multifaceted development: specialised supervision, comprehensive guidance for students, and enhanced agency through increased awareness. As a future research avenue, it would be valuable to gather descriptions of doctoral education contexts and best practices across Europe to further inform development. In addition, more research is needed on specialised supervisory practices and the evolving dimensions of supervisors' expertise.

Conclusion

This study demonstrates that doctoral education cultivates a multifaceted and evolving form of expertise. Doctoral graduates develop theoretical, practical, self-regulatory, and sociocultural competences, which are further shaped through integrative and networked experiences across contexts. These forms of expertise are closely interlinked and contribute to doctoral graduates' capacity to navigate complex academic and professional environments. The findings highlight the importance of recognising individual and disciplinary variation in expertise development. As doctoral graduates increasingly pursue diverse career pathways, there is a growing need to reform doctoral training in ways that foster agency, transferable skills, and awareness of employment opportunities. More intentional support through mentoring, supervisory development, and career guidance would better equip doctoral researchers to apply their expertise beyond academia. Doctoral expertise continues to evolve throughout the career trajectory, responding to changing contexts and societal needs. Its full value is not yet fully acknowledged across sectors, but with more deliberate structures and cross-sector dialogue, this potential could be more effectively realised. Developing doctoral education based on graduates' experiences can serve as a foundation for rethinking practices, clarifying expectations, and strengthening the societal relevance of doctoral-level expertise.

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