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Learning how to develop a research question throughout the PhD process: training challenges, objectives, and scaffolds drawn from doctoral programs for students and their supervisors

Nathalie Girard¹ · Aurélie Cardona² · Cécile Fiorelli³

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Abstract

With the higher education reform putting forward the professionalization of doctoral students, doctoral education has been strongly focused on generic transferable skills to ensure employability. However, doctoral training should not forget core skills of research and especially the ability to formulate research questions, which are the key to original research and difficult to develop at the same time. Learning how to develop a research question is traditionally seen as a one-to-one learning process and an informal daily transmission between a novice and a senior researcher. The objective of this paper is to offer a framework to design doctoral programs aimed at supporting the process of development of research questions for doctoral candidates guided by their supervisors. We base our proposal on two doctoral training programs designed with a pedagogical strategy based on dialogs with peers, whether they be students, supervisors, or trainers from a diversity of scientific backgrounds. The resulting framework combines three learning challenges faced by doctoral students and their supervisors when developing their research question, as well as training objectives corresponding to what they should learn and that are illustrated by the scaffolds we have used in our training programs. Finally, we discuss the conditions and originality of our pedagogical strategy based on the acquisition of argumentation skills, taking both the subjective dimensions of PhD work and the added value of interactions with a diversity and heterogeneity of peers into account.

Keywords Doctoral training · Research question · Problem finding · Supervision · Scaffolding · Peer-learning

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Introduction

With the higher education reform ongoing in the Western world, doctoral education has undergone “a shift from the master–apprentice model to the professional model” (Poyatos Matas, 2012), focusing doctoral education on doctoral graduate employability (Cardoso et al., 2022) and thus on generic transferable skills (Christensen, 2005). However, Poyatos Matas (2012) warns doctoral educators of the danger of reducing doctoral education to a business or team skills approach, arguing the “importan[ce of maintaining] an adequate balance between skill-based and knowledge-based approaches to doctoral education.” Along the same line, Christensen (2005) argues that training in transferable skills “should not be overemphasised with respect to original research.” Nevertheless, Poyatos Matas (2012) does not explicitly explain what the core skills of research, grouped into a broad category referred to as “research skills,” are among seven other skills listed by the European Universities Association’s Salzburg principles.

Among research skills, the way the research question is formulated is critical. As Einstein and Infeld expressed it in 1971, “the formulation of a problem is often more essential than its solution [...]. To raise new questions, new possibilities, to regard old questions from a new angle, requires creative imagination and marks real advance in science.” In this article, we consider the development of a research question as a process that consists of determining and reducing the identified problems, whether scientific or socio-economic, and translating them into a relevant and treatable question (Callon, 1984). We assume that it is a key process for research activities and a skill that PhD students have to acquire during their PhD experience. However, learning how to develop a research question is far from being easy, as revealed by the multiplication of methodological guides and tutorials on this topic. As researchers and human resource advisors working in a multidisciplinary research institute (INRAE)¹, we have also observed many PhD students struggling to formulate their research question, which may seriously inhibit the writing of the final manuscript, whether it be a thesis by publication or not. Some authors have pointed out that the current graduate school education system has largely focused on producing better learners and problem solvers, thus neglecting problem-finding or creativity development in doctoral education (Whitelock et al., 2008). Preparing a “research proposal” and developing a researchable question is even recognized as a critical step for doctoral students (Zuber-Skerrit & Knight, 1986), becoming a “threshold to cross” during the PhD journey (Chatterjee-Padmanabhan & Nielsen, 2018). It thus appears essential to explore the challenges of research question development and how doctoral training programs can contribute to its learning.

The objective of our article is to offer a framework to think about and design doctoral training programs that support the development of research questions for doctoral candidates guided by their supervisors. Our proposal is grounded in two doctoral training programs designed with a pedagogical strategy based on dialogs with peers, whether they be other students, supervisors, or trainers from a diversity of scientific backgrounds. This article is structured into four sections. We present our theoretical background in order to explore the diversity of approaches to develop a research question, laying out our vision of doctoral experience and education, and the way in which the concept of scaffolding has been used in the learning processes that underlie the development of research questions

¹ INRAE, the French public research institute devoted to the development of agriculture, food and the environment (<https://www.inrae.fr/en>), continuously hosts some 2000 PhD students.

(“[Theoretical background](#)” section). We then present our methodology, combining an analysis of the literature, our experience in conducting research, supervising and training doctoral students and their supervisors, and our case studies (“[Materials and methods](#)” section). Our results consist of a framework that combines three learning challenges and the corresponding training objectives, illustrated by scaffoldings we have used in our training programs (“[Results: scaffolding learning challenges for the development of the research question within a thesis](#)” section). Finally, we discuss the conditions and originality of our proposal based on the acquisition of argumentation skills, with the consideration of the subjective dimensions of PhD work and the added value of interactions with a diversity and heterogeneity of peers (“[Discussion: Enriching peer-learning scaffolding to support the development of a research question as a dialogical process](#)” section).

Theoretical background

Opening up the process of research question development: a diversity of approaches

According to the literature about the development of research questions, it is a task that is difficult to formalize and for which several approaches coexist. It may differ according to the disciplines (Xypas & Robin, 2010) as well as according to the practical context of the doctoral thesis (i.e., participative research, methodological or fundamental research, financial support). We identified four approaches to research question development:

- Gap-spotting (e.g., Locke & Golden-Biddle, 1997), the more classical approach, which consists in identifying gaps in existing literature that need to be filled.
- Challenging the assumptions underlying existing theory in order to develop and evaluate alternative assumptions. Such an approach aims at coming up “with novel research questions through a dialectical interrogation of one’s own familiar position, other stances, and the domain of literature targeted for assumption challenging” (Alvesson & Sandberg, 2013). These authors explicitly adopt a critical perspective of gap-spotting, which they consider as a form of “underproblematization.”
- Expressing a contrastive stance to create dialogical space, presented as critical in order to develop a convincing research question (Mei, 2006). This approach has addressed the research question formulation by focusing on the writing process.
- Problem-solving study based on a negotiation about the “problem framing” involving scientists and stakeholders, and which focuses on practical problem-solving (Archbald, 2008).

The literature and our experience show that these different approaches coexist, but do not fall within the same temporality. For example, gap-spotting can be an operation that takes place at the beginning of the research process and which is limited in time, whereas the negotiation of problems between scientists and stakeholders can be much longer and can arise at different stages of the research process. In the same way, challenging existing theories can be a long and incremental process that evolves as the doctoral student acquires new knowledge from scientific literature along the doctoral path or due to an unexpected observation in the field. Trafford and Leshem (2009) also explain how research begins with a gap in knowledge or professional practices and how research questions evolve with new

inputs from the literature, fieldwork, and the progressive establishment of a conceptual framework and theoretical perspectives, to finally end up by proposing a “justifiable contribution to knowledge”. In this perspective, the formulation of a research question can be considered as an incremental path that continues during the doctoral journey.

The knowledge and know-how involved in research question development are thus of a very specific nature (metacognition, implicit, diversity of thinking, etc.), rendering it impossible to design doctoral training programs focused on this complex task as a simple “knowledge transfer”. Moreover, beyond the cognitive learning required, it also refers to more developmental challenges, both for doctoral students and their supervisors, since it is embedded in their specific epistemological and social working situation.

Our vision of the PhD experience and doctoral education

We consider research and, thus, doctoral experience as an activity involving affects, interests, and social networks (Shapin, 2010). In line with other scholars (Lonka et al., 2019; Sun & Cheng, 2022; Xypas & Robin, 2010), we argue that doctoral education should rely on a person-centered approach. This means paying attention to doctoral students’ profiles, their perceptions of the academic environment and their professional aims, i.e., the individual contexts of each PhD thesis and the diversity of PhD researchers’ needs and goals (Inouye, 2023), as well as their conceptions of research or epistemological backgrounds (Charmillot, 2023). We thus consider the PhD process as a professional experience with its multidimensional nature and the distinct quests of PhD students (quest for the self; intellectual quest; professional quest) when navigating their doctoral paths (Skakni, 2018).

This type of view leads to a developmental approach of the PhD journey, with doubts, uncertainties, and paradoxes in becoming doctoral researchers, and a “transformation of understanding and of self” (Rennie & Kinsella, 2020). Influenced by their personal trajectories and post-PhD goals, doctoral students may thus adopt various approaches in the yearly phase of the PhD process when developing their research projects, whether writing a research proposal constitutes or not a formal step to becoming a full doctoral candidate². We also consider the PhD experience as a transformative process of a bidirectional nature, for both doctoral students and their supervisors (Halse & Malfroy, 2010; Kobayashi, 2014).

When it comes to doctoral education, this point of view implies the necessity to combine both generic support and individual guidance, to tailor training and to take each of the doctoral student’s stage of development into account. It also requires that trainers take on the role of facilitators more than those “who know”, in a socio-constructivist approach to learning. Nevertheless, designing doctoral training dedicated to research question development throughout the doctoral journey opens up questions on how to promote such learning in the workplace.

Scaffolding as an adaptive support of learning

In line with Vygotsky’s approach to learning, we consider that the concept of scaffolding can be beneficial to understanding how PhD supervisors can assist their doctoral

² For example, in the UK, writing and defending a research proposal allows a *Transfer of Status* from an initial probationary status to that of a full doctoral candidate (Inouye, 2020), whereas in France, there is no such formal assessment.

students in learning how to develop their research question. Firstly defined by Wood et al. (1976) as a process similar to parents helping infants to solve a problem, this concept has proven to be an efficient pedagogical strategy to support learning in science (Lin et al., 2012). It can then be connected to Vygotski's Zone of Proximal Development (ZPD) (1978), consisting of tasks that students cannot yet carry out on their own, but which they can accomplish with assistance. Scaffolding has been specified by Belland (2014) in instructional settings as a "just-in-time support provided by a teacher/parent (tutor) that allows students (tutees) to meaningfully participate in and gain skill at problem solving". Beyond this use within formal instruction, it has been put forward as "a central educational arrangement in workplace learning", considered as a "socially-shared situation between master and apprentice" (Nielsen, 2008). Scholars argued that scaffolding could also be used to improve higher-order thinking abilities through social interaction, such as argumentation when solving ill-structured problems or when building dialectical arguments.

Three critical features are central to successful scaffolding:

- Firstly, the notion of a shared understanding of the goal of the activity is crucial (Puntambekar & Hübscher, 2005), requiring an "intersubjectivity" between the tutor and the tutee (Belland, 2014), which is reached when they collaboratively redefine the task. The stake here is to make sure that learners are invested in the task, as well as to help sustain this motivation, encouraging them to be informed participants who understand the point of the activity, the value and use of the strategies and "making it worthwhile for the learner to risk the next step" (Wood et al., 1976).
- Secondly, the tutor should provide the tutee with a graduated assistance based on an ongoing diagnosis of the tutee's current level of skill, which Belland (2014) sums up by "providing just the right amount of support at just the right time, and backing off as students gained skill". Therefore, scaffolding is highly contingent on both the task and the learner's characteristics, thus being "dynamically adjusted according to tutee ability" (Belland, 2014) and requiring the tutor to manage a careful calibration of support (Puntambekar & Hübscher, 2005).
- Thirdly, scaffolding is successful when the learner controls and takes responsibility for the task, thus moving towards autonomous activity. Scaffolding should then promote this transfer of responsibility, as well as including its own fadeout as internalization progresses.

First focused on the interactions between individuals, the scaffolding concept is now being more broadly applied to artifacts, resources, and environments designed as scaffolds (Puntambekar & Hübscher, 2005), with three main "scaffolding modalities":

- One-to-one scaffolding, which "consists of a teacher's contingent support of students within their respective ZPDs", considered as the ideal modality with a tailored scaffolding;
- Peer scaffolding, which goes beyond the original idea of assistance by a more capable individual (Wood et al., 1976) and which hypothesizes that peers can also provide such support;
- Computer/paper/artifact-based scaffolding, which emerged as a solution to the dilemma that teachers cannot provide adequate one-to-one scaffolding to all students in a classroom.

Beyond the advantages and limitations of each scaffolding modality, various scholars have discussed the challenges of designing scaffolding in complex environments. It can be a question of taking the heterogeneity of learners into consideration when designing tools (Puntambekar & Hübscher, 2005), of building dynamic assessments and fading into the whole environment (Puntambekar & Hübscher, 2005; Belland, 2014), or of considering the learning environment by combining tools and agents (Puntambekar & Hübscher, 2005) in a system of “distributed scaffolding” (Tabak, 2004). Lastly, beyond the dyadic relationship between the master and the apprentice, many authors have shown the distributed and collective nature of scaffolding at the workplace (Filliettaz, 2011), pointing out the role of “the entire work community” in workplace learning. This enlargement of the concept of scaffolding appears to be especially relevant for the learning of research question development, which is a long process that results from a diversity of interactions, as shown in the previous sub-section.

Existing scaffoldings to support the learning of research question development

In her report of the Bologna seminar on Doctoral Programs for the European Knowledge Society, Christensen (2005) argues that only training by doing research can provide doctoral candidates with core skills such as “problem solving, innovative, creative and critical thinking”. Until now, the traditional model of doctoral education was based on a supervisor-centered model and a transmission model “where the apprenticeship learns from the master by observation” (Poyatos Matas, 2012). Such informal learning thus takes place in private spaces, pointing out the lack of explicit knowledge on “what the academic career involves, the norms, values, and ethics embedded in their disciplines, and the expectations of work habits that they would be expected to meet” (Austin, 2009).

Even if this master-apprenticeship model was previously adequate, it turns out to be outdated because of the evolution of doctoral conditions. The increasing control and limitation of PhD duration and the obligation of regular reporting about the progress of the PhD leave less room and time for mimetic and trial-and-error learning. This is especially true in the case of specific doctoral education models such as the PhD by publication, the professional doctorate, the practice-based doctorate (Poyatos Matas, 2012), and the case of traditional PhDs. However, most of the time, doctoral students remain “without fully learning how to frame their own questions and design and conduct their own studies” (Austin, 2009). It is thus not surprising that the offer of learning supports for PhD students has greatly increased, with a wide diversity of options (handbooks, YouTube channels, writing courses or groups, etc.). Among the diverse training programs offered to doctoral students and sometimes supervisors, some doctoral schools and universities have also created specific training programs to support research question development, while some authors like Inouye (2020) put forward that training and supervision should include explicit training on the Research Proposal as a “threshold to cross” (see footnote n°2). On the basis of this diversity of offers, we identified three main scaffoldings corresponding to the three main modalities identified in the previous section: artifacts, peer-learning groups (e.g., Chatterjee-Padmanabhan & Nielsen, 2018; Poyatos Matas, 2012; Zuber-Skerritt & Knight, 1986), and supervisors (e.g., Manathunga et al., 2006; Whitelock et al., 2008).

Following a developmental approach to the PhD process, the present study aims at offering a generic framework to think about and design doctoral programs that scaffold the learning of the development of research questions.

Materials and methods

Building a framework by combining our experiences with the literature

This research was based on two distinct doctoral training programs that we designed and independently ran over a period of 10 years. Having reflected together on our department's doctoral training policy, we then progressively formalized the issues at stake in doctoral training and analyzed how our programs responded to them. The importance and difficulties of learning how to develop research questions during doctoral studies then became crucial, leading us to formalize what we had learned from our two programs. In this article, these programs are our case studies, i.e., the situation where we conducted an empirical inquiry to investigate the scaffolding of research question development and from which we can expand and generalize theories on doctoral training (Yin, 2018).

For each case study, we combined several methods to collect data:

- We used ethnographic techniques (Parker-Jenkins, 2018) with a participant observer stance. As researchers conducting research and supervising doctoral students, as HR advisors supporting doctoral students and researchers at INRAE, and as trainers and coordinators in two doctoral training programs, we are involved in prolonged and repeated periods of observation. We thus documented detailed field notes that were revisited as research data.
- We built a corpus of pre-existing documents presenting the two doctoral programs (brochures, Website contents, scientific articles, time schedules and targeted objectives at each sequence). For each document, we carried out an open-coding operation to identify the narratives about research question development.
- We gathered feedback spontaneously expressed by the trainees during the training courses, the hot debriefs occurring at the end of each course, and training assessments one month after the course, as well as in the course of our activity (in individual HR interventions or in reading the acknowledgements of a PhD thesis).

In parallel with data collection, we carried out a review of the literature on the evolution of doctoral education and the emerging learning challenges for doctoral students and their supervisors, some epistemological articles on research question development and the process of doctoral experience, empirical articles describing training for research question development and seminal articles, and reviews on scaffolding in education sciences. We undertook a cross-reading of this literature to build a conceptual framework identifying the key concepts to study training for research question development: scaffolds, scaffolding objectives, learning challenges, and scaffolding practices. We then analyzed our data to identify the scaffolds mobilized in each case study, the objectives of this scaffolding, and the learning challenges of research question development considered as a scaffolding system. Finally, we characterized our scaffolding practices, i.e., the way in which we, as trainers, concretely support the learning required to achieve the challenges of research question development. Both training programs result from a continuous improvement process based on the feedback of the trainees: with such feedback and our own observations, we were thus able to identify and select the most effective teaching methods in line with our objectives to support the learning of research question development. Behind the classical scaffolding modalities identified in the literature, we chose to identify the diversity of very contextual scaffolding practices and devices used, which we then linked to our training objectives. For

each program, we also detailed how these objectives relate to the larger learning challenges of research question development. This led us to formalize a generic grid, which was tested and improved by using it to describe each of our programs.

Two doctoral training programs as case studies for cross-analysis

As a public research institute, the main goals of INRAE are to produce and disseminate scientific knowledge, with a specific focus on the contribution to education and training. Given the broad field of competences within INRAE devoted to the development of agriculture, food and the environment, and its inherent multidisciplinary nature, the thesis defended may draw from extremely various disciplines, ranging from molecular biology to sociology, with a dominance of life and environmental sciences. Moreover, INRAE is a targeted research institute that works with and for various partners in higher education and research, industry, and the agricultural sector and regional governments. This means that many research projects, including doctoral research, are designed and carried out within partnerships with these various stakeholders. INRAE doctoral students are supervised by INRAE researchers, mainly within complex multidisciplinary supervision teams together with French or international academic partners.

In this context, we have developed our vision of research activity and doctoral experience (see the “[Our vision of the PhD experience and doctoral education](#)” section) and have been designing, improving, and leading two doctoral training programs for more than 10 years (Table 1), which share common postulates such as the following:

- Considering the PhD process as a part of the professional trajectory.

Table 1 Presentation of our two case studies

	Course A	Course B
Beginning year	2007	2013
Number of people trained up to 2023 (D: doctoral students; S: supervisors)	D: 247	D: 257 S: 319
At which stage of the doctoral process?	1st year, 2nd year, 3rd year of doctoral studies (once a year, for 3 years)	At the end of 1st year of doctoral studies
Audience in every session	Between 25 and 40 doctoral students	12 doctoral students with their supervisors -> up to 25–30 trainees
Program trainers	10 scientists with multidisciplinary backgrounds and highly experienced in interdisciplinary and transdisciplinary research	7 scientists with multidisciplinary backgrounds and experience in doctoral supervision 1 consultant in communication and management
Training duration	4 days	4 days

- Aiming at supporting autonomy of doctoral students through the enhancement of their capacity to defend the choices they have made to build research questions, thus also aiming at helping supervisors to adopt a companionship stance.
- Considering research question development as an activity, which implies the choice of pedagogical principles based on action learning rather than knowledge transfer.
- Considering diversity as an asset, we base our training programs on multidisciplinary workshops.

Nevertheless, they differ in terms of the training audience and times of training in the PhD process:

- Course A is only open to doctoral students of the ACT³ division of INRAE, whereas course B trains both doctoral students and their supervisors belonging to the different divisions of INRAE.
- Doctoral students may attend course A three times during their thesis, whereas course B is designed to train doctoral students once during their thesis, at the end of the first year.

Results: scaffolding learning challenges for the development of the research question within a thesis

In this section, we present a generic framework to think about and design doctoral training programs with the aim of scaffolding the learning of research question development. It combines learning challenges (LC) faced by doctoral students and their supervisors when formulating their research question and training objectives (TO) corresponding to what the participants should learn. We also illustrate how each of these TO can be scaffolded, drawing on some examples from our training programs.

First challenge: to empower doctoral students in the development of their research question, guided by their supervisors

As a professionalization period, the PhD process is considered as a peer-learning process (Boud & Lee, 2005) that relies on a mentoring relationship that aims at developing the autonomy of the young researcher (Willison and O'Regan, 2007). Developing doctoral agency (Inouye, 2023) and, more specifically, promoting a subject-centered approach (Sun & Cheng, 2022) to research question development is the first learning challenge that we identified. We then consider that the doctoral student is the one who makes the subject evolve, who reflects and chooses the components of the research question. We divide this first learning challenge into three training objectives and various sub-objectives (see Fig. 1), one focused on the doctoral student, one on the supervisor, and one on their relative roles.

³ The ACT research division of INRAE aims at understanding and supporting transformative changes in socio-ecosystems and agrifood systems, which take actors' practices and strategies into account in order to promote sustainable innovations and transitions, particularly at the territorial level.

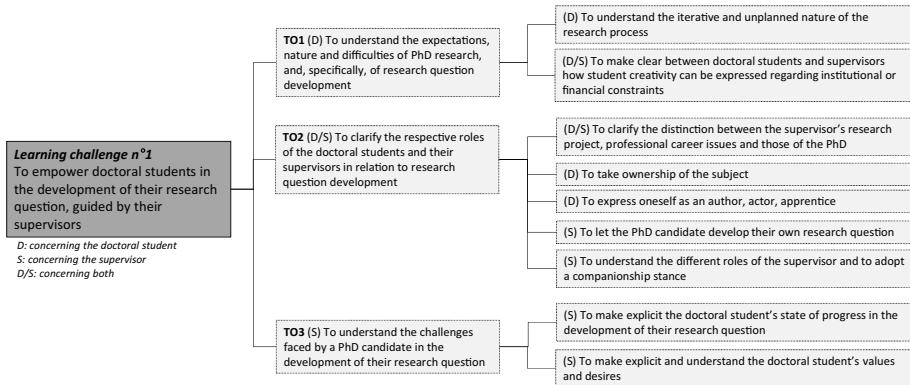


Fig. 1 Training objectives set out for the challenge: “to empower doctoral students in their research question development”

First, the doctoral student needs to understand the expectations, nature, and difficulties of PhD research and, specifically, of research question development (TO1). This encompasses the sub-objective of understanding the iterative and unplanned nature of the research process as well as making it clear with their supervisor(s) how their creativity can be expressed regarding institutional or financial constraints. For many authors, problem finding or identifying and describing a research question is part of doctoral subjective creativity and a key for an original contribution to knowledge. At the same time, we observe, as other scholars (Brodin, 2018; Frick, 2011; Whitelock et al., 2008) have, that there is a lack of explicit expectations on creativity in doctoral education, which is then limited by scholarly traditions and institutional requirements. During research question development, “standing at the border between the known and the unknown”⁴ can put doctoral students in a situation of uncertainty about their identity and purpose (Trafford & Leshem, 2009). For Frick (2011), doctoral becoming requires an alignment between “how students view themselves in relation to the research process of becoming a scholar (ontology), how they relate to different forms of knowledge (epistemology), how they know to obtain and create such knowledge (methodology), and how they frame their interests in terms of their values and ethics within the discipline (axiology)”. At the crossroads between these four dimensions, research question development is thus a key process that stimulates doctoral student becoming and that requires the support of supervisors so that their students can understand what is expected of them. Knowing that this can be a source of stress for doctoral students, we put the subject of “what is a research process” up for discussion between supervisors and students in course B. After discussing with other students on their perception of creativity in their thesis, students are invited to watch, together with their supervisors, a video calling for scientists to stop thinking of research as a linear process from question to answer but, instead, as a creative and eventually sinuous path (see footnote n°4). Students often express a sense of relief later on when they work with their supervisors on the second reformulation of the thesis subject. In this way, doctoral students become aware that a formulation is likely to evolve during the thesis and feel more comfortable about

⁴ As Uri Alon puts it in his TED video: “Why science demands a leap into the unknown” https://www.ted.com/talks/uri_alon_why_science_demands_a_leap_into_the_unknown.

formulating one that is in no way definitive at the end of the course. In the same way, in course A, we invite the second-year PhD students to work on the transformation of their research subject in order to illustrate its evolution. We ask them to write the formulation of their subject as worded in the PhD offer or initial PhD contract and the formulation that they would use today to describe it. We then collectively work with the other PhD students at various stages in their thesis to identify the differences between the two formulations, so that the concerned second-year PhD students may explain their choices, eventualities, or constraints that led to the transformation of the subject. During debriefs, trainees express that this exercise helped them to understand that this transformation is an integral part of the research process.

This learning challenge also implies that doctoral students and their supervisors clarify their respective roles regarding research question development (TO2). The degree to which supervisors encourage doctoral students to think and act autonomously has been shown to be associated with students' supervision satisfaction and greater research self-efficacy (Overall et al., 2011). This can be done firstly by clarifying the distinction between the supervisor(s)'s research project, professional career issues and those of the PhD. In course B, asking the doctoral students and their supervisors to describe and discuss the thesis supervision ecosystem has been observed as one of the crucial steps in this clarification of their respective roles in research question development. For doctoral students, research question development also implies that they take ownership of the subject, whereas it was often initially written by the supervisors. In course B, the rule "letting the student speak first" has been expressed by doctoral students as very useful for taking on the role, especially during the three workshops focused on the formulation of the thesis subject. In course A, we ask the doctoral students to present the professional context of their PhD (research project, subsidy, disciplines of the supervisors, proximity of the supervisors to the subject, etc.). This presentation helps the trainees to clarify the contextual framing of the PhD students' theses, as well as the margin of freedom. For their part, supervisors need to let the PhD students develop their research question by themselves and find the right stance, with a careful balance between "hands-off" and "hands-on" (Gruzdev et al., 2020). In course B, supervisors first exchange between themselves about what it means to supervise a thesis and their role in the PhD process. The three reformulation workshops are then practical opportunities to take on this role: experiencing this role of being a support and not the leader of the PhD project is sometimes seen as difficult by supervisors who are used to being research project leaders, but they also admit that it is a necessary step to experience the supervision stance.

Supervisors also need to understand the challenges faced by PhD candidates in the development of research questions (TO3) by first abandoning the assumption of the already autonomous student (Manathunga & Goozée, 2007). According to Halse and Malfroy (2010), the supervisor is "responsible for recognizing and responding to the needs of different students", within a "learning alliance" with the student. When it comes to formulating their research question, it becomes important to be able to situate their own role with their values and desires in the research process, in general, and, in particular, in the development of the research question, which is not just made up of rational intellectual choices. For this objective, supervisors have to be able to clearly identify the doctoral student's state of progress in the development of the research question within the thesis and, more broadly, the doctoral student's values and desires in doing research (Skakni, 2018). In course B, we ask them to step back and remain silent (even stolid!) when their doctoral students present their subject. While listening and writing down their observations, they foster their understanding of the states of progress and the orientations chosen by the students. With this rule,

we then observe that most of them are able to adopt the correct stance for later workshops when they are asked to work with students on their research question.

Second challenge: to be aware of the various forms and processes of research question development within a diversity of ways of doing research and to be able to situate oneself in this diversity.

The second learning challenge focuses on making the PhD students (and their supervisors) aware of the diversity of ways of doing research and especially various forms and processes of research question development (see the “[Opening up the process of research question development: a diversity of approaches](#)” section) and situating oneself in this diversity. Many authors argue that doctoral education should highlight scientific pluralism (Pallas, 2001), opening the epistemological doctoral experience in order to question the implicit norm of neutrality of the positivist ideal (Charmillot, 2023). This is particularly true when it comes to the development of research questions for “wicked problems” (Rittel & Weber, 1973), i.e., economic, political, and environmental issues involving many stakeholders with different values and priorities. In this context, developing research questions often requires analysis at the crossroads between several disciplines (Bosque-Perez et al., 2016) and between different social stakes (Manathunga et al., 2006). It requires reinforcing a scientific culture favorable to this practice of multi-/inter-/transdisciplinarity (Kemp & Nurius, 2015), then making interdisciplinary research skills a part of graduate education (Pallas, 2001; Bosque-Perez et al., 2016). Doctoral students then have to develop their awareness about the diversity of forms and processes of research question development, requiring that they are able to understand this diversity, to know how they themselves relate to different forms of knowledge (Frick, 2011), and to acknowledge their performativity in the world.

Within this second learning challenge, we distinguish four training objectives (Fig. 2), all concerning doctoral students and their supervisors.

Both of them need to understand and respect the diversity of research stances (TO4). In both of our case studies, we ensure that a diversity of disciplines is represented in each working group, and we guarantee the mutual respect among them. We facilitate the expression of all doctoral students about how they are developing their research question, thus illustrating the diversity of research stances. During the hot debrief of course A, trainees regularly point out the discovery of this diversity as a positive outcome, which helps them

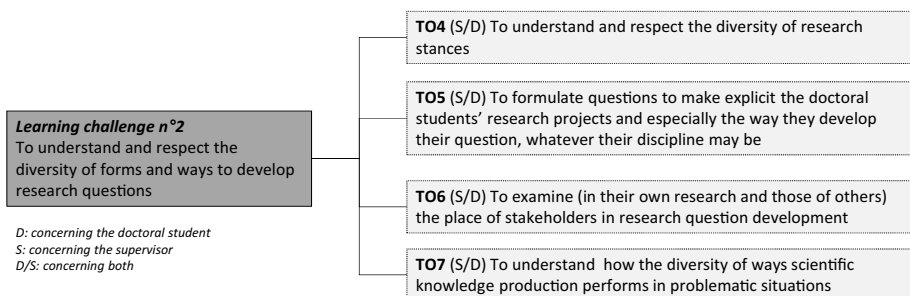


Fig. 2 Training objectives for the challenge: “to be aware of the diversity of ways of doing research, to be able to situate oneself in this diversity”

to situate their own work. Moreover, discussing research question development within small and heterogeneous groups in terms of disciplines is experienced by participants as a strength “to take a step back and clarify key points” (student, course B, 2017), acknowledging that “working with other disciplines, it helped us to refocus and clarify the subject” (supervisor, course B, 2023).

Doctoral students and their supervisors also need to be able to formulate questions and clearly explain the doctoral research project, especially the way they develop their research question, whatever their discipline may be (TO5). This is why active participation is required in the workshops in both case studies, putting doctoral students and supervisors in the position of an active learner, not a passive trainee. Since such workshops may be very demanding for the PhD student and might be emotionally intense, it is of utmost importance that the trainers carefully manage the collective discussion, guaranteeing trust, mutual respect, and achieving balance in speaking. In particular, doctoral students and their supervisors are the ones who know the scientific community(ies) to which they will contribute and are the only ones who can assess the relevance of the subject. Participants are then asked to question the PhD students without calling the relevance of their theses into question. When aiming at promoting the expression of PhD students as human subjects, trainers have to pay particular attention to the fact that participants do not reformulate the subject for the students but, on the contrary, help them to open up the possibilities, to sort out, and to clarify the status of the elements presented. Trainers also use expression modes such as the questioning forms (open/closed questions), the subject pronouns used (I/we), and the origin of the arguments or events expressed by the PhD student as points of vigilance for managing the group discussion and as levers to go deeper into the questioning and analysis of the PhD students’ thinking about their research questions.

They both have to examine (in their own research and that of others) the place of stakeholders in the development of the research question (TO6). In course A, we use the conceptual framework of translation from Callon (1984) to analyze how a social problem can be translated into a research question. In course B, the framework given to trainees to develop their research question specifically points out the distinction to be made between the academic research stakes and the stakes for society. They also have to understand how the diversity of ways of scientific knowledge production perform or do not perform in problematic situations (TO7).

Third learning challenge: to know how to develop their research question throughout the research process

The third learning challenge concerns the staggered process of formulation of the research question throughout the PhD process. For many authors, the formulation of a “researchable question” or “research conceptualization” (Badenhorst, 2021) by the doctoral student is the first step in the doctoral research process with the writing, and sometimes formal presentation, of a “research proposal”. It is often seen as a threshold in the doctoral journey (Chatterjee-Padmanabhan & Nielsen, 2018) and a key feature of “doctorateness”, combining gaps in knowledge, contributions to knowledge, research questions, conceptual frameworks, and research design (Trafford & Leshem, 2009). For Frick (2011), the preparation of a proposal requires background reading and “demarcation of the research question”. It consists in knowing to which scientific issues the thesis will contribute and in identifying the relevant disciplinary concepts. Mastering the various modes of communication in the development of a research question is of utmost importance for PhD students, enabling

them to accurately formulate their research question (Lim, 2014), as well as to take most of their supervisors' or other researchers' (colleagues, reviewers) feedback into consideration (Carter & Kumar, 2017). More widely, knowing how to formulate their research question is not sufficient without being able to step back from their own formulation. Boch (2023) expresses it as a necessary reflexivity in research writing, which means becoming aware of oneself in research and integrating this experience into the writing in an argumentative and convincing way. Stepping back from their research question also puts forward the need for doctoral students to be clear about the translations and reductions made (Callon, 1984), their research strategies (Inouye, 2023), or research stances (Hazard et al., 2020).

This learning challenge includes three training objectives (Fig. 3), two of them concerning the doctoral student and the third one concerning the students and their supervisors.

Doctoral students must clearly lay out the research stakes (both academic and for society) throughout their thesis process (TO8). In course B, we give learners a framework to think about and discuss research question development as a combination of three main ingredients (operational and scientific stakes, research question, strategy), requiring that students make the difference between the scientific stakes and the thesis objective clear, while defining the scope of the thesis within broader issues (European project, lab project). In course A, the conceptual framework of the translation from Callon is useful to recognize the driving forces of the reductions and translations in order to identify them and their consequences on the formulation of the research question. It helps clarify their research practices and understand how they contribute to the development of the research strategy, beyond what has been done so far. In course A, we use a trajectory to identify the consistency and the sense of the various research practices of the 3rd year PhD students. In course B, the “research strategy,” viewed both as a “realized” and “planned” one (Mintzberg, 1987), is useful as both a hindsight (what have been my choices so far?) and planning tool (how to reach my research objective as I can express it today?), allowing students to put the weight of their thesis schedule into perspective.

In order to progress in their reflection, the doctoral students need to understand the importance of different oral and written (scientific or not) communications for making the formulation of their research question evolve (TO9). In course A, when designing the trajectory of the 3rd year PhD students, we question them about their scientific

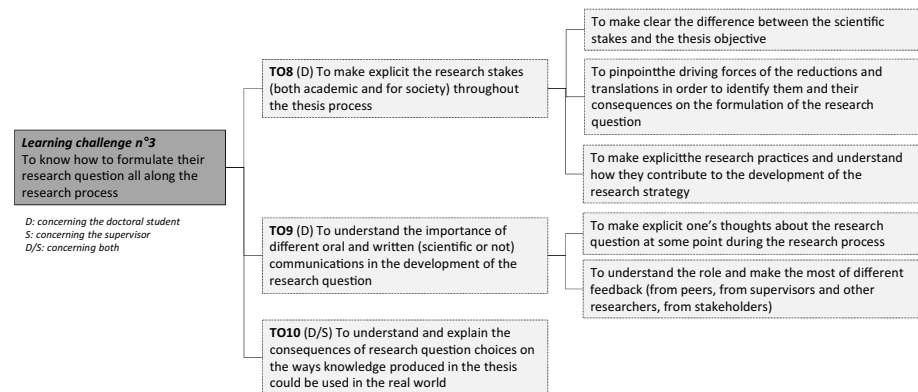


Fig. 3 Training objectives for the challenge: “to know how to express their research question throughout the research process”

communications or articles and about the consequences they had on the evolution of the formulation of their research question. We also ask them about the impact of the different feedback they had at the time of these communications and articles (from peers, from supervisors and other researchers, and from stakeholders) on the development of their research question. In course B, there are three exercises focused on the research question. While being considered as difficult, these exercises are also seen by trainees as effective for training themselves in expressing (orally and then on a written basis) their own subject and receiving feedback and questions from other students and their supervisors. We can observe that research questions and soundness of argumentation deeply evolve throughout the week, to the great satisfaction of students and their supervisors.

Doctoral students, as well as their supervisors for the research carried out under their responsibility, have to understand and explain the consequences of research question choices on the ways knowledge produced in the thesis could be used in the real world (TO10). In course A, we use a heuristic tool to help PhD students to understand the relevance for action of the knowledge they generate (Hazard et al., 2020).

Discussion: enriching peer-learning scaffolding to support the development of a research question as a dialogical process

Learning how to build a research question is traditionally seen as a one-to-one learning process based on informal and daily transmission between a novice and a senior researcher. In order to open up this informal process, we have grounded our pedagogical strategy in multiple opportunities for dialog with peers, whether it be other students, supervisors, or trainers. Taken as a whole, it thus combines interdisciplinarity, peer-learning, and dialogical principles that result in the construction of an “overall distributed scaffolding strategy” (Belland, 2014) and that create synergy between peer scaffolding, one-to-one and media scaffolding (Belland, 2014).

Firstly, our case studies emphasize speaking and argumentation skills rather than writing competencies. Many research works like Zuber-Skerritt and Knight (1986), Maher et al. (2013), Kumar and Aitchison (2018), and Badenhorst (2021) have explored the needs and modalities of doctoral education in terms of writing, even from the supervisor’s perspective (González-Ocampo & Castelló, 2018). Our pedagogical choice contrasts with this focus on doctoral writing since we give trainees many dialogical opportunities to train themselves to orally express and defend their intellectual autonomy. Doing so, we join Cahusac de Caux et al. (2017) who argue, “peer feedback and discussion benefits students by helping them verbalise their internal reflective thinking, fostering reflective practice skills development”. Even if we use some media-based scaffoldings, tools are not at the core of our case studies: our objective is instead to help trainees to put their thoughts into words, in line with the cognitive apprenticeship of Austin (2009), referring to a specific kind of apprenticeship for the less easily observed processes of thinking.

Secondly, our training programs make the most of the diversity and heterogeneity of peers, whether they be more or less experienced in supervision, from various disciplines, or at different stages of their thesis, thus enriching peer-learning scaffolding. All the participants, in their capacity as scientists, are considered as peers who are able to understand the work of other researchers, regardless of the discipline and the thesis subject. It is also by striving to understand and question subjects that are sometimes far from their field of research that researchers acquire the capacity for analysis, synthesis, and hindsight that is

necessary in research work. By setting up dialogical spaces to help inexperienced researchers hone their argumentation skills, our training programs implement our view of research in practical terms as a collective process and of doctoral education as a professional socialization process, thus requiring that research organizations facilitate collective practices in the workplace (Malfroy, 2005). Moreover, with the inherent heterogeneity of participants, these workshops also constitute places where the multidisciplinary and plurality of the sciences are experienced firsthand, convergent with Manathunga et al. (2006) or Bosque-Perez et al. (2016). Doing so, we are taking part in the debate of whether scaffolds need to contain domain-specific knowledge (Belland, 2014) by saying that there is no need for discipline or domain-specific scaffolds. Moreover, being active on one's own case as well as on others' situations is an efficient training strategy to move away from the objects and routines of a discipline or community when expressing ideas between specialists. Such collective reflexivity, sometimes turning into an analysis of professional practices, is a classic vocational training principle known to enhance the development of professionalization in the long term. What we add in our training sessions is the heterogeneity of participants, which is a resource for reflexivity, but that has to be carefully managed.

Thirdly, trainees are considered as human subjects engaged in their PhD with their various motivations and professional projects, which can strongly impact the way they see their thesis and envision their research work (Skakni, 2018), as well as their affinities and values, their doubts, and fears. Thanks to our focus on oral exchanges, we are then able to reveal and deal with these subjective dimensions of PhD work, which are often hidden when training PhD students in scientific writing. More precisely, expressing one's doctoral experience and professional situations experienced is known as an efficient scaffolding practice within the collaborative reflective writing of "learning journals" with peer feedback (Boldrini & Cattaneo, 2014). We have shown how to implement such scaffolding in small groups of doctoral students with the facilitation of experienced researchers.

However, our proposal requires that some binding conditions be met:

- Learning to formulate a research question through dialog with peers requires spending time, in our case, 4 full days, within small groups to ensure that everyone can take part in it and take advantage of the feedback of others.
- This dialog is made possible and emphasized by the diversity of participants (either in terms of discipline, stage of the thesis, experience, etc.).
- Managing both the human and scientific conditions of this dialog requires reflexive and open-minded trainers that adopt a facilitating stance.

As a result, our perspective on scaffolding is not merely an issue of training technique but, on the contrary, a situated perspective that echoes the view of Nielsen (2008) on training "both as part of a social practice and as part of the learner's trajectory of participation", within an expansive process inspired by Engeström's work. With this developmental view on doctoral experience, we acknowledge that research question development is a process that goes beyond the limited time of a 4-day training program. Trainee feedback collected after their participation in course A or B revealed that they continue the work begun during the training programs, on the basis of the given scaffolding (e.g., "I feel that we familiarized ourselves with these tools [referring to the concepts of translation and reduction] because we work on them and I started to think. [...] I know these tools will remain in my head until I write my thesis and that I really learned a lot" Hot debrief, course A, 2016). It is also not rare that trainees mention their participation in course A or B to their PhD steering committees as having helped to frame/define their research question. Course A or B is also frequently

mentioned as an essential support in acknowledgement of their PhD thesis. Although limited in time, the training programs studied in this article act as an accelerator in research question development (e.g. course B “we saved several months”, supervisor, 2017, “In just 2 days, everything became much clearer and more focused”, student, 2021). We thus assume that they contribute to awareness and reflexivity on research activity and to the professional development of trainees, which is particularly crucial in France with the pressure put on thesis duration and the absence of formal recognition of the research proposal stage.

Our experience puts forward two avenues for future research. Firstly, bringing together doctoral students at different stages of their thesis and then offering them the opportunity to participate each year of their PhD process opens a window on to their intellectual trajectory and a situated adjustment of our scaffolding practices. Secondly, training doctoral supervisors—and trainers involved in these doctoral programs—remains of utmost importance to make scaffolding last and be adapted throughout the next months and years.

Conclusion

This study examined the learning challenges and objectives required for the task of research question development throughout the PhD process, both for doctoral students and their supervisors. We have drawn some lessons for the scaffolding of these challenges and objectives from two different doctoral training programs that we have been designing and leading for more than 10 years.

Considering the development of a research question as a dialogical process, we suggest three conditions to scaffold these learnings: firstly, offering many dialogical opportunities is an effective way for students to train themselves to express their intellectual autonomy and to defend their research project; secondly, making the most of the diversity and heterogeneity of peers, whether they be more or less experienced in supervision, from various disciplines, or at different stages of their thesis, thus enriching peer-learning scaffolding, proved to be beneficial when the multidisciplinary and plurality of the sciences are experienced firsthand; and finally, giving priority to oral communication allows trainers and trainees to reveal and deal with the subjective dimensions of PhD work and their various motivations and professional projects that always underlie the development of a research question. Taken as a whole, our work seriously rises to the challenge of training reflexive researchers with an acute awareness of the collective nature of research and an intellectual openness to the plurality of sciences.

Declarations

Conflict of interest The authors declare no competing interests.

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