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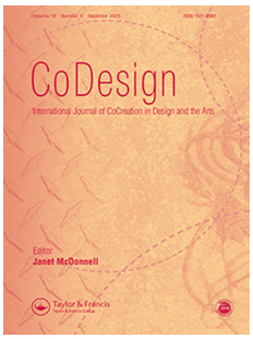
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How design professionals learn within collaborative research projects

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ABSTRACT

Collaborative research projects are great opportunities for the involved design professionals to learn. Many design professionals join in such collaborations to contribute with their existing professional expertise, but also to further develop and extend that expertise. However, learning by individuals is usually not the main aim, and we lack insight in the learning opportunities through collaboration in such projects. We propose that we need to understand this learning process better in order to make this happen more often and more effectively. This paper presents how four design professionals who each participated in different collaborative research projects look back on their learning processes. We interviewed each participant and drew a process map with them. The results show that these projects offer multifaceted learning opportunities and outcomes of important value for the professionals.The paper shows that their learning a) is not always easily recognised by the professionals themselves, b) benefits from their active engagement as learners, and c) requires supportive conditions in project arrangements. The paper provides guidelines for lead researchers, design professionals, as well as funding agencies to recognise and value this learning, to support explicit reflection and articulation, and to facilitate supportive learning conditions.

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1. Introduction

The challenges that design professionals face are getting more complex and their roles evolve accordingly, becoming more orchestrating and connecting (Manzini 2009; Sleeswijk Visser 2018; Yee, Jefferies, and Michlewski 2017). To be equipped for these new roles and challenges, the professionals need to continuously develop their skills and knowledge. The academic design field aims to support them in this. However, the methods and theory that academics produce are often complicated, lack practice vocabulary or simply do not address relevant topics for practice (Rogers 2004; Stolterman 2008). As a result, knowledge from academic research does not always land in design practice.

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A good learning opportunity for design professionals is to actively participate in research projects. Many design professionals join in such collaborations not only to contribute with their existing professional expertise but also to further develop and extend that expertise. Zielhuis et al. (2022a) suggest that design professionals gain much richer insights in such projects than colleagues who draw on indirect sources such as workshops, events, presentations, papers, and books. Such learning could be seen as part of the *mutual learning*process, which Simonsen and Robertson (2013, 2) describe as the emergent, informal, and mostly unconscious learning by all involved in participatory design processes. As indicated by Calvo (2019)and Pihkala and Karasti (2016), such mutual learning by collaborating stakeholders is rather taken for granted. It is only actively facilitated or studied when it concerns users. Design professionals though are often not regarded – even by themselves – as users or learners but rather as contributors (Zielhuis et al. 2022b). We propose that their learning is currently unclear for all actors and therefore potentially not facilitated optimally.

This paper provides more clarity on the learning processes by design professionals, by reviewing the experience of four design professionals of participating in academic driven collaborative research projects and by offering suggestions to promote such learning in future collaborative research projects.

2. How design professionals gain knowledge

This section reviews literature about what useful learning outcomes are for design professionals, how they learn in collaborative research projects, and how this translates to their activities.

2.1. Unnoticed learning

Knowledge that helps to get things accomplished in practical situations is described as *actionable knowledge* or working knowledge by Markauskaite and Goodyear (2017). Ryle (1949) argues that this consists of know-how as well as know-that, thus knowledge which directly supports action (e.g. practical techniques) as well as knowledge which underpins this action with understanding (e.g. grasping a certain model). Some actionable knowledge is explicit and easily shared with others. However, some are embodied and experiential, as indicated by Polanyi (1966) as tacit knowledge.

Zielhuis et al. (2022a) interviewed design professionals and collected a range of examples of actionable knowledge that these professionals derive from research, such as a designer's network in the health sector that has been increased, or a useful strategy for facilitating sessions with clients. The research showed three relevant content categories for practice: 1) design methods and tools, 2) the application domain at hand (such as healthcare), and 3) managing a complex design project (e.g. Dorst 2008; Kou and Gray 2019). Apparently, design professionals learn on much more topics than only the project topic, and different professionals learn different things. This range of individual learning outcomes could easily go unnoticed when only the collective learning process is studied and supported. What is more: potential for more learning may go unnoticed and unused.

2.2. Engaging as learners

Goodyear et al. (2021) argue that learning benefits from an active engagement by the learner: taking initiative within the learning process. An active dynamic between action and reflection is seen – within and beyond the design domain – as important for learning (e.g. Goodman, Stolterman, and Wakkary 2011; Kolb 1984; Stolterman 2008, often referring to Schön (1983).

However, as design professionals do not see themselves as learners, their learning is mostly implicit and reactive. Their learning concerns *non-formal learning*, which Eraut (2000) argues to be a combination of deliberative (i.e. intentional), reactive, and implicit learning. Deliberative learning takes place in time specifically set aside for that purpose, such as in planned training. Reactive learning takes place almost spontaneously, but requires further articulation. In implicit learning, there is neither intention to learn nor awareness of learning at that moment. We propose that the involved design professionals are often not explicitly supported to actively engage as learner, be it planned or reactive. The next session discusses how such engagement translates to activities.

2.3. Learningactivities

Goodyear, Carvalho, and Yeoman (2021) argue that to improve the conditions in which learning can happen, one should understand what learners *do* that makes them learn: their learning activities. We discuss the key aspects of such learning activities.

Moving away from traditional notions of learning as only a process within one's mind, Vygotsky (1978) described how learning is a process in which artefacts can mediate. In Research through Design (RtD) literature, the interaction with artefacts – such as prototypes – is put forward as a way to communicate knowledge which cannot be fully captured in words (Hoök and Lowgren 2012; Löwgren 2013), but also – in making and reflecting on these artefacts – as a way to develop knowledge (Stappers and Giaccardi 2017; Wensveen and Matthews 2015). The research projects in this paper all involve ways of working in which the creation of and discussion about artefacts are part of the knowledge development. Their potential as *boundaryartefacts* (Star 1989) to connect the design professionals' learning context to their daily application context is not studied yet.

We propose that learning opportunities are also largely influenced by *project roles*, which we define as mandated responsibilities, associated with typical activities and geared towards typical end results. Sleeswijk Visser (2018) argues that roles within RtD projects are not much studied at all. In her paper, she describes the role arrangements for academics and industry partners within one RtD project. This set of roles includes several content-oriented roles (e.g. theoriser, designer), but also several more organisational and practical ones (e.g. manager). Stappers and Sleeswijk Visser (2014) describe how different project roles are associated with different interactions with artefacts, as they each operate on a different so-called *meta level*. The outcome of one role (or level) can be the tool for another level. For example, a 'product designer' is the 'user' of the 'design tool' produced by a 'tool developer', who in turn is a user of prototyping methods developed at a higher meta level. An individual – such as a design professional – can be active on multiple levels and utilise the crosstalk between these levels. Currently, not much is known about the learning opportunities for design professionals that the various roles facilitate.

Furthermore, learning is seen as a social phenomenon (Wenger 1998), which takes place in collective activities within a community and its rules (Engeström 1987). This has become known as Cultural Historical Activity Theory (CHAT) and has been applied to analyse design research by for instance Calvo (2019) and Tessier and Zahedi (2022). Learning by design professionals can be supported by the exchange with fellow project partners or other stakeholders.Engeström (1999)emphasises that such exchanges are influenced by the work arrangements (such as in the role arrangements as described above) as well as the formal and informal rules and conditions. In the context of our study, learning opportunities for design professionals will be influenced by financial constraints, such as limited budget for practice partners involvement, but also by clashing standards between academics and practitioners (Gaver 2014).

2.4. Conclusions for this study

The literature reviewed in this section suggests that: (1) there are many facets about which designers can learn, ranging from the project topic, to networking, and process management skills, and these facets may cover more than the project topic, (2) the involved have a limited awareness of this range of outcomes nor of the implicit learning taking place, and (3) researchers and designers themselves do not structure explicit activities towards this end. Therefore, this study aims to better understand this learning process and how this can be improved. As the designers' own perspective on this phenomenon currently lacks, we choose to explore this in four retrospective case studies.

3. Method

We observed the learning by design professionals from their own (first person) perspective and analysed this learning in light of the above theory. Participants were four design professionals. Each was interviewed about a collaborative research project in which they had participated and which they considered as useful for their work. The interviews centred on project activities which they described as important for their learning. In a process research approach (Langley et al. 2013), we viewedthe cases as activity systems. The research question is: *How do design professionals learn when they take part in a collaborative research project?*This led to three main characteristics of this learning process and practical tips to support this.

3.1. Cases

We selected design professionals based on several criteria. Most important was that they had a project from which they indicated that they had learned valuable knowledge or skills for their design practice. Therefore, the interviews were respective: the projects had been completed in the past and regarded as useful for the present. A second criterion was that the design professional had had an active and substantial part in the project for a period longer than 6 months. Third, all participants had over 6 years of design experience in industry. Fourth, all projects had a substantial design component (e.g. using the double diamond process). One of the projects (labelled 'John' in Table 1) was explicitly described in project documents as RtD project.

Table 1. An overview of the four cases in which design professionals learned.

Case learner Case elements	Bob	John	Mary	Tess
(1) Background design professional	Product and service designer: Industrial design; six years' experience; prior experience in solar park design	Research director & service designer: Industrial design, 10 years' experience	Owner, designer, facilitator, illustrator: Communication and multi-media design; Six years' experience	Strategic designer, organizational designer: Information science, industrial design, art academy, psychology; 14 years' experience
(2) Design agency	Service design agency (10 employees)	Social design agency (10 employees)	Self employed	Self employed
(3) Motivations for agency to join	All: Make relevant contribution; positive prior collaboration with these partners Further build portfolio of agency		To learn from research partners	To learn from other design professionals; to extend network
(4) Other project partners	University (landscape architecture) knowledge institute (behavioural science and PV technology), printing company, service design agency	University (design research), university (design academy), care institutions, municipalities, four design agencies	University of Applied Science (co-design; lifestyle), hospitals, physiotherapists, university (behavioural science). The design professional was hired by the UAS.	University of Applied Science (co-design), energy cooperation, two design agencies. Note: the design agencies take part without funding.
(5) Project topic	Involving residents in solar parks design	Designing meaningful conversations about personal futures	Activity monitoring of children for physiotherapy	Facilitating design-oriented future thinking
(6) Research project structure	A central case study in which a mock-up of a solar park is built.	Several case studies which contribute to the development of a central conceptual framework.	A design project to build an activity monitor and corresponding tools in design sprints.	Design sprints to develop futuring tools and a central case study to apply the tools.
(7) Tangible design outputs or materials	Mock-up of solar park, theoretical model, co-design materials	Tools and templates to support conversations, an installation for an exhibition	Contextmapping tools (e.g. sensitizers), an activity monitor, education materials	Tools to support future thinking, cards, talking sticks
(8) Timespan of project and entry point for designer	2 year project. Shortly after start. A colleague was involved in proposal writing.	2 years. Shortly after start, because of missing expertise.	1 year. Shortly after start as replacement.	6 months. Involved before project initiation.

The scope of selection had some limitations: all cases were funded research-practice collaborations in the Netherlands with a participatory design approach. The participants all work in the so-called fuzzy front-end of design (see Sanders and Stappers [2012]) in co-design, service design, and organisational design. This scope resulted from authors' available network. We note that all four projects valued the uptake by design practice but did not follow a particular strategy to support design professionals' learning.Table 1 describes the four cases, labelled by a pseudonym representing each of the four design professionals as learners.

3.2. Data collection and analysis structure

We used various theoretical lenses to review the data. The cases were analysed as taking place within a collective process by using the CHAT aspects from section 2.3 (Engeström 1999) to organise findings. In this, the roles for structuring RtD collaborations by Sleeswijk Visser (2018) were used as a starting point to organise the project roles. The results (Tables 1 and A1–A4) are organised along these aspects. To better recognise as well as organise the learning outcomes, we used the topic categories of designing, application domain, and project organisation by Zielhuis et al. (2022a). To recognise where active engagement as learners took place, we mapped the key learning events as deliberative, reactive, and implicit learning (Eraut 2000).

Each participant was interviewed by the first author; during the interview, participant and interviewer together drew a process map of the case. Different episodes in the participant's learning process were distinguished and mapped. Due to covid measures, the interviews were held online using an online collaborative environment, in which drawings, post-its, and texts were created and organised. Additionally, several project documents, such as publications and end-reports, were collected, studied, and used as prompts. The interviews were audio-recorded and transcribed. The interview questions were aimed at gathering information on the learning activities.

The relevant activities were organised in the corresponding roles, as distinguished by the participants, into different lanes in the timeline (see Figure 1). Some roles were explicitly assigned and labelled in the project, others were identified and labelled by the participant during the interview. The interviewer constructed the timeline and its contents with input of the participant. Some participants took an active role in drawing up sticky notes and moving them around. As talking about learning can be difficult, we used several prompts, such as pictures from the project, to activate the participant's memory, and existing timelines to triangulate. The interviewer offered several examples of actionable knowledge, from explicit to implicit (Markauskaite and Goodyear 2017) on a variety of topics, so that the participants would not hesitate to name things which they would otherwise consider too mundane, such as a new method that they continued using after the project, an increased network, or practical tips they shared within their design agency.

Each interview resulted in a large poster with an organised process map, annotated with quotes and short narratives on the various events (example in Figure 1). These process maps were analysed in a cross-case analysis session on the wall.

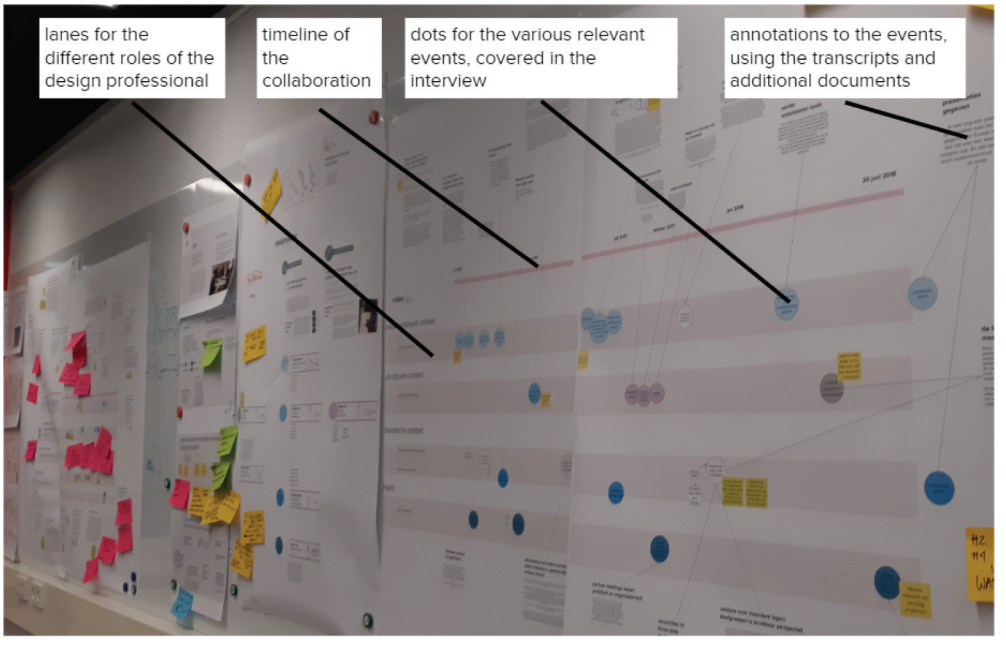


Figure 1. The process map of the research collaboration process of one participant, organized along a timeline and in different roles (lanes) and events (dots) which were annotated (text blocks).

To validate the analysis results, a focus group was held in which the participants reflected on their own and each other's process maps and the presented insights.

4. Observations

The four cases of design professionals in research projects gave insight into what and how they learned and how their learning was related to their project activities. Tables A1–A4 in the Appendix provide a detailed overview of the learning activities of each participant organised by roles. In this section, we discuss our observations on these learning activity systems; in the next, we draw conclusions and provide implications for future research projects.

4.1. Much learning goes unnoticed

All four design professionals reported a wide variety of *actionable* (i.e. turned out as useful for them) learning outcomes. Each participant reported examples on at least two of these three categories, see Table 2. The table shows that many learning outcomes do not concern the project topic.

Two participants developed useful knowledge about the application domain. A big learning outcome for John was that he better understood the pressure under which healthcare professionals have to operate, and what designers can offer in that context. Bob learned about the central project topic: the involvement of residents in solar parks development. Not all domain theories are relevant for design practice. For instance, Bob

Table 2. Overview of the learning outcomes as reported by the design professionals in the four cases, in the topic categories by Zielhuis et al. (2022a). For each learning outcome, the table indicates whether this is closely linked to their prior knowledge, and whether this learning is on the project topic.

Topic category	Learner Learning	Bob	John	Mary	Tess
Designing	Outcome	Deepened expertise in facilitating co-creation sessions *'I realized the power of giving people specific instructions in a co-creation session to get them going'.*	Knowing how to talk about futures; Deepened understanding of working with sensitizers *'We worked more with sensitizers since then, to warm up the topic and keep it alive'.*	Deepened understanding of methods and techniques (e.g. contextmapping); improved grasp of facilitating *'Methods became alive'.*	Deepened understanding of futuring methods and techniques; Tips for practical techniques and tools *'I applied the tips we shared directly in the next client session, about getting people from one state to the next'.*
	Link	Yes	Yes	Yes	Yes
	Project topic	-	Yes	-	Yes
Application domain	Outcome	Insights in how people view solar parks, and ways to involve them in a design process; Extended network; Showcase in solar park design	Extended network and follow up projects; understanding of domain issues and what design can offer. *'Healthcare is under so much pressure that people run into problems but don't have the time to zoom out'.*	(nothing reported)	(nothing reported)
	Link	Yes	-	-	-
	Project topic	Yes	-	-	-
Project organization	Outcome	Improved skills and confidence to work with a complex consortium *'I became more confident in addressing things. In future projects I will ask where partners would like support'.*	Insights about layering your project outcomes; Extended network	Benefits of working in large consortium; Extended network; Insights on how to work (and how not to) in complex consortia	Insights on the potential of research-practice collaborations; Extended network and follow up projects
	Link	Yes	Yes	Yes	Yes
	Project topic	-	-	-	-

described a behavioural model as interesting, but alas too time-consuming for practice. Moreover, they all learned much beyond the application domain, namely about designing (techniques and methods) and project organisation. For Mary and Tess, the value of the projects lay in the exchanges about methods, not in the respective application domains of physiotherapy or sustainable energy. Mary did not even report the application domain at all in this list. Her normal work is visualising client processes, which does not go deep into domain topics.

All participants reported learning about designing. Most examples concern co-design and context mapping, the area of work of these participants. Bob and John both deepened their understanding of and expertise in working with sensitisers (a technique in context mapping (Sleeswijk Visser et al. 2005)). Already familiar with the concept sensitising, they even better appreciated its value by the prominent use in the project: 'We worked more with sensitizers since then, to warm up the topic and keep it alive'. (John)

All four reported on learning about project organisation, particularly in such complex, layered consortia. For instance, Bob realised that project partners tend to go their own, mono-disciplinary, way, and developed ways to deal with that.

According to the participants themselves, the majority of these learning outcomes concern a deepening and strengthening of the existing knowledge and expertise of the design professional (see Table 2). Not all these learning outcomes were easily recognised or articulated by the design professionals. Although some, for instance, on a method, could easily be put into words, others were less explicit. The interviews helped them to identify and articulate several less explicit outcomes, such as the improved confidence as mentioned by Bob.

4.2. Learning is supported by and actively sought out in exchanges with peers

Active and conscious engagement as learners took place in exchanges with others in the project team, such as researchers or other professionals. Bob reflected that 'by explaining and motivating your approach, you are almost forced to make this explicit'. This activity helped him to articulate the implications for his own practice, to become more aware of his own strengths, and more aware of what he would do differently in future situations.

The exchange with peer design professionals brings the most. Tess described that 'exchanging with other agencies that work in industry is really different from exchanging with researchers'. With these colleagues, they can talk about similar practice experiences: 'It is so valuable to exchange with colleagues about difficulties you encountered and how you handled them'.

Exchanging with designers beyond the actual project also contributed to learning. For instance, Mary discussed a tool which was used within the project with her own partner. This was a dice-tool which sides could be changed, for instance, to make a name-generator. 'I took it home, and my partner, working in a similar field, immediately said: we also need to use this in our work, as it is versatile and handy beyond co-creation sessions'.

Some of these exchanges are planned activities within the project, such as the above exchange with peers for Tess.In several cases, these peer exchanges resulted from a project task. John worked intensively on a design challenge with one other design agency and learned much about 'the tools and the type of conversations in healthcare'.

The above examples already show that many exchanges were supported by artefacts, such as templates, tools, or prototypes. Some of these artefacts were object of study or intended project outcomes, and some were tools as used in the project. In the above described exchange, Tess and the other design professionals brought tools and materials from their own practice to reflect on. 'It made it very practical to see the worksheet that they use, or my talking stick'. Seeing each other's artefacts and work methods was very helpful. 'We immediately applied the tips that we received in the next client session'.

4.3. Learning happens in a variety of roles

The above learning took place in a variety of project roles. Tables A1–A4 in the Appendix show that each design professional took on at least four roles and that many roles (e.g. manager and facilitator) emerged during the project. Bob did not only take part in user research and the design of the solar park but also joined the theory development and facilitated stakeholders meetings. Experienced in dealing with group dynamics, Mary even took the initiative to make everybody's roles more explicit which led to role adjustments.

The design professionals learned in a variety of roles in which they could connect to activities in their own daily design practice, but especially when they could connect experiences from multiple roles. For instance, in the earlier described example were Tess reflected with peers about futuring, learning did not only result from the exchange with peers as a stand-alone activity but also because of the ongoing interplay between the roles of tool developer and theoriser.

The data shows that much learning was reactive, triggered by what transpired in a role, but that design professionals also actively orchestrated learning opportunities. For instance, Mary joined the project with a firm intent to learn about facilitating – not the topic of study – and co-facilitated several sessions. She took the opportunity to learn from a project colleague how and why to apply a certain facilitation technique: 'This really deepened and strengthened the methods I already used'.

4.4. Conditions can support learning

Although they learned much, the participants indicated that chances were missed for even more learning, especially in exchange with others. John expressed a need for more profound exchange with the other involved design professionals, to 'look back at how they approached things'.

The necessary reflective exchange requires certain ways of working and conditions in these projects. Working with each other is no guarantee for exchange yet: 'Working alongside other designers and researchers, you can still exchange little'. John mentioned that 'partners rather keep within their own silos instead of questioning each other's approach'. Tess explained her positive learning experience by the 'space holding', of conditions such as time, openness, equality, and trust between partners. A complicating factor in this is when teams change during the project. Finally, the cultures of practice and academia sometimes do not support each other, described by Bob as 'working on a paper for a year versus having to finish your project in a month'. John notes that analyzing is much more extensive in academia than in their design practice. For this

reason, it is a certain type of design professional who joins such collaborations. Bob adds that unlike some colleagues, he has 'a fair amount of patience for such long projects' himself. This slower and more extensive process can also have a beneficial flip side: 'Normally, you talk with other design professionals or watch or read each other's cases, but you don't have the time to go that deep' (Tess). Finally, Tess proposes that better funding arrangements for practitioners in research projects would 'even better support the exchange'.

5. General discussion

5.1. Learning in research activities

This study started from the notion that collaborative research projects in which design professionals are involved hold potential for helping these professionals with their work, but that this potential is currently underused. The results confirm this. Moreover, they show that, from the viewpoint of the participating professionals, these projects provide multifaceted learning opportunities and multifaceted outcomes of important value for them.

In these four projects, we found that their learning can be characterised in three dimensions: they learn in a way which A) is not always recognised by themselves, B) benefits from active engagement as learners and articulation of learning, and C) requires supporting project conditions and arrangements. These dimensions play out differently for learning on and beyond the project topic.

The design professionals in our study were not always aware of all their learning, as is typical in non-formal learning (Eraut 2000). They learn on the project topic but don't always recognise this as learning. Their focus on contributing to the project makes it difficult for them to see themselves as learners. Furthermore, it is difficult for them to recognise and oversee what they learn during their involvement. This especially concerns topics on which they already have an extensive repertoire, such as designing. These experienced professionals need explicit reflection on how the project strengthens or better articulates their prior knowledge, in line with how Eraut (2000) describes how learning involves synthesis with prior knowledge.

On the project topic, the necessary explicit reflection by all project actors was often organised, but seldom directed to the learning of design professionals and the link to their practice. Especially on topics beyond the project focus, the design professionals took much initiative to create and seize learning opportunities, which Goodyear et al. (2021) indicate as supportive for learning. The exchanges with fellow project partners – especially peer design professionals – helped them relate the project findings to their own practice. Various tools or other artefactssupportedthese exchanges as boundary objects (Star 1989) between the project context and the various practices. Since the interviews and focus group in this study helped to further articulate their learning, we propose that even more opportunities could be created in the project itself.

Finally, we conclude that there is not one specific role that promotes such articulation and reflection, but that the key lies in identifying for each professional which possible project aspects are relevant for their practice – they can even learn in roles as facilitator or

Table 3. Three characteristics of learning by design professionals within research projects, on the main research project topic and on topics beyond this.

Characteristics of learning	Learning on project topic	Learning beyond project topic
A: Low awareness of individual learning	Learning is recognized with some difficulty, and rather seen as 'developing knowledge together'. *'The whole project is about developing knowledge together' (Bob)*	Learning is recognized with some difficulty: learning outcomes are varied and sometimes implicit, and much is strengthening what they already know. *'Learning about designing has overlap with what you already know' (John)*
B: Active engagement enhances reflection and articulation	Active engagement as learner is required to connect to professional practice. This is supported by exchanges with others, and by interactions with tools and artefacts as object of study or intended end products. *'It's a rare opportunity to exchange with colleagues' (Tess)*	Professionals take initiative to pursue learning goals, seek out exchanges with others and engage in reflections on applied tools and artefacts. *'I saw this researcher develop a tool, and went to discuss this with her' (Mary)*
C: Supportive arrangements and conditions	Being involved in the heart of the project supports learning, as different roles inform one another. Still, learning requires a setting of trust, mutual interest, and time. *'Time to share and willingness to let go of a set way of working and really connect' (Tess)*	Various roles can be relevant for a professionals' specific practice and support learning. It helps if professionals have the opportunity to pursue these at the start or during the project. *'What I do in such projects is keep the focus on the user perspective' (Bob)*

manager – and in providing sufficient conditions of reflective time and space. Furthermore, we found that design professionals learn better when involved in multiple roles. In line with Stappers and Sleeswijk (2014), these various roles, especially when carried out by the same person, inform each other.

Table 3 summarises these three dimensions of the learning processes. Column A depicts the awareness of learning by the design professional within the collective process; column B, the active engagement as learner with explicit reflection; and column C, the supportive project arrangements in conditions and roles.

5.2. Implications for collaborative research projects

We propose that learning on the project topic by the involved professionals should be a matter of interest for all involved. Apart from that, enhanced learning by the design professionals beyond that topic will make the collaboration itself more effective. Table 4 summarises guidelines based on our findings for the lead researchers (R), design professionals (D), and funding agencies (F) on the three introduced dimensions.

6. Conclusion

The main contribution of this study is the concrete learning stories from the first-person perspective of the partaking design professional. These descriptions can help to further improve the learning opportunities in collaborative projects. Another contribution lies in showing the many different roles of the design professionals in such projects. Researchers may not sufficiently realise this varied contribution of design professionals.

Table 4. Guidelines to make research collaborations more actionable for the involved design professionals.

	On project topic	Beyond project topic
Awareness: Recognize and value learning	• R: Find out where project goals match the professionals' personal interest. • F: Recognize the opportunity towards practical impact through these partaking design professionals. Include this in criteria and evaluations.	• D: Reflect on personal learning intentions before the start and be keen on emerging opportunities.
Engagement: Support articulation and reflection	• R: Include reflective activities on the design professionals' practice and facilitate the use of artefacts to enhance this reflection. • D: Get involved in activities that enable the translation of theory to design practice, such as the creation of tools. • F: Facilitate the above conditions for learning.	• D: Pursue opportunities to exchange and concretize. • R: Facilitate exchanges with peer design professionals.
Conditions: Assign relevant roles and facilitate reflexivity	• R: Involve design professionals throughout the project on multiple meta-levels and in more than one role. • R: Closely collaborate with D in planning, conducting, and evaluating activities including (or aimed at) reflection on learning goals and outcomes. • D: Pursue roles that are relevant for your practice. • F: Facilitate this involvement of design professionals in funding.	• R: Embrace the additional roles that design professionals want to take to contribute and learn. • R: Facilitate reflexivity on collective and individual learning

The learning stories, however, are limited, as they only report the learning that designers themselves retrospectively identify and only roughly describe how learning actually developed throughout the cases. A longitudinal study of successive cases may better identify whether the professionals actually learned. A richer understanding of the learning process may result from studying multiple perspectives within collective learning, for instance, with a learning histories approach (Kleinsmann, Sarri, & Melles, 2020; Roth & Kleiner, 1998). The applied theoretical lens which was useful in this study (i.e. CHAT combined with descriptive models by Sleeswijk Visser 2018; Zielhuis et al. 2022b), could be used in such studies to further conceptualise learning activities in design collaborations.

This study focused on the 'fuzzy front-end of design' and projects which a similar national (research) culture and funding context. Although we grew our understanding of the learning processes in these contexts, we propose that learning may be different in other design areas such as app development, AI, or VR design, and in different international contexts.

Within the above limitations, this study provided new insights into how design professionals look back on how they developed actionable knowledge for their practice in collaborative research projects. They do not recognise some of their learning, need to actively step in as learners and need supportive conditions. With the guidelines, researchers, design professionals, and funding agencies can better support this learning.

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Appendix A

Table A1. The learning activity system of Bob in the research project organised by roles. Roles or activities marked as* developed during project.

Roles	Activity + quote	Learning	Rules	Prior knowledge	Artefacts	Community
Within research project						
Theorizer*	**contribute to the theory development**. *The researchers used a certain theoretical model about how people relate to the place they live. We contributed our ideas about how to apply this model.*	–	Academic approach	No addition to DP experience		
Tool designer	Not applicable	–				
Designer	**develop a prototype**. *We designed a prototype for the test with residents. We made a sunpark set-up as a kind of sample card. How do you like this, or how do react to that? We designed prints for that.*	Yes	Work as usual	Design experience	Prototype of sunpark	
User researcher	**interviews**. *The interviews were organized by the research partners. We assisted them in setting up the interview format and conducted some of the interviews at people's homes.*	Yes	Academic vspractice standards	Interview experience		Residents
	facilitate co-creation sessions. *In the co-creation sessions, we really showed what we do best. We showed the residents what we learned in the interviews. We prepared several scenarios and let the participants work on those scenarios.*	Yes	Work as usual	Facilitating experience	Materials in session	Residents, stakeholders
	evaluate the prototype with users*. *The researchers had the lead in this. We managed to get involved in this, because we wanted to contribute to this. This type of thing is what we do best! We helped them to make the questions simpler.*	–	Academics in the lead	Practice experience		
Facilitator*	**facilitate stakeholders meetings***. *There was tension between stakeholders in this problem context. My presence added value there, by being there at meetings and bringing my experience as facilitator. To keep addressing: 'I hear what you say". It's about asking questions, intervening and steering the conversation.*	Yes	Space to address things	Facilitatingcomplex projects experience		Project partners
Manager	Not applicable	–				
Trainer	Not applicable	–				
Engineer	Not applicable	–				
Outside project (EX)						
(outside project)	**interview for this study***. *I realize only now, that we have to make more clear to the consortium partners, right from the start, that the exposure is very important for us.*	Yes	Space to consider	Reflective attitude	Learning timeline	Interviewer

Table A2. The learning activity system of John in the research project organised by roles. Roles or activities marked as* developed during project.

Roles	Activity + quote	Learning	Rules	Prior knowledge	Artefacts	Community
Within research project						
Theorizer*	**take part in analysis sessions & reflecting on case**. *The researchers were in the lead, but I was participant in several analysis sessions in which we reflected on the case and on a higher level, overarching the cases.*	Yes	Extensive analysis		Model about futuring	Researchers
Tool designer	Not applicable	–				
Designer	**develop tools for the domain context, together with other agency (case A)**. *We developed two interventions for the care partners, like a conversation tool.*	Yes	Work as usual	Similar experience	The tools	Other design agency
	further develop tools. *We made a small next step on the tools.*	–	Work as usual			
	develop and build prototype (case B). *This case for us had a very practical take: we had to build an installation. The question was: how can we engage visitors in a festival setting in thinking about their futures?*	–	Rather practical work		The installation	
User researcher	**conduct interviews at peoples' homes and sessions with stakeholders (case A)**. *We conducted interviews with caregivers and elderly people at their homes.*	Yes	Interview approach at homes	Context mapping experience	Interview materials	Elderly people
	test and evaluate the developed tools in practice. *The tools that we developed were applied by the care organisation.*	Yes	Observing role		The tools	Care organisations
Facilitator*	**co-facilitate workshop about follow-up projects**. *We had a session with relevant partners about a potential follow-up. We facilitated a workshop.*	–				
Manager	**organize practicalities with care partner**. *Sometimes I was the project lead in this design case, together with the researcher. And I organized practical details.*	–	Practical work	Similar experience		Care organisations
Trainer	Not applicable	–				
Engineer	**technical installation and logistics (case B)**. *We took care of very practical things, such as hiring a van and making the technical installation work.*	–	Practical work			
Outside project (EX)						
(outside project)	**host workshops and sessions as follow-up**. *With several partners, we did follow-up activities such as a small project and some workshops.*	–				Project partners
	develop new tools. *A concrete result is that we worked more with sensitizers.*	Yes	Trying out is common		Sensitizers	Colleagues

Table A3. The learning activity system of Mary in the research project organised by roles. Roles or activities marked as* developed during project.

Roles	Activity + quote	Learning	Rules	Prior knowledge	Artefacts	Community
Within research project						
Theorizer*	**analyze in session**. *I participated in a analysis session combining all efforts.*	-	Academic			Researchers
	analyze individually. *I also did my own analysis on data from another researcher. Some things did not appear in the presentations. I thought these very important, so I used several bits for my own task.*	-	Each their own method	Design research experience		
	analyze results in small group. *We analyzed a session with researchers*	-				Researchers
Tool designer	Not applicable	-				
Designer	**design tools for physiotherapists**. *I developed three tools for physiotherapists: an activity monitor cover, educational means,and an infographic for children.*	-	Work as usual	Design expertise		
User researcher	**prepare interviews and send sensitiser**. *The design researcher explained to me that you best send a sensitizer as preparation for a generative session.*	Yes	Sharing, interest	Learning goals	Tools (sensitiser)	Researcher
	conduct interviews. *We conducted contextmapping to provide more depth to the qualitative interviews. In generative sessions, I explored with children what they need when wearing an activity monitor. We send a sensitizer in advance.*	Yes	Context mapping	Learning goals	Tools (sensitiser)	
	conduct interviews. *Before the co-creation session, I interviewed therapists.*	Yes		Experience		Physios
Facilitato *	**facilitate co-creation sessions**. *With a researcher, I co-facilitated and prepared the co-creation sessions with physiotherapists and behavioural scientist.*	Yes	Mutual interest	Learning goals		Researcher
	design sprint. *I organized a design sprint for the team as a dedicated week*	-				
Manager	**exchange in project meetings & stand ups**. *A weekly check-in with the team.*	Yes	Sharing			Researchers
	address group dynamics×. *There was much unclarity about the roles. Because I work a lot with group dynamics, I took initiative to discuss this.*	-	Open to initiative	Practice experience		
Trainer		-				
Engineer		-				
Outside project (EX)						
(outside project)	**talk to partner***. *My partner does similar work as me, sometimes we discuss methods or tools at home.*	Yes	Similar work	Learning goals	Tool	Peer professional
	informal exchange with colleagues*. *I met another researcher at the university. I saw her put together another tool and discussed this with her.*	Yes	Informal exchanges	Learning goals	Tools	Researchers
	be interviewed for this study*. *Good to discuss this. Thinking about it, it raises some questions, like shouldn't we plan an evaluation for this project?*	Yes	Reflective setting	Reflective attitude	Learning timeline	Researcher

Table A4. The learning activity system of Tess in the research project organised by roles. Roles or activities marked as* developed during project.

Roles	Activity + quote	Learning	Rules	Prior knowledge	Artefacts	Community
Within research project						
Theorizer*	**analyzing the sessions**. *With one of the researchers, I made a document and some graphics to capture what we exchanged so far.*	Yes			The graphic overview	Researcher
Tool designer	**take part in reflection session and develop tools**. *We explored new forms, new tools.*	Yes			Tools (for futuring)	Peer professionals
	reflection sessions. *The researchers asked me to devote a few sessions to capture our current knowledge. The other design agency was not involved yet.*	Yes	Reflective space	Reflect. attitude		Researchers
	take part in reflection session. *In half-day sessions, we shared the problems we run into in practice. How we deal with that and could learn from that. We made the final session more practical by bringing materials from our practice.*	Yes	Reflective space & trust	Reflect. attitude	Practice tools (for futuring),	Researchers & peer design professionals
Designer	Not applicable	-				
User researcher	Not applicable	-				
Facilitator*	**prepare and faciliate session**. *We divided tasks in who would prepare the sessions. I designed and facilitated one of the sessions.*	-	Practice as usual			
Manager	Not applicable					
Trainer	**coach students on futuring**. *I was already involved on this topic, by working with students.*	Yes	Learning setting	Teached before		Students, researchers
Engineer	Not applicable					
Outside project (EX)						
(outside project)	**applying insights in lead for client**. *I was able to apply some of the tips we shared directly in the next session with one of my clients: about how to get people from one state to the next.*	Yes	Trying out is common	Interest		Client
	applying insights in lead for client. *We had a lead, in which we operationalized this futuring approach in several steps. I saw a lot of synergy between these projects. But this project did not start.*	Yes	Trying out is common	Interest	Project plan in steps	
	contact researcher beyond project context. *I gained access to new people. I contacted one of the researchers to talk some more about a particular topic.*	Yes	Mutual trust	Interest		Researcher
	interview for this study. *Now we talk about it like this, I realize what the qualities are that make this type of collaboration work. We work as equals and find similarities.*	Yes	Reflective setting	Reflect. attitude	Learning timeline	Interviewer