



Research

Learning systems and learning paths in sustainability transitions

Helge Svare¹ , Mads Dahl Gjefsen^{1,2,3} , Alanya C. L. den Boer⁴  and Kristiaan P. W. Kok⁴ 

ABSTRACT. Scholars have stressed the need to better understand the role of learning in sustainability transitions. Even though progress has been made, there is a call for more research, both in the form of large-scale empirical studies and theoretical clarity. Based on pragmatic learning theory, this paper responds to this call by presenting the results of an empirical study on learning within the context of a European large-scale multi-level transition-oriented sustainability project. Following the empirical analysis of the learning in this project, the concept of a learning system is proposed as a theoretical innovation, and the question of how to most effectively facilitate learning in sustainability transitions is rephrased as how such a learning system is best designed. Moreover, the term “learning path” is introduced to describe how individuals or groups maneuver within a learning system. We argue that to understand this maneuvering, the focus needs to be directed at the perceived learning needs of the actors relative to the challenges they are experiencing. Finally, the article discusses how to improve learning in sustainability transition projects and points to the potential value of using the concepts of learning systems and learning paths in doing so.

Key Words: *learning; learning paths; learning systems; pragmatic learning theory; sustainability transitions*

INTRODUCTION

Persistent and growing social-ecological problems have prompted calls for change toward a more sustainable future (see, e.g., Grin et al. 2010, Markard et al. 2012, Köhler et al. 2019), that is, for sustainability transitions (STs) involving change across deeply anchored structures, practices, and cultures along material, ecological, sociocultural, and political dimensions (Loorbach and Rotmans 2006, Geels and Schot 2007).

It is generally acknowledged that learning is a crucial success condition for STs (Loeber et al. 2007, Grin et al. 2010, Wals and Rodela 2014, Beers et al. 2016, van Mierlo and Beers 2020, den Boer et al. 2021). In this context, learning should be treated as a broad multidimensional concept, involving both individual and collective dimensions (van Poeck et al. 2018). One of its central aims is to help individuals, institutions, and systems develop transformative capacities (Strasser et al. 2019) that may help them confront complexity and unpredictability (Beers et al. 2016), as transitions are typically characterized by a lack of blueprints, requiring continuous adaptation of strategies and action plans. Within pragmatic learning theory, this is learning in its most basic form (Elkjaer 2018).

Several knowledge gaps exist in this area. According to van Mierlo and Beers (2020) learning in STs has “hardly been conceptualized, discussed, and elaborated,” and theory remains underdeveloped and fragmented (van Mierlo and Beers 2020: 255). They also call for more empirical research on learning in STs. Based on a literature review, van Poeck et al. (2018) identify a lack of conceptual clarity in the field, in particular, due to differences in disciplinary definitions of learning. Moreover, they call for research “examining the conditions under which learning occurs (or not) and by what mechanisms” (van Poeck et al. 2018: 303). In this paper, we respond to these gaps by formulating the following research questions:

1. What are the perceived learning needs of change agents in STs, and to what extent do these needs change over time?

2. How do different learning activities meet the perceived learning needs?

Empirically, we analyze a large-scale, multilevel, transition-oriented sustainability project, FIT4FOOD2030. We explore the changing perceived learning needs of its central change agents (Lunenburg 2010) in various phases of the project, how different learning activities meet these needs, and how agents initiate individual learning activities. Discussing this, we then introduce two new concepts, the concepts of a learning path and a learning system, and elaborate on how these concepts may be used both as theoretical tools to improve our understanding of the learning taking place in STs, supplementing pragmatic learning theory, and to enhance learning practices. Addressing a growing field of research on competencies (see, e.g., Redman and Wiek 2021), we also include competencies in our discussion.

The article is organized as follows: first, we present an overview of the literature on learning in STs and on pragmatic learning theory more generally. We then go on to present our empirical case, our research design, and our main findings concerning the research questions, before discussing the broader theoretical relevance of our study, and its implications for practice.

THEORETICAL BACKGROUND

Sustainability transitions vs. sustainability transformations

In the literature discussing the need for change toward a more sustainable future, the terms transition and transformation are widely used, often interchangeably (Hölscher et al. 2018). To the extent that they diverge in meaning, transformation typically denotes radical, large-scale, and nonlinear long-term change that transcends sectors, whereas transition refers to changes within more clearly defined fields, such as societal sub-subsystems, sectors, or activity areas (e.g., mobility or agriculture) (Loorbach et al. 2017).

As a transition may represent a necessary step in the process toward transformation and may have many of the same

¹Work Research Institute, Oslo Metropolitan University, ²NTNU Social Research, ³Ruralis Institute for Rural and Regional Research, ⁴Athena Institute, VU University Amsterdam

characteristics (e.g., nonlinearity and complex feedback loops), we agree with Hölscher et al. (2018) that the concepts should be seen as overlapping and mutually enriching, rather than mutually exclusive. We extend this view to the theory of learning in sustainability transitions and transformations as well.

FIT4FOOD2030 exemplifies the fuzzy boundaries between the concepts as its stated aim is to contribute to a sustainability transformation (Baungaard et al. 2021), even as it targets the more narrowly defined subsystems of food and research and innovation (R&I). In this respect, FIT4FOOD2030 might be more accurately described as a transition project. Consequently, this is the concept we employ in the current study. As the concepts and respective literatures around sustainability transition and transformation overlap, however, our study may serve as a contribution to both. Also, more specifically, when we use the concept of transformative capacities, we see them as relevant to transitions as well.

Learning in sustainability transitions

Research on learning in STs needs to be embedded in a more general theory of learning. Several such theories exist (cf., van Mierlo and Beers 2020). In this article, we follow van Poeck et al. (2018) in arguing for the relevance of pragmatic learning theory, proponents of which include American pragmatists such as John Dewey and C. S. Peirce, as well as more contemporary representatives like Étienne Wenger, Chris Argyris, and Donald Schön. A central outlook shared by all these authors is how learning occurs continuously through experience as individuals or groups are confronted with real-life challenges, and as they learn to handle them, that is, through learning-by-doing (Dewey 1980, Elkjaer 2018). The idea of challenge-driven learning, therefore, stands central to all the mentioned theorists. Another commonality lies in the understanding of knowledge as such, and the idea that knowledge is defined not by remembering and being able to reproduce verbally the content of books or lectures, but by looking at practice.

Pragmatists also emphasize the value of critical thinking. Learning-by-doing alone is not sufficient and should be supplemented, from time to time, with a more critical outlook, for instance, as reflected in Bateson's (1972) concept of first-, second-, and third-loop learning, each corresponding to one of the following questions: (1) "Are we doing things the right way?" (2) "Are we doing the right things?" and (3) "How do we decide what is right?" Another example is Argyris and Schön's (1978) notion of reflection in action and their distinction between single-loop (following the rules), double-loop (changing the rules), and triple-loop learning (learning about learning).

Pragmatic learning theory aligns well with the ambitions for change in transition studies (van Poeck et al. 2018). Dewey's pragmatism, for instance, sees a deep connection between action and thinking and considers learning as a way to cultivate the latter to act still more intelligently (Dewey 1980, Elkjaer 2018). It thus offers a useful framework for understanding learning in STs, where learning is introduced specifically to develop new strategies in response to unexpected challenges (Beers et al. 2016), and to strengthen the transformative capacities in individuals, institutions, and systems through individual and social learning (Wals and Rodela 2014, Strasser et al. 2019). Pragmatic learning theory is also relevant for transition studies as it has already informed many of the more specific learning concepts and

theories that have been taken advantage of here (Shields 2003), such as the concept of a Community of Practice (Wenger 2000), which may be seen as based on the pragmatic idea that learning occurs through social interaction with others, and the idea that learning comes in strata (Bateson 1972, Argyris and Schön 1978, Tosey et al. 2012).

Although Paolo Freire and his followers are not normally classified as pragmatists, the two schools share several principles, such as the prominence of challenge-driven learning, learning-by-doing, and dialog (Freire 1972, Maboloc 2021). However, the Freirian notion of learning places a heavier emphasis on the hierarchical power relations of the learning situation and requires that learning should support marginalized groups in their emancipation, which is also reflected in the Freirian concept of praxis. Although the Freirian position was not explicitly part of the FIT4FOOD2030's theory basis, a Freirian perspective was present in the ambition to include marginal stakeholder groups in the project (cf. Kok et al. 2021).

The role of competencies in transitions

Wiek et al. (2011) offer a widely cited framework for the development of transformative capacities, including five "key competencies" for change agents in STs: (1) systems thinking, (2) anticipatory/futures thinking, (3) normative/values thinking, (4) strategic thinking, and (5) interpersonal/collaborative competency. In a recent study by Redman and Wiek (2021), three additional competencies were suggested, including integration, implementation, and intrapersonal competency, the latter referring to mindset. Together, these key competencies complement disciplinary competencies or topical knowledge of specific sociotechnical configurations, professional competencies (e.g., project management), and general competencies (e.g., critical thinking) (Redman and Wiek 2021).

Reflexivity has also been emphasized as an essential competency in STs and is considered an important dimension of each of the competencies presented above (Sol et al. 2018, Brundiers et al. 2021). Reflexivity here includes the willingness to explore and challenge underlying frames, as well as self-reflexivity involving the effort to gain insight into one's position within a system of change (Sol et al. 2018).

Although practitioners might interpret competency overviews as checklists ensuring comprehensiveness in learning, not all competencies are equally relevant in every phase of a transition (Brundiers et al. 2021). Pragmatic learning theory reminds us that a specific competency (or cluster of competencies) is primarily useful when it helps us face a specific challenge. Therefore, a theory of learning in STs needs to consider the learning needs of the learners, how these relate to shifting perceived challenges, and to what extent the resulting learning is useful in dealing with these challenges.

Where and how does one learn?

In a paper on social innovation, Strasser et al. (2019) argue for a research agenda examining the settings and processes through which learning takes place in addition to its outcomes and impact. Furthermore, they distinguish between intentional and spontaneous learning activities.

Examples of the former are intentionally designed learning activities or learning resources, such as lectures or textbooks. We

suggest that this may also be referred to as organized learning, adding that the term should be seen as referring both to learning organized by institutions—like universities—and learning organized by individuals if it follows from an explicit intention to learn.

Spontaneous learning typically takes place without such an explicit intention and is typically a by-product of activities initiated for some other reason. According to pragmatic learning theory, most learning belongs to this category and occurs as we involve ourselves in real-life situations or social practices (Nielsen 2008). Everyday learning through conversations with friends, family members, and coworkers also belong in this category (Argote et al. 2000).

A further distinction is the one between individual and social learning. The former concept here comes with a focus on the individual learning outcome, or change in behavior, whereas social learning occurs when change goes beyond the individual to become situated in the wider social units or communities of practice (Reed et al. 2010, Sol et al. 2018).

As evidenced by studies on learning in innovation networks, spontaneous learning activities are often highly valued by network members as a source of learning (Svare et al. 2020). This includes, for instance, the informal dialog occurring during breaks or meals and spontaneously occurring learning-by-doing (Svare 2016). In STs as well, learning has frequently been found to take place in real-life settings such as governance networks, grassroots initiatives, and other transition arenas (Larsson and Holmberg 2018, Strasser et al. 2019).

CASE

FIT4FOOD2030 was a 3-yr Coordination and Support Action (CSA) (2017–2020) funded under the Horizon 2020 program of the European Commission (EC) to support the EC in the implementation of the FOOD 2030 policy framework. That framework sought to promote transformation toward “future-proof” (sustainable, resilient, responsible, diverse, competitive, and inclusive) food systems (European Commission 2016, Baungaard et al. 2021). FIT4FOOD2030 was organized and managed by a consortium of R&I institutions.

Within the project, 25 multistakeholder “labs” were established across Europe, some oriented toward the city or regional level, others toward the national level (Kok et al. 2019). Building on the concepts of real-world labs and living labs (Hossain et al. 2019, McCrory et al. 2020), they sought to engage a wide variety of societal stakeholders, both powerful and marginalized, in processes of co-creation and experimentation for a sustainable transition (Schäpke et al. 2018, Kok et al. 2019, 2021). Labs were established in two batches: at the beginning of the project, seven regional and seven national labs were established; then, midway through the project, seven more regional labs and four more national labs were added. Within the general framework and aim of the project, the labs were granted a high degree of autonomy in designing visions, strategies, and activities adapted to local or national conditions, and in dialog with stakeholders. Each lab was managed by one or more lab coordinators.

To support the lab coordinators, the project offered a variety of learning activities and learning resources. FIT4FOOD2030 also involved learning among stakeholders. In this article, however, we limit our attention to learning among lab coordinators, and more

specifically the first batch of coordinators, as we were able to follow them over a longer period.

Learning activities and resources included, first, a series of training sessions and webinars. A training session typically involved a meeting over 2 days, including lectures, workshops, and interactive exercises as well as informal breaks and a joint dinner. Second, various forms of printed or web-based learning resources were developed by project partners, for instance, playful card games on trends and breakthroughs in the food system, or manuals and tools for workshops (Baungaard et al. 2021). Finally, a Dynamic Learning Agenda (DLA) (van Veen et al. 2014) was set up to further enhance the coordinators’ learning. A DLA is a method for challenge-driven reflection and learning through dialog, addressing challenges arising in complex transition processes. DLA sessions were organized for the regional and national lab coordinators separately, each group constituting a separate Community of Practice (CoP) (Wenger 2000). Each session focused on learning questions that were submitted by the coordinators before each session, allowing them to address unexpected challenges or else focus on whatever questions or topics they believed to be timely.

RESEARCH METHODOLOGY

To answer the research questions, we first explored the coordinators’ perceived learning needs, with an emphasis on the variation that could be observed in these needs over time. We then focused on the learning activities and resources that were offered by the consortium, as well as learning activities that the coordinators initiated themselves, exploring how they contributed to the coordinators’ learning, and how useful this learning was viewed to be relative to the changing learning needs. Finally, through critically analyzing and evaluating the resulting findings and developing new concepts, we developed recommendations on how to improve learning in STs. Data were collected through the following methods:

1. Surveys

Two comprehensive surveys were sent out to the coordinators of the first batch of labs ($N = 14$), with a response rate of 100%. The first survey was sent out in the second year of the project (November 2019), and the second survey was sent out closer to the end of the project (October 2020). In both surveys, respondents were asked to assess their learning needs, responding to a predefined list of needs, with an open response entry field for additional input. The list of predefined alternatives included the following:

1. Stakeholder identification
2. Stakeholder engagement
3. Food system analysis
4. Workshop design and/or facilitation
5. Lab management
6. Responsible research and innovation (RRI)
7. Research and innovation (R&I) relevant to the food system and/or food system transformation

The respondents were invited to assess their learning outcomes from the following predefined list of learning activities and resources:

1. Training sessions (i.e., the 2-d training sessions)
2. Webinars
3. DLA sessions
4. Manuals and other resources
5. Informal dialog between lab coordinators during and between training
6. Informal dialog with local/regional stakeholders and contacts
7. Learning-by-doing

Here, too, an open response entry field was included for additional input.

2. Interviews

Semistructured and in-depth interviews were conducted with the coordinators in the winter of 2019–2020. This provided us with more detailed data on the coordinators' learning needs and their satisfaction with various learning activities. Unless indicated otherwise, quotes in the results section are derived from the interviews.

3. Learning questions from DLA sessions

Before each DLA session, that is throughout most of the project period, the lab coordinators submitted forms with open response entry fields that supplied data on the challenges that they were facing at that time and the questions that they wished to discuss in the upcoming session, the so-called learning questions. The response rate was 100%.

4. Observation

In addition to collecting data, we—the authors of this article—were actively involved in the organization and facilitation of the learning activities, for instance during the training sessions and the DLA session, and the data that were collected as part of our research also served as the basis for revisions and improvements to better accommodate the coordinators' learning needs. As such, our research may be described as participatory, action oriented, and interventionist in nature (Lang and Wiek 2021). In this study, we also include observation data collected in our roles as facilitators of workshops and meetings.

Qualitative data was analyzed with NVivo, using a simple coding structure related to perceived challenges, learning needs, and learning outcomes, while SPSS was used to analyze survey data.

Research ethics

As this study involved human subjects, we followed the ethics review procedure of the coordinating institution of the FIT4FOOD2030 project (Vrije Universiteit (VU)). Our study was in compliance with the online self-check tool of the research ethics review committee of the VU, and, therefore, did not require full review by the ethics committee. Following the ethics review procedure and the data management protocols that were developed within the project, informed consent was obtained from all participants before data collection started. With the informed consent procedure, participants were informed about the purpose of data collection and that the data were processed confidentially. Participation was voluntary and participants were given the opportunity to raise any potential questions to the researchers if they wished.

RESULTS

We first present findings on perceived learning needs, followed by findings relating to the learning outcomes of a diverse set of learning activities and resources and their perceived usefulness.

Learning needs as perceived by the lab coordinators

The learning questions that were submitted before each DLA session give an overview of how the perceived learning needs of the coordinators changed during the project. During the first project year, questions revolved around lab focus and stakeholder engagement. This corresponds closely to the main challenges that the coordinators were facing in this period.

Toward the second year, questions relating to the design and facilitation of workshops became more frequent, which corresponds to the phase where they started to meet with stakeholders. These questions concerned how best to organize meetings and workshops with stakeholders, both regarding their general setup and facilitation, and special methods or tools.

Later again, a more diverse set of questions entered the scene, such as “How do I manage my time, energy, and resources as a coordinator?”

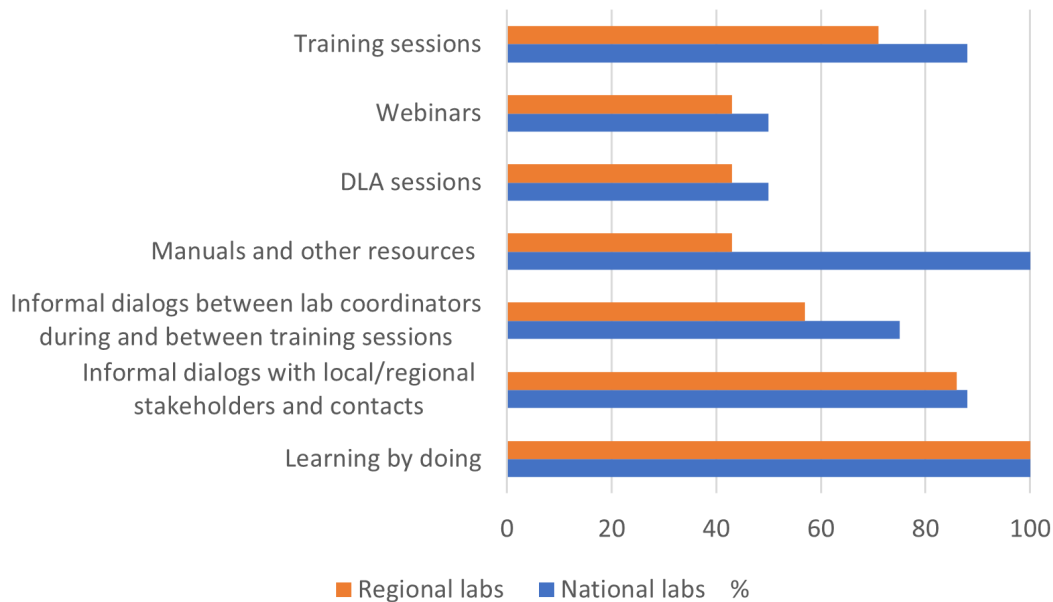
Although learning questions relating to stakeholder identification and engagement were more frequent in the first project phase, they continued to be relevant throughout the project. After the initial phase, the challenge was not so much how to identify stakeholders or generate their initial engagement, as how to secure their continued engagement. An emerging theme was also the question of whether the stakeholders that had been involved were the right ones. In the 2020 survey, one coordinator left the following comment relating to this point in the survey's open response field:

I still need to learn how to be more successful with the success ratio of participants, and especially among those stakeholder groups that are participating with a lower proportion.

A final, more general learning need that we discovered by observing the DLA sessions and informal dialog related to contextualization and implementation. In the training sessions, coordinators were presented with a set of general methods, for instance, methods on how to design and organize workshops based on collaborative and deliberative principles. However, although some of the labs oriented themselves toward stakeholders who were well acquainted with such methods in advance, this was not generally the case. Consequently, the coordinators had to consider whether these methods would be suitable in their local context in its original form, or whether they would need to be revised to better fit this context. The questions involved in these discussions resonate closely with Bateson's (1972) questions defining first-, second-, and third-loop learning. Thus, in discussing the challenge of contextualization, we could say that the coordinators emphasized the need for reflexivity. Another competency pointed at by these discussions, and that they needed to develop, was implementation competency, as the question of implementation is closely related to that of adaptation.

A final observation addresses not so much learning needs as such, but rather the intensity with which these needs were felt. For most

Fig. 1. Perceived usefulness of learning activities/resources (%). $N = 7$ regional labs, $N = 8$ national labs.



coordinators, entering the role as a lab coordinator mobilized a strong desire to succeed, often accompanied by an equally strong fear of failing. This fear was accentuated by the fact that the role was new to them and came with challenges that they did not know how to handle. Thus, we realized that the coordinators would benefit from learning activities that would alleviate their fear of failure and empower them to act with the necessary confidence.

How did different learning activities meet the perceived learning needs?

In both the surveys and the interviews, the coordinators were invited to evaluate the usefulness of the various learning activities in which they became involved. Figure 1 below summarizes the response to the 2020 survey, distributed close to the end of the project. The horizontal columns represent the share in percentages of coordinators from the regional and national labs who gave high ratings to each of the learning activities or resources, adding together those who responded “to a high degree” and “to a very high degree.”

The training and learning-by-doing

If we focus on those response alternatives where the two groups of coordinators were more in alignment, we find that the training sessions received high scores. However, learning-by-doing received even higher scores. Why were these learning activities so highly valued? Looking at the interview data for an answer, we find that the coordinators valued those moments during the training sessions where they were allowed to practice those skills or competencies they were supposed to acquire, for instance, related to workshop design and facilitation, through learning-by-doing. As one coordinator stated:

If you do it [try out a workshop format] in the training, it works a lot better than if you only read about it in a book. [...] So, yeah, learning-by-doing is the method, it's the way to learn. For me, it has been very valuable.

Learning about stakeholder identification and engagement during the training sessions occurred along similar lines, that is, through learning-by-doing. First, the coordinators were tasked with mapping potential stakeholders, assisted by tools that were supplied by the project. Then, they used role-play exercises to practice stakeholder communication. Among the reasons why the training sessions received high scores, thus, is that they allowed space for learning-by-doing, and that this learning-by-doing addressed what the coordinators experienced as acute learning needs.

The survey response alternative learning-by-doing was stated generally, without context. From the interviews, we learned that in addition to the learning-by-doing taking place in organized forms during training sessions, there was also a more spontaneously occurring learning-by-doing when the coordinators started working. The high value of this learning-by-doing is also emphasized in the interviews. One coordinator reflected:

How I learned during this project? By doing things mostly [laughs]. Learning-by-doing was very much present. Looking back now on how I felt when I was doing the first workshop and then all the next ones—yeah, I definitely gained experience.

Thus, it seems safe to assume that the high scores attributed to learning-by-doing in the 2020 survey, are also based on the high value ascribed to such more spontaneously occurring learning-by-doing.

In addition to being experienced as useful in a practical sense, learning-by-doing also triggered reflections on adaptation or implementation, as this coordinator explains:

My experience is that if you already tried out such a methodology, you learned how it could work in other situations.

This adds yet another point to the explanation of why learning-by-doing was valued. Trying out a method in practice—whether during a training session or in a real-life context—triggered reflections because one was forced to consider the actual situation in which the method would be used and reflect upon whether it needed to be adapted to this situation, and if so, how.

The need for empowerment was mentioned above in connection with the coordinators' fear of failure. Several of the coordinators emphasized how learning-by-doing was also useful in this respect, helping them to act with more confidence. One example addresses a workshop exercise where the coordinators were invited to use a piece of clay to visualize their vision for the future. Initially, this exercise created some anxiety among the lab coordinators. They feared that “playing with clay” would not be taken seriously by their stakeholders, or even scare them away. However, their actual experiences of doing the exercises during the training were mainly positive. Consequently, they felt both safer and more empowered to try the exercise with their stakeholders. This adds yet another point to the explanation of why learning-by-doing was valued: It built confidence and empowerment.

DLA sessions

Empowerment was also emphasized as a valuable learning outcome of the DLA sessions. Perhaps somewhat surprisingly, this had not so much to do with the challenges being discussed, as with the fact that most of the coordinators struggled with the same challenges. Especially in the first project phase, many found it comforting to hear that they were not alone in having a problem, assuring them that their lack of initial success did not necessarily reflect negatively on them individually:

We realized that all of us faced these struggles and that was a thing that was nice to think about: You're not the only one having that problem. Things are not easy and smooth.

Thus, discovering that they were not alone in facing a challenge contributed to empowerment as it reduced stress and served to de-dramatize the situation.

Informal dialog

The third learning activity that received consistently high scores in the 2020 survey was informal dialog. In the interviews, the coordinators give several examples of how this contributed to learning. By talking with people in their local context, they acquired valuable knowledge on local conditions, they could test out and receive feedback on ideas and analyses, and they received suggestions and ideas that could be useful to the lab in a myriad of different ways. One coordinator explains:

Talking with the others, I realized how we could do it. The ideas did not so much come from me. This was inspiring, for my usual way of learning is very social.

Another valuable outcome of these dialogs concerned reflection. In emphasizing the value of reflection as part of their learning process, the coordinators explained that this could take place both individually and through social interaction, i.e., dialog. As one coordinator described it:

I think I learned a lot from just doing things... just facilitating a session... and then sort of reflecting on it ... and also talking about it ... talking with people...

Thus, it is hardly surprising that informal dialog received such high scores in the survey. A final point explaining why informal dialog with local stakeholders and contacts was emphasized as representing a useful form of learning, relates to the fact that it established a community with the very same people with whom the coordinators would later work to achieve the lab's goals. It occurred in the very same real-world context as the one that their learning was supposed to help them handle. Individual initiatives So far, most of the learning activities that we have focused on, took place in a social setting. In the interviews, however, the coordinators also pointed out the value of the individual learning activities that they initiated and mostly carried out alone. An example is how they searched for relevant literature or used the internet as a knowledge source. Such searches helped them identify information on, for example, alternative workshop design, food system transformation, policy design, or other areas where they felt that they needed more input. One coordinator said:

I studied transformative change, issues that I knew little of as a food scientist. I needed to know certain definitions, so I read through the scientific literature.

Typically, initiatives like these were triggered by specific challenges that coordinators were facing individually, thus resulting in learning processes that were tailored to a high degree to individual and momentary learning needs that would be difficult to handle by the organized learning activities designed for the whole group.

Interconnections between learning activities

A finding that emerged in the final phase of the data analysis concerned the interconnectedness of the learning activities described above. For most of the coordinators, the learning activities formed a temporal sequence in the sense that a learning process that started in one context continued in a series of others. For instance, a specific workshop method was introduced in a lecture during a training session, then later at the same training session one was invited to experience the workshop method as a facilitator or participant, followed by individual reflection. Then, the learning process continued when the coordinator was faced with the challenge of adapting and facilitating the method at home, followed by further reflection, either individually or with others. The learning activities that are connected in this way take place in different contexts and include both organized and more spontaneous learning activities. Moreover, the connection between them is established by the individual. This means that the connections are easily missed by an external observer.

DISCUSSION

In this section, we develop the notions of learning paths and learning systems and argue that although these notions may often be implicitly present in contexts of learning, making them more explicit and using them more actively could have analytical as well as practical benefits. Additionally, we argue that the two concepts

represent a useful augmentation of pragmatic learning theory when it is applied to sustainability transitions.

First, however, we may observe that the way the coordinators learned in FIT4FOOD2030 is consistent with pragmatic learning theory (Dewey 1980, Elkjaer 2018). The adoption of the role as lab coordinator, and the challenges that followed, largely defined how the coordinators perceived their learning needs, reflecting the pragmatic idea of challenge-driven learning. Furthermore, this starting point, along with their strong motivation to succeed, reflects back on their evaluation of the learning activities. The learning activities that were emphasized as more useful, took place in situations that were either similar to or close to the situations in which they would be working as lab coordinators and involved learning-by-doing and dialog. This aligns with pragmatic learning theory, and its claim that the best learning takes place, not in the classroom, but in real-life contexts as people work to solve real-life challenges and then reflect together on their experiences.

Another point worth noting is that activities enhancing reflexivity were appreciated, not as a luxury addition to the development of more instrumental skills, but as a crucial condition for success, as deploying specific skills must always be adapted to a specific context, which requires reflexivity. Also, whereas much of the learning in FIT4FOOD2030 was designed to stimulate first-order learning, such as how to organize a workshop, or how to engage stakeholders, second- and third-order learning followed immediately due to the challenge of contextualization and implementation, triggering questions, like, “Are we doing the right things?” and “How do we decide what is right?” (Bateson 1972).

Another trigger of second- and third-order learning was the high degree of autonomy that the labs were granted in setting up their labs’ visions and priorities—within the larger context of the project and the FOOD 2030 policy framework (see also Kok et al. 2021). This autonomy forced the labs to continuously reflect on the consistency—or lack thereof—between this larger framework and their priorities, again evoking the above-mentioned second- and third-order learning questions. Even if this autonomy was not originally conceived as a learning mechanism, it served as a significant trigger for learning.

Finally, as practical success depends on confidence, we find it interesting how many of the learning activities that were valued as useful in a general sense, were also valued for their empowering effects. Again, this includes learning-by-doing and dialog.

Learning paths and learning systems

So far, our findings are consistent with the main assumptions of pragmatic learning theory, confirming van Poeck et al.’s (2018) claim of the relevance of this theory to the field of transition studies. If this result is not original, it is far from trivial. Notably, we emphasize the explanatory power of the pragmatic perspective, that is, how it explains both why a certain learning need gets prominence, and why a certain learning activity is seen as the appropriate response. In both cases, real-world challenges and real-world activities constitute the core of the dynamics, as was explained in the previous paragraph.

As an addition to this more general point, we will now present two conceptual innovations that may be regarded as the more original contribution of our study, responding to the call for

theoretical and conceptual contributions to the field (van Poeck et al. 2018, van Mierlo and Beers 2020). This involves the concepts of a learning path and a learning system.

As we have seen, the coordinators typically described their learning as a process, starting at one point in time with one learning activity, and then continuing through a series of subsequent learning events. To account for this processual nature of the learning process, we introduce the concept of a learning path. Traditionally, the concept of a learning path (or trajectory) has been used in educational institutions to refer to the specific track of courses, academic programs, and learning experiences that individual students are expected to complete as they progress toward graduation. Typically, students define their individual learning paths within a context predefined by their institution. Such paths may also include learning experiences occurring outside of traditional classroom settings, such as internships, independent research projects, or community-service learning projects (Klahr and Nigam 2004).

The concept of a learning path or trajectory has also been used as an analytical tool to examine how *de facto* learning takes place in real-life settings through successive organized and spontaneous learning activities or experiences. The concept has, for instance, been used to examine learning in the workplace, where learning activities include both formal education modules and informal spontaneously occurring discussions and participation in everyday work practices (Eraut 2004, Nielsen 2008, Poell et al. 2018).

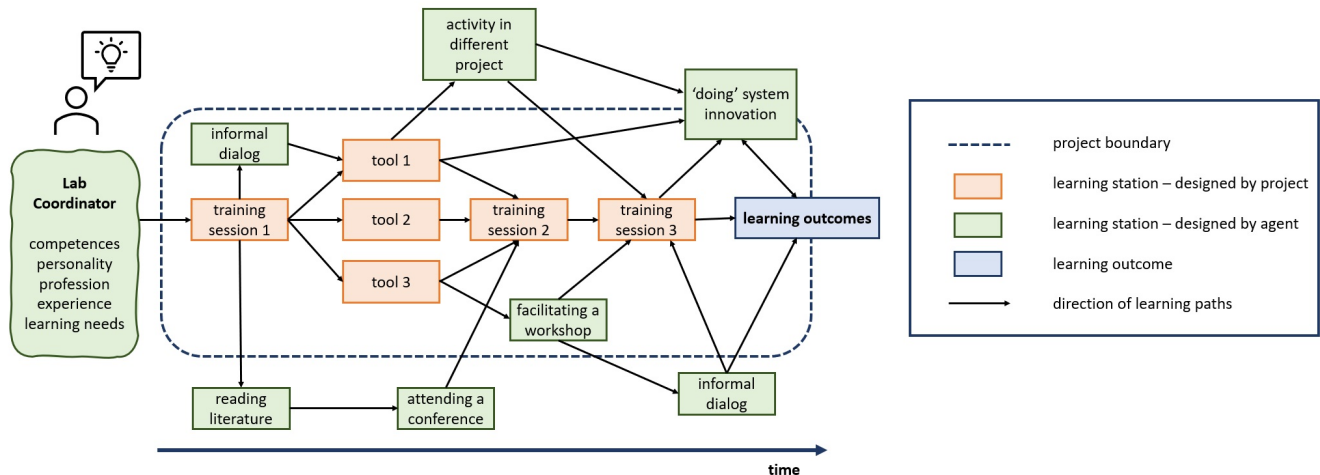
In this article, we adopt a definition of the concept that is inclusive of both of the above uses, viewing learning paths as something that may include both organized and spontaneous learning activities both inside and outside of institutional settings. Although the concept is not new as such, our innovation is to introduce it to the transition learning literature. We also draw a firmer connection between the concept and pragmatic learning theory.

As a further elaboration of the concept of a learning path, we introduce the concept of a learning station. This concept reflects the same underlying metaphor as that of a learning path, conceptualizing learning as a journey, where the stations represent temporary stops. At each stop, an experience is made that is conducive to learning. Additionally, the metaphor of a station points at the socio-material context and resources that a station needs in order to offer the opportunity to learn, in the form of, for instance, reading materials or social events.

In line with pragmatic learning theory, we see the basic design principle behind a learning path as based on a perceived challenge and the need to handle this challenge. Contexts that are believed to make the individual more competent in handling this challenge, constitute the learning stations of this path. A learning path, thus, may be defined as the temporal sequence of learning stations, where the initiation of the path and the motivation to follow it, as well as the selection, design, and temporal order of the stations are motivated by the idea that the learning they offer helps an individual to handle a challenge.

Along with the concept of a learning path, we introduce the notion of a learning system. We propose a definition of a learning system closely connected to the concept of a learning path. Whereas a

Fig. 2. Schematic visualization of FIT4FOOD2030's learning system. The learning stations designed by the project are depicted in orange, and the learning stations introduced by the coordinators are depicted in green. The boundaries of FIT4FOOD2030 are visualized by the dotted line, and some potential learning paths of a coordinator are represented by arrows.



series of learning stations make up a learning path, a learning system is made up of several related learning paths and their stations. There is also a social aspect: a learning system is established when a group of individuals constructs learning paths in response to a common set of learning needs that emerge from a common set of challenges, which again addresses a more overarching challenge, such as, for instance the need for a ST. This is also our definition of a learning system. Another way of stating this point is to say that this overarching challenge is what defines the boundaries of the system: the learning paths that help individuals address the challenge are part of the system, whereas those that do not, are outside the system. In our case, the learning system of FIT4FOOD2030 consists of the learning paths that helped the lab coordinators succeed as coordinators in the shorter term and that contributed to a more sustainable food system in the longer term. We also suggest an additional design principle: when someone takes on a particular responsibility for designing learning activities that are meant to serve as learning stations for individuals facing a challenge, these activities may also be seen as included in the learning system defined by this challenge. Initially, however, these are potential learning stations. Only when individuals integrate them into their actual learning paths, they become actual learning stations.

This means that in FIT4FOOD2030, the learning activities and resources that were organized by the consortium were part of the project's learning system in the way just specified. In addition, however, so were the multitude of learning paths and stations designed and included by the lab coordinators themselves. A schematic depiction of FIT4FOOD2030's learning system, including learning stations designed by the project consortium and learning stations introduced by individual coordinators, as well as the learning paths that these open up, is presented in Figure 2.

The idea that learning in STs needs to include several topics and learning activities, is not new, neither is the idea that instances of

learning occur, or should occur, in a certain sequence (Beers et al. 2016, Ernst 2019, van Mierlo and Beers 2020). This means that the concepts of learning paths and learning systems are often implicitly present in situations where people learn. We argue that making these concepts more explicit could have analytical benefits in highlighting learners' agency relative to their own learning, as well as practical benefits pertaining to enhancing learning practices.

Analytically, these concepts may encourage researchers to be more aware of the actual learning taking place in the field they are studying. Without them, there is a risk that important instances of learning are overlooked, especially those occurring outside formal settings. There is also the risk that the intricate web of interdependencies and interactions between learning stations is ignored, or not fully understood or appreciated. By allowing us to see more clearly and fully what is going on, the two concepts expand and improve pragmatic learning theory in a useful way when applied to sustainability transitions.

Pragmatic implications

Based on our pragmatic starting point and the findings of our study, a piece of basic advice to those in charge of organizing learning activities in STs is to give priority to learning activities that respond to the actual challenges and learning needs of those involved at successive stages of the transition. Another piece of advice would be to design learning stations that are similar to the real-life situations in which individuals or groups will be working. Learning-by-doing and dialog—also outside the classroom—are learning activities that are valuable in this respect. At a minimum, formal learning mechanisms should not be seen as the sole and exhaustive basis for learning but rather as mechanisms whose influence on learning takes place in interaction with influences from informal learning stations. A further recommendation based on our findings is to organize and create room for unstructured moments and dialogical spaces that allow participants to propose and explore topics of interest or address ongoing concerns or

needs, which may encourage further engagement, reflection, reflexivity, and creative experimentation. This is in line with earlier research (see e.g., Svare et al. 2020).

As a more original contribution, we want to stress the value of individuals' capacity to codesign their individual learning paths and the importance of designing learning systems that give individuals the flexibility to make productive choices in this respect. One way to do so is to grant such individual learning paths more explicit attention, for instance by inviting people to talk publicly about how they have constructed individual learning paths within a learning system. In FIT4FOOD2030, such attention was granted during DLA sessions in instances where coordinators had initiated literature searches or other learning activities on their own, which generally raised high interest among and probing questions from the other coordinators, and occasionally emulation.

We believe that there lies great potential for improved learning by foregrounding individuals' learning initiatives, learning paths, and learning stations in this way. By doing this, others get ideas on how they might design or improve their learning paths, and those more passive in designing such paths might get inspired to become more active. This could also be seen as an extension of the recommendation of Singer-Brodowski et al. (2018) to encourage participants "to jointly explicate learning goals in advance" (2018: 25) to stimulate competency development. It might also be an important way to stimulate the coordinators' reflexive capacities relative to what Argyris and Schön (1978) referred to as learning about learning. Additionally, it aligns with calls for more disruptive ways of capacity building that include co-learning processes for developing individual and systemic agency (Lotz-Sisitka et al. 2015). We believe that a more explicit focus on identifying, encouraging, and sharing experiences from individual learning initiatives, learning paths, and learning stations from the very beginning of the project, might have enhanced the coordinators' learning even further.

Limitations

A limitation in the current study is its limited empirical basis in only one transition project. Moreover, methodologically, the authors' role as both facilitators and members of the project consortium may have affected how coordinators described their own learning experiences and needs. Analysis and comparisons across multiple ST projects, as well as a less participatory methodological approach, might have generated different or additional insights. Another limitation concerns the complexity of the processes of a learning system like the one we have studied. Even with the extensive data collection and analysis that support our study, additional potentially relevant variables might have been added to the analysis. For instance, to explain why the coordinators of the regional and national labs evaluated the usefulness of the learning activities differently, we would probably have needed to know more about how the two groups differed. In line with the theoretical outlook of our study, we hypothesize that the variation has to do with the difference in challenges that the two groups were facing, and how they perceived their learning needs relative to these and relative to their competencies. Other features not covered by our data, may however also have had some influence, such as features of the food and R&I systems upon which the transition efforts were targeted, or the social and

organizational situatedness of the change agents taking part; analyses into such aspects constitute promising avenues for further research.

In the background section, we briefly discussed the Freirian concept of praxis (Maboloc 2021), emphasizing the emancipatory dimension of learning. Even though a corresponding perspective was partially present in FIT4FOOD2030 through the call to include marginalized groups among the labs' stakeholders, the present study does not give this aspect any explicit focus. This is a further limitation of the study. For those interested in this discussion, an interesting contribution may be found in Kok et al. (2021), and a more general discussion may be found in Souza et al. (2019).

CONCLUSION

Our study of learning among the lab coordinators of FIT4FOOD2030 addressed the following research questions:

1. What are the perceived learning needs of change agents in STs, and to what extent do these needs change over time?
2. How do different learning activities meet the perceived learning needs?

The perceived learning needs that we identified in our study mainly emerged from interconnected challenges of strategy development for the labs and effective and meaningful stakeholder identification and long-term engagement, corresponding to interpersonal/collaborative competencies, strategic thinking, systems thinking, reflexivity, and implementation competencies. In line with pragmatic learning theory, we found that the learning activities that were most highly valued were those that responded to the participants' perceived learning needs and connected to the participants' challenges as lab coordinators. The emotional and existential energy that permeated the ambition to succeed in this role both motivated and structured their learning process.

Learning-by-doing was highlighted as the most useful form of learning, as it had the most in common with the real-life situations and challenges that the lab coordinators were facing, and thus also prepared them better for handling these situations and challenges. Learning-by-doing also allowed formal training content to be rehearsed, digested, reflected on, and reworked to fit local contexts and needs. Also considered useful for many of the same reasons were dialogs with local colleagues and stakeholders—formal and informal—reflecting on strategies and action plans adapted to the local context. The high degree of autonomy granted to the labs in designing visions and strategies, the task of adapting general ideas and methods to local contexts, and the opportunities to reflect upon one's own and others' challenges within the projects' trusted learning community also triggered second- and third-order learning.

Our main concern in this article has been to respond to the calls for further conceptual developments (van Mierlo and Beers 2020, van Poeck et al. 2018) by observing that different types of learning activities and events are related to what may be conceptualized as a learning system and explicating how learning paths develop within such a system. Further research is needed on the dynamics of learning paths and the systems they comprise. Even at this point, however, we argue that the concepts of learning systems and learning paths offer useful contributions to the theory of

learning in transitions. At a practical level, we suggest that the question of how to facilitate learning in sustainability transitions can best be rephrased as the question of how to design optimal learning systems in support of such transitions.

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Data Availability:

Data are not publicly available as they contain information that could compromise the privacy of research participants.

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