Learning for transitions: An experiential learning strategy for urban experiments

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ABSTRACT

Urban experimentation has been increasingly applied as an urban development tool for finding new ways to face grand societal challenges, as they unfold in cities. Experiments might trigger systemic change, since they differ conceptually from conventional urban development, as they can be radical in ambition, limited in scope, and place emphasis on learning from real-world interventions. However, while there seems to be a common understanding of the importance of learning through urban experiments, there seems to remain a lack of, or unclarity on, learning and reflectivity in the practice of urban experimentation. This paper aims to provide principles for developing more explicit, testable, and improvable learning strategies in urban experimentation by addressing the following question: How to foster learning for transitions through urban experiments? For this, insights from transition studies and experiential learning theory (Kolb, 1984) were used, resulting in a synthesized strategy for learning for transitions through experimentation.

1. Learning and transitions in urban experimentation

Urban experimentation is a rapidly developing field of practice and research, seemingly holding great potential for creating more sustainable forms of urban building, managing, and living (Evans et al., 2016; Majoor et al., 2017; Szejnwald Brown et al., 2003). This interest in experimentation arises from the notion that business as usual cannot solve the grand challenges that cities faces, for example climate change or social and economic inequality. These challenges call instead for modes of governance that catalyze radical alternatives and shape transformative change (Evans et al., 2016). Experiments promise a way forward amid otherwise disturbing urban trends associated with environmental degradation and social injustice. Experimentation, therefore, has been increasingly applied as an urban development tool (Castan Broto and Bulkley, 2013; Löw, 2013). This is evident, for example, in the concepts of urban living labs (Bergvall-Käreborn et al., 2009; de Jong et al., 2015; Maas et al., 2017; Neef et al., 2017; Steen and van Bueren, 2017, Von Wirth et al., 2018), novel practices (Hoffman, 2016), and urban field labs (Majoor et al., 2017).

The emergence of experiments relates to the expectation that they may trigger systemic change. Experiments differ conceptually from conventional urban development, as they can be radical in ambition, limited in scope, and place emphasis on learning from real-world interventions. They offer a relatively controlled way of introducing fundamental changes and, subsequently, evaluating and learning from the impact of these changes (Evans et al., 2016). The ethos of experimentation resonates with the theory of "practical wisdom" or *phronesis* (Loeber, 2007), the notion of the reflective practitioner (Schön, 1983), and Beck's distinction between "the

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science of data" and "the science of experience" (in: Evans et al., 2016, 2). Moreover, experimentation promises more scientifically rigorous knowledge that is both reflective of and shaped by a given experiment's context. As a consequence, it is expected that such knowledge is more easily applicable and effective in practice (Evans and Karvonen, 2011; Straatemeier et al., 2010).

However, whether and how experiments can generate genuine alternatives and far-reaching transformations remains questionable (Sengers et al. 2016). Smith and Raven (2012) capture the extent to which experiments possess transformative capacity by distinguishing between those that "fit and conform" the dominant socio-technical practice and those that "stretch and transform" it. Many urban experiments fall in the first category and neither entirely subvert nor reinforce the status quo (Evans et al., 2016). In some cases, experiments merely further a familiar set of dominant interests. Experiments may, for example, privilege certain actors such as multinational corporations (Evans et al., 2016), or articulate preferred visions of a political future, excluding other options. Also, experiments may predominantly focus on technological solutions while neglecting social innovations (Cástan Broto and Bulkeley, 2013; Hoogma, 2002). A key area of discussion is about the role of learning in urban experimentation. Learning is a, if not *the* central aim of experimentation. It has been claimed that "an experiment only fails when nothing has been learnt from it" (Nevens et al., 2013, p. 119). However, learning is often still poorly conceptualized and implemented in urban experimentation.

Related to these more critical assessments of learning in urban experimentation, three key shortcomings have been identified. First, and although (social) learning and reflectivity is often mentioned as an important goal for experimentation, experiments often lack a clear strategy for learning and transformation beyond a single case. As a result, they lack the means of transferring the lessons gained in an experiment beyond its niche context or boundaries (Majoor et al., 2017; Smith et al., 2010; Beers et al., 2014; Von Wirth et al., 2018). Second, experiments routinely fail to monitor whether and how learning and transitions take place (Van Mierlo and Beers, 2018; Van Mierlo and Regeer, 2010; Von Wirth et al., 2018). Third, even when learning is one of the initial experiment goals, attention to learning may wane in the course of the experimentation process as other, more immediate concerns become dominant (Majoor et al., 2017). As shown in a database analysis of the transformative capacity of 400 experiments in 225 cities by Cástan Broto et al. (2019), reflectivity and social learning were by far the least satisfied criteria, with a rate of less than 1%. Notwithstanding the popularity of experiments in research and practice, and their potential or intention for stimulating radical change, their transformative capacity therefore often seems to remain unclear, particularly in terms of social learning and reflectivity.

In order to contribute to addressing these shortcomings, and provide principles for developing more explicit, testable, and improvable learning strategies in urban experimentation, this paper addresses the following question: How to foster learning for
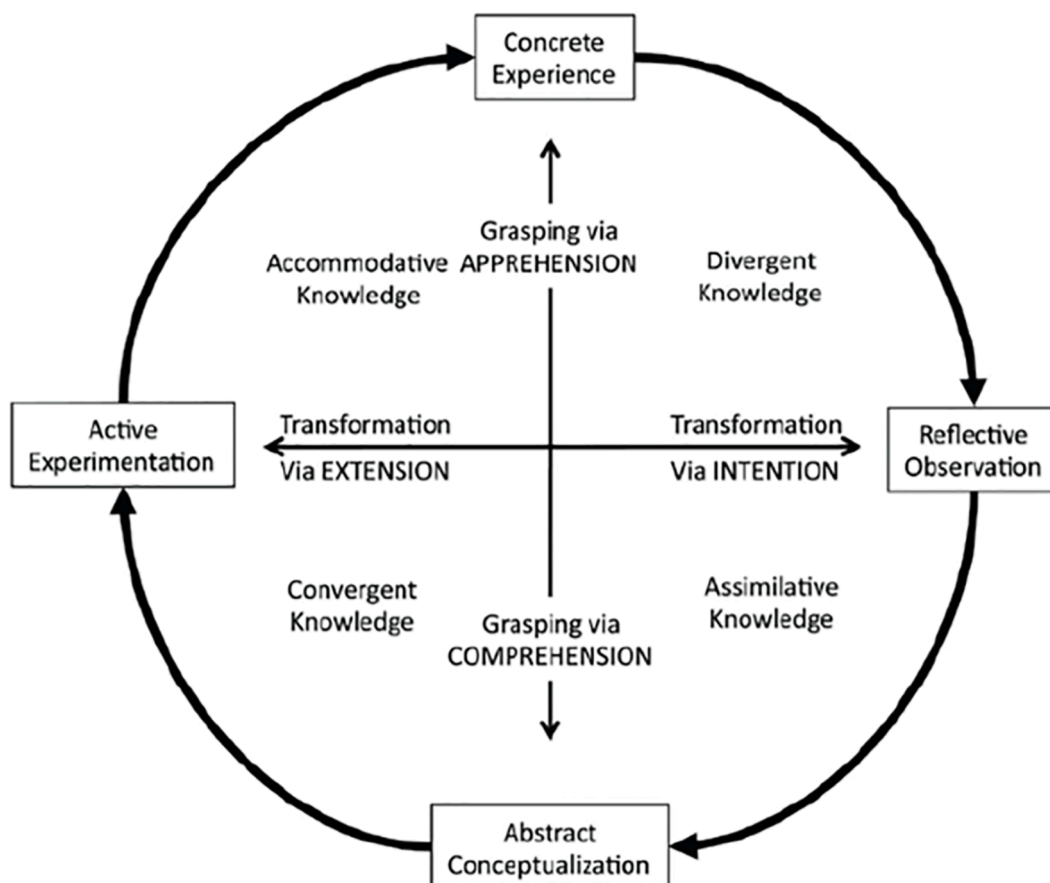

Fig. 1. The Experiential Learning Cycle (Kolb, 1984).

transitions through experiments? By focusing on learning for transitions through experiments, the aim of this paper is to better articulate how a more general openness to change could be fostered through learning through experimentation, even if it might be unclear what kind of change should take place, and how.

The paper is structured as follows. Following this introduction in Section 1, Section 2 further reflects on the relation between experimentation, learning, and transformative capacity. In Section 3, we conceptualize a strategy for learning for transitions through experimentation through a literature review on insights from transition studies. We propose to complement these findings with insights from the experiential learning theory (ELT) introduced by Kolb (1984) in education studies. In section four, we discuss a research agenda for applying this conceptualization of a strategy for learning for transitions through experimentation. As such, the sections of this paper follow the logic of the ELT (see Section 3.2 and Fig. 1): by sharing concrete experiences in Section 1, diverging in Section 2, conceptualizing in Section 3, and proposing to put the conceptualized strategy into action in Section 4.

2. Experimentation, learning and transformative capacity

The relationship between experiment, learning and transformative capacity is a growing concern of literature in the field of transition studies. Within transition studies, several concepts have been developed to understand the dynamics of socio-technical change, how these are influenced through experimentation, and the extent to which learning comprises a crucial mechanism in this process. See, for example, the seminal conceptualizations of the Multi-Level Perspective (MLP) (Geels, 2002), Strategic Niche Management (SNM), and Transition Management (TM) (Loorbach, 2007; Hoogma et al., 2002; Kemp, 1998; Loorbach and Rotmans, 2006; Roorda, et al., 2014). Such accounts increasingly emphasize how learning is crucial if experiments are to trigger systemic change. In the MLP, for example, the value of a novelty or niche experiment lies in whether it allows lessons to be learned (Smith et al., 2010). The SNM, for its part, emphasizes that experiments can build momentum in social learning processes (Raven et al., 2008; Kemp et al., 1998; Naess and Vogel, 2012), generating insights about transitions' problems, needs, and possibilities (Kemp et al., 1998). According to Kemp et al. (1998), SNM is distinguished from a "technology-push" approach to technological innovation by the way in which it generates social learning processes and institutional adaptation. It does this by drawing on the knowledge and expertise of users and other actors in developing technology. Social learning and a reflective mind-set are also central to TM's approach to transition experiments (Kemp and Loorbach, 2006). Hence, TM focuses on the organization of process and content through an interactive and selective procedure with participatory stakeholders, with the aim of learning and experimentation (Grin et al., 2010).

According to Smith et al. (2010), it is imperative that we address how learning-by-doing experiences transfer beyond the context of experiments. Moreover, they point to the need for more research on how practices (as "embedded configurations") replicate, scale-up, or translate in other contexts of application. Since experiments are by definition oriented towards practice, they are deeply contextualized and cannot simply be replicated or scaled-up (Evans et al., 2016). In addition, experiments are premised on the value of "trying out," meaning that experiments may fail, remain small, or cease after a period (Von Wirth, et al., 2018). As relatively isolated events, many experiments exert limited influence on strategic decision making (Hoogma at al., 2002, p. 195). Overall, there is a danger that the knowledge accumulated in experiments is lost once they are concluded (Kemp et al., 1998; Von Wirth et al., 2018) or that experiments do not build on related efforts elsewhere (Szejnwald Brown et al., 2003). At the same time, it must be recognized that, even if an experiment "fails" or is not successfully disseminated, it can serve as a source of knowledge about how to build on previous experiences and avoid repeating mistakes (Szejnwald Brown et al., 2003). This all underlines that, whether successfully disseminated or not, an experiment only succeeds if technological, social, and institutional learning occurs.

Wolfram (2016) recognizes social learning and reflexivity as core mechanisms of the urban transformative capacity of experiments. Urban transformative capacity represents the power to change, and is defined as *"the collective ability of the stakeholders involved in urban development to conceive of, prepare for, initiate and perform path-deviant change towards sustainability within and across multiple complex systems that constitute the cities they relate to"* (Ibid, p. 126). Social learning and reflexivity are articulated as crucial mechanisms that should address all agency levels and must be linked to all actions for change and relate to all core development processes, as well as to leadership, governance, and community empowerment. Social learning and reflexivity are further elaborated as taking place when (Ibid, p. 128):

- "Reflexive monitoring is carried out on all dimensions of urban transformative capacity development.
- Participants in experiments have methodical and practical skills for enabling reflexivity (monitoring, assessment, evaluation).
- Wider stakeholder and leadership reflexivity is enabled through diverse formal and informal interaction formats, providing room for critically questioning progress towards the vision.
- Practical know-how for initiating and performing radical change for sustainability (i.e., transformational knowledge) is managed systematically."

This characterization underlines that learning and change through experimentation does not happen spontaneously, a point that others have also made (Beers et al., 2014; Leeuwis, 2000; Loeber et al., 2007; Luederitz et al., 2017; Majoor et al., 2017; Van Mierlo and Beers, 2018). As Smith and Raven (2012, p. 1028) recognize, *"dedicated intermediating work is needed for interactive learning to take place […]"*. Even if learning is one of the experiment's goals, attention to learning may decline while the experiment is being conducted or if it encounters difficulties. For example, reflecting on their Amsterdam living lab program, Majoor et al. (2017, p. 193) conclude that: *"There are several reasons why the creation of […] learning environments is never a given. In many situations, parties certainly learn, but this knowledge is not sufficiently made explicit and thereby productive."* So, although learning is broadly acknowledged as a pivotal mechanism for transitions through experiments, it may remain unclear as to whether these processes are either deliberately organized or

unintended consequences, and if experiments' learning effects and change capacity are monitored (Von Wirth et al., 2018).

As mentioned in the introduction, this concern was dramatically shown by Cástan Broto et al. (2019) in a database analysis of the transformative capacity of 400 experiments in 225 cities in which reflectivity and social learning were by far the least satisfied criteria, with a rate of less than 1%. The little reported criteria of reflexivity and social learning in these cases, suggests that *"either few projects involve explicit attempts to reflect on insights and shape activities according to how previous processes have unfolded, or that, because of the vagaries of the project cycle, most initiatives rarely report such processes of learning"* (Ibid, p. 459). Furthermore, they found that those cases that did meet the criteria of social learning and reflectivity also met most other criteria of urban transformative capacity. This suggests that social learning and reflectivity could be a crucial indicator of transformative actions towards sustainability, like considering inclusive and multiform forms of urban governance, deliberately trying to empower communities, exhibiting foresight practices, and working across levels of human agency and scales (Ibid, p. 460).

There seems, in conclusion, to be a discrepancy between a shared understanding of the importance of learning and reflectivity as key mechanisms of the transformative capacity of urban experiments, and a lack of, or unclarity on, learning and reflectivity in the practice of urban experimentation. This discrepancy entails three main concerns: (1) lack of an explicit strategy for learning for transitions through experiments; (2) lack of monitoring whether and how learning and transitions take place; and (3) lack of maintaining attention for learning throughout the whole process of experimentation for urban change. In this paper we focus on the first concern, as the need for "dedicated work for interactive learning" (Smith and Raven, 2012, p. 1028), the notion that a "learning environment is never a given" (Majoor et al., 2017, p. 193), and the call for "explicit attempts to reflect on insights" (Cástan Broto et al., 2019, p. 459) indicate in our view the need for strategic action, not something that happens coincidently or spontaneously. Such a strategy should, however, not be interpreted as a blueprint, but as a set of guiding principles that practitioners could use for inspiration when designing and developing a strategy for learning, adjusted for their specific urban experiment context. Furthermore, conceptualizing a strategy for learning that could be applicable in the context of urban experiments could possibly also enable the second and third concerns to be tackled.

3. Conceptualizing a strategy for learning for transitions through experiments

For conceptualizing a strategy for learning for transitions through experimentation, a literature review in the field of transition studies was first conducted (Section 3.1). The aim was to better understand how to foster learning in the context of urban experiments, by focusing on practical directions or instructions. Also, it aimed at identifying omissions that could explain why learning for transitions by means of experiments may remain underdeveloped, even though it is widely acknowledged as a key mechanism for transitions. Next, to explore ways of addressing these omissions, we attempted to complement the learning approaches in transition studies with insights from the experiential learning theory (Kolb, 1984) (Section 3.2). This resulted in a conceptualization of an applicable strategy for intentionally organizing learning in experiments for transitions in the context of urban experimentation (Section 3.3).

3.1. Literature review: learning for transitions through experiments

3.1.1. Learning concepts and methods

A literature search was done in Google Scholar (search date: 12-07-2020), using the keywords "transition experiment learning." We selected published papers (no books) that address learning for transitions through experiments, and focused on how such learning should take place. Papers from other domains (like chemistry or ICT), and with different foci (like papers that mention learning and transition experiments superficially or focus on what to learn instead of how to learn), were not included. Appendix A shows the first 20 references in the search, and the papers that were selected.

This selection resulted in eight relevant papers, in which insights on learning in the context of experiments for transitions were coded. Considering the strong overlap in the used conceptualizations of learning among the selected papers, this search gave apparent theoretical saturation for gaining a general overview of how learning for transitions through experiments could be organized. These coded insights on learning were then synthesized into the following three 'components of learning': *Concepts on learning, and the learning process* (1)*; Modes, methodologies, and/or conditions for learning* (2)*; The supposed learners and/or their characteristics* (3)*.* These components focus on how learning should be organized and leave out insights on what to learn. Even though the reviewed papers also elaborate the content and desired outcome of learning, this is not the focus of this paper and review (See Appendix B for a detailed elaboration of this review).

The used concept/concepts (review component 1) theorize that learning takes place in niches or transition arenas (Rotmans and Loorbach, 2009), and more specifically in transition experiments, through a process of deepening (Van den Bosch and Rotmans, 2008; Van den Bosch, 2010; Porter et al., 2015). Deepening is seen as a first step in implementing lessons from a transition experiment level to the regime level (i.e. the level of the systemic status quo) and is followed by processes of broadening (second step) and scaling-up (third step). Through deepening, a better understanding is to be gained about the culture, practices, and structure of more sustainable approaches for societal needs. In the process of deepening, high quality learning (Van den Bosch and Rotmans, 2008; Raven et al., 2010) is characterized as being:

- Broad: learning about many dimensions of a problem and the alignment between these dimensions.
- Reflective: double-loop or second order learning (Argyris, 1977), and
- Social: collaborative learning with relevant experiment participants.

Broad learning emphasizes that sustainable issues are multi-dimensional, and have institutional, technological, socio-cultural, environmental, and economic components. They are framed as socio-technical issues or as wicked problems (Rittel and Webber, 1973). This underlines that there are no simple, one-dimensional, solutions and that more radical changes are required. Through broad learning, this complexity should become more insightful. Furthermore, underlying assumptions, norms, and social values should be questioned in a reflective learning process through double-loop or second-order learning (in contrast to single-loop or first-order learning) (Szejnwald Brown et al., 2003; Van den Bosch and Rotmans, 2008; Van de Kerkhof and Wieczorek, 2004; Raven et al. 2010). This should be done in a process of social learning in which multiple actors interact and develop an alternative perspective on reality, with a group of relevant experiment participants (Szejnwald Brown et al. 2003; Van de Kerkhof and Wieczorek, 2004; Van den Bosch 2008; Raven et al. 2010).

Learning in transition experiments by deepening through broad, reflective, and social learning forms the main conceptual framework about learning that authors build upon. These are further elaborated in practical learning approaches: methods and modes about how to facilitate and organize the learning process (review component 2). These can be summarized as follows (see Appendix B for detailed sources):

- Formulate explicit learning goals.
- Create space for learning: dedicated time, regular learning meetings, budget, and support by management.
- Have a small, stable group of participants.
- Perform reflective and interactive exercises, like focus groups, stakeholder workshops, system analysis, visioning, back casting, aggregation activities, network events.
- Facilitate learning by appointing a process manager or transition manager: an intermediary between academics and practitioners.
- Create links among related experiments.
- Create a sense of urgency, group commitment, fairness, transparency, and competence.
- Monitor the transition process, transition management, and transition experiments.
- Set up an explicit learning trajectory and monitor the actual learning.

These approaches for learning for transitions through experiments emphasize that learning should be organized explicitly, creating a proper setting to learn: in regular meetings, dedicated time, with a diverse but stable group of participants, performing relevant exercises and moderated by a facilitator. This facilitator, a process or transition manager, should mediate between the diverse experiment participants, establishing an equal level playing field for generating knowledge, and enabling the sharing of scientific or practical insights and understandings. A such, these methods and modes for learning should help to facilitate broad, reflective, and social learning.

The involved experiment participants (review component 3) should be a group that strikes a balance between: heterogeneity (people with different backgrounds, opinions, and thinking styles) and homogeneity (people with sufficient communication skills, and willingness to learn, invest time and energy, and integrate aspects of sustainability into their own organizations) (Van de Kerkhof and Wieczorek, 2004). So, these should be visionaries and forerunners, who are able to look beyond their own domains or working areas, as well as participants with more practical, strategic, executory, and near-term thinking styles. Moreover, those learning from transition experiments should be not only the directly involved experiments participants but also their immediate professional networks (business partners, members of the organizations that employ them, other organizations with which they routinely interact), and society at large, diffusing the newly gained ideas (Szejnwald Brown et al., 2003).

3.1.2. Underdeveloped aspects and potential ways to address them

The review shows that learning for transitions through experiments in transition studies especially elaborates the process of deepening through broad, reflective and social learning. The review also gives insights into what conditions for learning are necessary, how learning should be facilitated by exercises and a moderator, and who should learn. However, while the need is mentioned, what seems less elaborated is how learning should also take place in processes of broadening and scaling-up. That is, learning by applying experiments in other contexts (broadening) or learning from other related experiments (Porter et al., 2015). Within this broader context, not only should the directly involved participants learn, but the indirectly involved actors and society at large should also learn, scaling-up norms and ideas about more sustainable practices (Szejnwald Brown et al., 2003; Beers, et al., 2014). Related to the definition of social learning and reflectivity for transformative capacity of sustainability experiments (Wolfram, 2016), learning should address all agency levels, be linked to all actions for change, and relate to all core development processes, as well as to leadership, governance, and community empowerment.

To address this, it might be necessary to further articulate how these different actors at different levels could learn in practice. However, the reviewed learning approaches especially advocate intense and ongoing learning practices with small, stable groups of committed participants. When embedded in a broader and societal context, though, learning for transitions through experiments will inevitably also be characterized by chaos and fragmentation, and might gain by spontaneously including diverse participants along the way, besides a stable core group of learners. Therefore, although there might be a need for forming a stable group of participants to collectively and reflectively learn through transition experiments, there could also be a need to generate learning experiences with actors beyond the experiment boundaries—with indirectly involved stakeholders and society at large. At the same time, it seems to be unrealistic to involve all actors that should learn through transition experiments (directly and indirectly involved, and beyond) in similar ways, and to perform all learning exercises jointly. Moreover, even the directly involved experiment participants might have insufficient time, involvement, knowledge, or overview to fully grasp the complexity of an issue at stake (Van de Kerkhof and

Wieczorek, 2004). As such, the reality of transition experiments might not always offer the ideal conditions for learning with diverse participants in the processes of broadening and scaling-up.

This suggests that it might be useful to consider different levels of learning intensity in the practice of urban sustainability experiments, involving different types of participants in different ways throughout the experiment process. It would then be relevant to understand which learning exercise should be performed with whom, and when along the process of experimentation. And to understand how, in a fragmented setting, a valuable learning experience could still be facilitated. For this, the experiential learning theory (ELT) by Kolb (1984) might be of help. This seminal learning theory elaborates on individual learning taking place through four connected stages of learning experiences: by reflecting, conceptualizing, experimenting, and connecting the lessons learned to concrete practice. It underlines that complete (deep) learning only takes place when all four stages of learning are experienced. So, even though the process of learning through transition experiments might be fragmented, including different participants at different phases of the experiment, a complete learning experience that touches all four learning stages should be facilitated. Furthermore, the experiential learning theory might help to understand how the different perspectives of the diverse participants could be connected and lead to stronger and richer insights. In Section 3.2 we further elaborate how the ELT could complement insights on learning through transition experiments in transition studies.

3.2. Learning for transitions through experiments with the experiential learning theory

The ELT frames learning as a process through four quadrants in which knowledge is created by iterations of concrete experience, reflection, abstraction, and action, in a cyclical - although not necessarily orderly - fashion (Kolb, 1984; see Fig. 1). The experiential learning process underlines an interplay between acquiring and transforming knowledge: moving from apprehension (what is grasped or sensed through concrete experiences) through knowledge internalization (reflection on concrete experience, for example relating it to other information) to comprehension (conceptualizing this reflection in abstract models or theoretical concepts) to knowledge extension (applying the conceptualization in interactive experimentation in an external environment) (Kolb, 1984; Kayes, 2002). In this way, knowledge gained from concrete experience is diverged, assimilated, converged, and accommodated, allowing for new concrete experiences to emerge in other contexts, varying in time, space, size, participant groups, and institutional context, among other areas.

The experiential learning process is therefore also described as a learning spiral, wherein experiences become richer, broader, and deeper with each new loop (Kolb and Kolb, 2009), and is therefore transformative (Itin, 1999). While this learning process may symbolize personal growth through a lifetime, it primarily grasps small scale learning processes. For example, a teaching course that addresses both theoretical insights and abstractions, on the one hand, and personal experience and experiential action in an interim or test case situation, on the other hand.

The ELT also raises awareness of the different experiences and learning preferences that individuals have, related to the four quadrants (Kayes, 2002), and positions different jobs and careers accordingly, as well as how people can achieve deeper learning by working together. In Fig. 1, scientists could be positioned in the second and third quadrant of "assimilative knowledge" and "abstract conceptualization," whereas organizational and business professionals are framed in the fourth and first quadrant of "accommodative knowledge" and "concrete experience" (Kolb, 1984). Furthermore, the ELT emphasizes that each learning quadrant asks for different cognitions: concrete experiences are grasped through our senses (feeling), reflection requires observation (watching, listening), abstract conceptualization entails thinking, and active experimentation involves doing. These cognitions should be facilitated differently depending on the (educational) contexts, as well as the learner's characteristics or learning preferences. This determines when to stimulate individual reflection or group interaction, or when to include theoretical input or practical anecdotes.

Although the ELT is of central importance for not only educational studies but also for organizational learning, sustainable development (Loeber et al., 2007), and other areas (see Kayes, 2002, for a reflection on this matter), the ELT has also been criticized. For example, it has been observed that it ignores the psychodynamic, social, and institutional aspects of learning, such as power relations, social status, gender, and cultural dominance (Kayes, 2002). Furthermore, the ELT leaves out unconscious learning processes and defense mechanisms which could inhibit higher order learning, such as the questioning of assumptions, as addressed in the concept of double loop learning (Argyris, 1977). What makes the ELT distinctive, though, is its concern for different but connected individual learning experiences (concrete experiences, observation and reflection, conceptualization, and action), that all should be touched upon for a deep understanding, and that ask for different learning facilities.

Following the ELT's learning quadrants might offer insights into what learning exercises are most suitable at what stage of an experiment process, and how to facilitate full learning experiences for participants with diverse backgrounds and learning styles, and who are more or less intensely involved. Furthermore, in spite of the ELT focusing on individual learning, the ELT can still be beneficial for structuring group learning processes, especially if the group includes participants that represent the four quadrants. For example, when connecting the knowledge of academia to the practical know-how of practitioners (and vice versa), or, in terms of the ELT structure, to connect the second and third quadrants (primarily dominated by academia) to the fourth and first (primarily dominated by professionals in practice). As such, the ELT has been successfully used as a framework for group learning, and has formed the basis of experiential urban planning case studies in a diverse range of contexts (Straatemeier et al. 2010; Beukers et al., 2014; Beukers, 2015; Thomas and Bertolini, 2015; Soria-Lara et al., 2016).

With respect to learning for transitions through experiments, the ELT could help complement existing theories and methods in three ways. First, by understanding that all participants should touch upon all four learning quadrants for a deep understanding. Second, by understanding that participants need to be actively stimulated to gain these different four learning experiences, since participants have different learning preferences and backgrounds. Third, by being aware that participants with different learning preferences and

professional backgrounds, representing the four quadrants, could together form a symbiosis for richer and more rigorous learning experiences (but could also conflict, or stay separate if the process is not well managed). This third understanding refers to group learning, enriching the individual learning experiences. These three understandings from the ELT could help to facilitate suitable learning conditions in experiment processes by knowing when to facilitate what kind of exercise (e.g., exercises that help to diverge, assimilate, converge, or accommodate knowledge). Furthermore, for optimal group learning, the theory suggests that experiment groups should entail participants that are able to diverge, assimilate, converge, and accommodate knowledge. Or, more concretely, an experiment group should ideally entail:

- Participants who know about the underlying experiment problem and assumed mechanisms through concrete experiences from everyday life or practice.
- Participants who are able to relate these concrete experiences to other relevant cases and more theoretical reflections.
- Participants who can bring these experiences and reflections together in a comprehensive, conceptualized, and applicable solution.
- Participants who know how to put this into action.
- And participants who know how, and are able, to connect the experiment outcomes to other contexts in time, space, size, participant groups, and institutional context. This facilitates, in other words, the need to scale up the lessons learned in an experiment to contexts outside of that experiment.

3.3. A strategy for experiential learning for transitions through experimentation

3.3.1. Combining learning principles from transition studies and the ELT

Table 1 summarizes and codifies the learning principles from the literature review on learning for transitions through experimentation, and from the ELT. It shows that the principles on learning through transition experiments derived from the review have a focus on the conditions required for learning: having learning goals, space and time for learning, a moderator, learning exercises, a stable group of committed learners, connecting to other experiments, and monitoring the learning process and outcomes. While the need for learning with diverse participants is mentioned, less articulated seems how these different actors at broader levels could learn in practice, that is, throughout the experiment process of broadening and scaling-up. This broader context might form less ideal circumstances for learning, with loosely involved participants. Also, it remains unclear in the review when and with whom to perform what type of exercise or mode of learning.

Table 1
Learning for transitions through experiments in transition studies, and the experiential learning theory.

Components of Learning	Learning through transition experiments in transition studies	Experiential Learning Theory
A. Concept/concepts on learning, and learning process	A.1 Learning through a process of deepening by: broad; reflective (double-loop); and social learning. A.2 Process of broadening A.3 Process of scaling-up	A.4 Learning through gaining learning experiences in all four quadrants for all actors, intensely or loosely involved, by diverging, assimilating, converging, and accommodating knowledge, allowing for new concrete experiences to emerge. Framing learning as a spiraling, transformative, process.
B. Modes, methodologies and/or conditions for learning	B.1 Formulate explicit learning goals; B.2 Create space for learning: dedicated time, regular learning meetings, budget, and support by management; B.3 Have a small, stable group of participants; B.4 Perform reflective and interactive exercises, like focus groups, stakeholder workshops, system analysis, visioning, back casting, aggregation activities, network events; B.5 Facilitate learning by appointing a process manager or transition manager: an intermediary between academic scientists and practitioners; B.6 Create links among related experiments; B.7 Create a sense of urgency, group commitment, fairness, transparency, and competence; B.8 Monitor the transition process, transition management, and transition experiment; B.9 Set up an explicit learning trajectory and monitor the actual learning.	B.10 Implement learning exercises that help to diverge, assimilate, converge, and accommodate knowledge: exercises that facilitate reflecting, conceptualizing, acting, and experiencing; B.11 Implement exercises that both (although not necessarily simultaneously) stimulate individual learning and group learning together enabling richer and more rigorous learning experiences (for example, when connecting the knowledge of academia to the practical know-how of practitioners, and vice versa); B.12 Facilitate full learning experiences, experiencing all four quadrants, for participants with diverse backgrounds, learning styles, and who are more or less intensely involved.
C. The supposed learners and/or their characteristics	C.1 A balance between: heterogeneity, people with different backgrounds, opinions, and thinking styles; and homogeneity, people with sufficient communication skills, and with willingness to learn, invest time and energy, and integrate aspects of sustainability in their own organizations. C.2 Directly involved experiment participants; C.3 The immediate professional networks of experiment participants (business partners, members of the organizations that employ them, other organizations with which they routinely interact); C.4 Society at large.	Participants from the four quadrants who can: C.5 relate concrete experiences to other relevant cases and more theoretical reflections; C.6 bring these experiences and reflections together in comprehensive, conceptualized, and applicable solutions; C.7 know how to put this into action; C.8 scale up the experiment's lessons to contexts outside of the experiment.

The ELT could complement this by emphasizing learning as an individual experience that takes place as part of group learning processes. The ELT emphasizes that all experiment participants, intensely or loosely involved, should be enabled to diverge, assimilate, converge, and accommodate experiment knowledge into action. These learning experiences should be facilitated by learning exercises that relate — and be connected to the four quadrants. In other words, every participant needs to be enabled through tailored learning exercises to reflect on the how and why of a sustainability problem, to think about a possible conceptual solution for this, to put this in action, and to experience how this works (or not). Furthermore, the ELT could offer insights into how groups could gain richer and more rigorous knowledge (related to the understanding of who should learn in the literature review), if the participants represent the four ELT quadrants. Notwithstanding this suggested complementarity, the insights on learning in the literature review and the ELT also show overlap. For example, although framed differently, both approaches emphasize the need to learn in mixed teams, to include participants who have a background in academia and in practice, and to acknowledge the need for explicit learning exercises.

3.3.2. A strategy for learning for transitions through experimentation

As mentioned in the introduction, an aim of this paper is to conceptualize and articulate a strategy for learning for transitions through experiments. This conceptualization and articulation could help to intentionally organize learning for transitions through experimentation, since, as highlighted in Section 2, learning and change through experimentation does not happen spontaneously (Wolfram, 2016; Beers et al., 2014; Leeuwis, 2000; Loeber et al., 2007; Luederitz et al., 2017; Majoor et al., 2017; Van Mierlo and Beers, 2018; Smith and Raven, 2012).

Combining insights on learning from transition studies and the ELT, we propose a synthesized strategy for guiding learning in the context of an urban experimentation program, based on the components and principles in Table 1. This strategy should be interpreted as a set of guiding principles, that practitioners can use for inspiration when designing and developing a strategy for learning, adjusted to their specific urban experiment context. It is therefore framed as a narrative, highlighting what should be done when setting-up an urban experiment, considering the generated insights on learning.

<u>Conditions for learning</u>

- When setting-up an urban experiment, aim to start a joint experiment program with related experiments [B.6].
- Think of a strategy for joint learning for transition throughout the experiment process [B.9, B.11].
- Formulate explicit learning goals [B.1].
- Involve someone to monitor the learning and transition process and outcome [B.8, B.9].
- Involve a moderator who mediates between participants with diverse backgrounds, is sensitive to creating a sense of urgency, group commitment, fairness, transparency, competence, and connects knowledge of participants related to different ELT quadrants (like, connecting academia to the practical know-how of practitioners, and vice versa); [B.5, B.7, B.11].
- Set-up a scheme for regular and irregular (on-demand) learning events for individual and collective learning; ensure time, budget, and management support for joint learning [B.2].
- At these learning events, have individual and interactive learning exercises for sharing concrete experiences and reflections (e.g., storytelling, site visits), co-creating experiment set-ups, actively participating in experiment applications, and adapting experiences to new contexts (e.g., through training or a manual with strong iconic and communicative aspects). These exercises should help to reflect, conceptualize, act, and experience, and (not necessarily simultaneously) stimulate individual learning and group learning [B.4, B.10, B,11, B.12].

<u>Involved learners</u>

- Form a core group of directly involved participants, who represent the four ELT quadrants [B.3, C.1, C.2, C.5 – C.8].
- More incidentally, involve the immediate professional networks of the core experiment participants (business partners, members of the organizations that employ them, other organizations with which they routinely interact), paying attention to representing the four ELT quadrants [C.1, C.3, C.5 – C.8].
- Interact with society at large [C.4, C.5 – C.8].

<u>Learning process</u>

- Pay attention to the process of deepening by broad, reflective and social learning [A.1]
- Shift the focus of the (individual and group) learning experiences, and learning exercises, along the way: from thinking about the societal problem at early stages of the experiment, to conceptualizing alternatives when the experiment matures, and putting these alternatives into action. [B.4, B.10, B.11].
- Facilitate reflective learning and questioning underlying norms through a moderator who intermediates between diverse participants [A.2, B.5, C.1, C.5].
- Facilitate social learning, involving diverse participants throughout the experiment process, and group learning exercises, intermediated by a moderator [A.3, B.4, B.5, B.10, B.11, C.2, C.3, C.4].
- Enable all experiment actors, intensely or loosely involved, to diverge, assimilate, converge, and accommodate experiment knowledge into action. For this, learning experiences should be facilitated by learning exercises that relate to—and be connected to—the four ELT quadrants. This should enable all actors to reflect on the how and why of an urban sustainability problem, to think about a possible conceptual solution for this, to put this in action, and to experience how this works (or not) [A.4].

4. Conclusion: from formulation to application and testing

This paper was driven from the notion that there seems to be a discrepancy between understanding of the importance of learning as a key mechanism of the transformative capacity of urban experiments, and a lack of learning and reflectivity in the practice of urban experimentation. Forming a strategy for learning in the context of urban experiments could possibly help to narrow this gap. The aim of this paper was therefore to conceptualize and articulate such a strategy by addressing the following question: How to foster learning for transitions through experiments? We answered this question by building on insights from transition studies on learning through transition experiments, complemented with insights on experiential learning from the ELT, as summarized in Table 1, and synthesized the findings into a strategy for learning. This strategy could be interpreted as a set of guiding principles that practitioners could use for inspiration when designing and developing a strategy for learning, adjusted for their specific urban experiment context.

In this synthesis we propose to use these two frameworks complementarily. On the one hand, learning through experimentation in transition studies is mainly framed as a process of deepening through broad, social, and reflective learning, underlining learning as a collective, interactive, and critical event. Learning is advocated as intense, with small, stable groups of committed participants. However, the reality of transition experiments might not always offer ideal conditions for learning, especially when embedded in a broader and societal context. On the other hand, learning in the ELT is seen as an individual journey, through which the learner grasps and transforms different learning experiences into a deeper understanding in interaction with others. It advocates how different participants at different phases of the experiment should have a complete learning experience that touches all four learning stages. Furthermore, the ELT might help to understand how different perspectives of diverse participants could be connected and lead to stronger and richer insights. Finally, the ELT might help to articulate who should participate; bringing in what kind of knowledge and know-how.

As such, we suggest that the ELT could help to facilitate learning in processes of experiment broadening and scaling-up. The two approaches could possibly reinforce each other: by facilitating both collective and individual learning; for all experiment actors, who are intensely or loosely involved; using experiential learning exercises that enable to reflect on the how and why of an urban sustainability problem, to think about a possible conceptual solution for this, to put this in action, and to experience how this (not) works.

A proof of the value of this strategy for learning for transitions through experiments lies in its application; the fourth ELT quadrant. Its effectiveness and contribution to the learning and transformative capacity of urban experiments can thus only be assessed by applying it to actual experiments. In an ideal situation, the strategy should be tested in a case study that incorporates a bundle of related experiments, including the participation of diverse participants who are involved throughout the experiment process, and are engaged through interactive, collective, and individual learning activities, all guided by a moderator. Such a setting would enable the measurement of their learning effects and transformative capacity with respect to a strategy for learning for transitions through experimentation. Our documentation and discussion of the conceptualization and articulation of a strategy for learning for transitions through experimentation in this paper has been conducted in the belief that already sharing this strategy at a conceptual level is in keeping with its spirit, and with the aspiration that this may inspire others to explore experimental learning and transition strategies suitable for their experiments. We hope this paper has set this process in motion, in practice as well as theory.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A: Selection of articles for literature review

Nr.	First author, year of publication, title, online path	Included?
1	Luederitz, 2017, Learning through evaluation – A tentative evaluative scheme for sustainability transition experiments	Yes
	https://doi.org/10.1016/j.jclepro.2016.09.005	
2	Szejnwald Brown, 2003, Learning for Sustainability Transition through Bounded Socio-technical Experiments in Personal Mobility	Yes
	https://doi.org/10.1080/09537320310001601496	
3	Van den Bosch, 2010, Transition Experiments: Exploring societal changes towards sustainability	Yes
	https://repub.eur.nl/pub/20714/	
4	Van den Bosch, 2008, Deepening, Broadening and Scaling up: a Framework for Steering Transition Experiments	Yes
	https://repub.eur.nl/pub/15812/	
5	Van de Kerkhof, 2005, Learning and stakeholder participation in transition processes towards sustainability: Methodological considerations	Yes
	https://doi.org/10.1016/j.techfore.2004.10.002	
6	Thompson, 2007, Statistical Learning of Syntax: The Role of Transitional Probability	No: different topic
	https://www.tandfonline.com/doi/full/10.1080/15475440709336999	
7	Rotmans, 2009, Complexity and transition management	Yes
	https://doi.org/10.1111/j.1530-9290.2009.00116.x	
8	Rosenbloom, 2018, Transition Experiments: Opening Up Low-Carbon Transition Pathways for Canada through Innovation and Learning	No: different focus
	https://www.utpjournals.press/doi/abs/10.3138/cpp.2018-020	
9	Rotmans, 2008, Transition management: reflexive governance of societal complexity through searching, learning and experimenting	No: book
10	Raven, 2010, Strategic Niche Management and Transition Experiments. From analytical tool to a competence kit for practitioners	Yes

(*continued*)

11	Chang, 2009, What can one learn from experiments about the elusive transition state? https://doi.org/10.1110/ps.04713804	No: different topic
12	Porter, 2015, Transition experiments in Amsterdam: Conceptual and empirical analysis of two transition experiments in the WATERgraafsmeer program https://doi.org/10.1016/j.techfore.2014.02.010	Yes
13	Kemp, 2007, Transition management as a model for managing processes of co-evolution towards sustainable development https://doi.org/10.1080/13504500709469709	No: different focus
14	Foxon, 2009, Governing long-term social–ecological change: what can the adaptive management and transition management approaches learn from each other? https://doi.org/10.1002/eet.496	No: different focus
15	Chen, 2006, Market instability and economic complexity: theoretical lessons from transition experiments https://doi.org/10.1142/9789812773234_0003	No: different focus
16	Kelly, 2018, Conceptualising change in marine governance: Learning from Transition Management https://doi.org/10.1016/j.marpol.2018.06.023	No: different focus
17	Engler, 2019, Towards more effective and transferable transition experiments: learning through stratification https://link.springer.com/article/10.1007/s11625-019-00663-2	No: different focus
18	Kemp, 2006, Transition management: a reflexive governance approach	No: book
19	Sakai, 1998, Transition of Brain Activation from Frontal to Parietal Areas in Visuomotor Sequence Learning https://doi.org/10.1523/JNEUROSCI.18-05-01827.1998	No: different topic
20	Huang, 2018, Predicting Gaze in Egocentric Video by Learning Task-dependent Attention Transition https://openaccess.thecvf.com/content_ECCV_2018/papers/Huang_Predicting_Gaze_in_ECCV_2018_paper.pdf	No: different topic

Appendix B: Learning in the context of transition experiments

Literature review: How to learn in transition experiments?	
Paper: first author, year, title	*Luederitz, 2017, Learning through evaluation–A tentative evaluative scheme for sustainability transition experiments*
Concepts on learning, and the learning process	- Iterative and reflective monitoring and evaluation - Facilitating a participatory setting and interactions - First- and second-order learning
Modes, methodologies, and/or conditions for learning	Methods for participation and interaction: focus groups, stakeholder workshops, and more dynamic processes such as participatory modeling; information sharing, consultation, collaboration, and empowerment.
The supposed learners and/or their characteristics	Participants (collaborators) of the experiment
Paper: first author, year, title	*Van den Bosch, 2010, Transition experiments: exploring societal changes towards sustainability*
Concepts on learning, and the learning process	Deepening: a learning process through which actors can learn as much as possible about a transition experiment within a specific context, about all relevant aspects of a societal challenge (e.g., financial aspects, institutional aspects).
Modes, methodologies, and/or conditions for learning	Success criteria for the process of deepening: - allocating resources (time, money, knowledge, etc.) to an open search and learning process - building in space for reflection on and adjustment of the vision and learning goals - organizing a broad, reflexive, and social learning process; - developing supportive incentives/accountability mechanisms that increase the quality of learning - the management guarantees that project results are related to the societal challenge - define learning objectives, regular learning meetings, reporting of learning experiences
The supposed learners and/or their characteristics	- Involve different types of actors in the learning process (e.g., the professionals who actually work with a new practice and the target group themselves) - Select project participants with an open mind and willingness to learn - Feedback learning results to strategic actors (e.g., directors, policy makers)
Paper: first author, year, title	*Szejnwald Brown, 2003, Learning for sustainability transition through bounded socio-technical experiments in personal mobility*
Concepts on learning, and the learning process	- Social learning - Higher order/double-loop learning: changes in the norms, values, goals, and operating procedures that govern the decision-making process and actions of organizations
Modes, methodologies, and/or conditions for learning	- Self-examination, reflection, and change of objectives in response to new developments - Sense of urgency, group commitment, interactions among actors around a shared goal or problem - Structured exercises in visioning, system thinking, mental model building, and trust building - Diffusion of ideas among related bounded socio-technical experiments (BSTE), by innovative couplings of problems and solutions, and by creating links among related experiments
The supposed learners and/or their characteristics	- BSTE participants; - their immediate professional networks (business partners, members of the organizations that employ them, other organizations with which they routinely interact); - and beyond (diffusion of new ideas into society).
Paper: first author, year, title	*Van den Bosch, 2008, Deepening, Broadening and Scaling up: a Framework for Steering Transition Experiments*
Concepts on learning, and the learning process	- Deepening: (social) learning processes, experimenting and learning in niches; developing new ways of thinking (culture), doing (practices), and organizing (structure) - High quality learning: i) broad learning: many dimensions of a problem (e.g., institutional, technological, socio-cultural, environmental,

(*continued*)

	economic) and the alignment between these dimensions
	(ii) reflexive/second-order learning: attention for questioning underlying assumptions such as social values, and the willingness to change course if the innovation does not match these assumptions
	(iii) social learning – a process in which multiple actors interact and develop different perspectives on reality
Modes, methodologies, and/or conditions for learning	- System learning: enabling participants to look at the interrelationships between the structures in which they operate and their own practices in a new light
	- Making space for learning processes
	- Stimulating interaction processes between the experiment and its broader context
	- Actively working on embedding processes to increase the impact of the experiment at a higher level
	- Formulating explicit learning goals that are connected to societal (transition) goals in order to develop new ways of thinking, doing, and organizing
	- Allocating resources (time, money, knowledge, etc.) to an open search and learning process
	- Building in space for reflection on and adjustment of the vision and learning goals
	- Organizing a broad, reflexive, and social learning process
	- Developing supportive incentives/assessment mechanisms that increase the quality of learning
The supposed learners and/or their characteristics	Multiple actors across society
	Project participants with open minds and willingness to learn
Paper: first author, year, title	**Van de Kerkhof, 2005**, *Learning and stakeholder participation in transition processes towards sustainability: Methodological considerations*
Concepts on learning, and the learning process	- Social learning, political learning, government learning, organizational learning, and policy-oriented learning
	- Single and double loop learning
Modes, methodologies, and/or conditions for learning	- Formulating explicit learning goals for transition experiments
	- An open process in which actors are receptive for new claims and ideas
	- An argumentative process in which actors become aware of the assumptions on which their own and other claims are based
	- An intermediary body that acts as a "process facilitator," like a "transition manager"
	- Facilitate the development of future images in combination with interactive backcasting (using a seven-step procedure)
	- Use aspects of process management:
	● Commitment: sufficient opportunities for learning, e.g., in an interesting group, by providing relevant information or by giving sufficient opportunity to initiate transition experiments, "ownership" in the transition process, responsibility for the choices for the organization of the arena, the formulation of a transition agenda, the development of sustainability visions, and the execution of transition experiments.
	● Fairness: (process/transition manager) facilitate an open discussion in which minority viewpoints are not a priori excluded
	● Transparency: (process/transition manager) communicate the objectives, procedure, rules of the game, and time planning of the process to the participants.
	● Competence: (process/transition manager) as an intermediary between academic scientists and the participants in the arena, assesses the broad range of scientific information on the specific transition theme, including the controversies and uncertainties, and makes these available and understandable for the participants
The supposed learners and/or their characteristics	- A group that strikes a balance between heterogeneity (i.e., people with different backgrounds, opinions, and thinking styles) and homogeneity (i.e., people with sufficient communication skills, willingness to invest time and energy, and to integrate aspects of sustainability in their own organizations).
	- Participants who function quite autonomously within their organization and, at the same time, have the ability to convey the developed vision(s) and set it out within their own organization
	- Visionaries and forerunners able to look beyond their own domain or working area, open-minded thinkers
	- Participants with more practical, strategic, executory, and near-term thinking styles
	- Participants who are able to communicate with people from different backgrounds and with different interests and knowledge levels
Paper: first author, year, title	**Rotmans, 2009**, *Complexity and transition management*
Concepts on learning, and the learning process	Social learning processes in transition arenas, as part of transition management
Modes, methodologies, and/or conditions for learning	- interaction and cooperation between different actors involved
	- multiple in-depth discussions, structured according to system approach
	- facilitators synthesize discussions and work toward convergence of perspectives, assumptions, and ambitions
	- continuous monitoring of the transition process itself, the transition management, and transition experiments (with regard to specific new knowledge and insights and how these are transferred, but also with regard to the aspects of social and institutional learning)
The supposed learners and/or their characteristics	Different actors
Paper: first author, year, title	**Raven, 2010**, *Strategic Niche Management and Transition Experiments. From analytical tool to a competence kit for practitioners*
Concepts on learning, and the learning process	A good learning process is:
	- Broad – focusing not only on techno-economic optimization, but also on alignment between the technical (e.g., technical design, infrastructure) and the social (e.g., user preferences, regulation, and cultural meaning)
	- Reflexive – there is attention for questioning underlying assumptions such as social values, and the willingness to change course if the innovation does not match these assumptions.
	- Social – in social innovation, learning is guided by specific social goals and can be characterized as "social learning" – a process in which multiple actors interact and develop an alternative perspective on reality.
	- Deepening, broadening, and scaling up
	- Higher-order learning

(*continued*)

Modes, methodologies, and/or conditions for learning	- Aggregation activities: standardization, codification, model building, formulation of best practices, etc. - Circulation of knowledge and actors is important to enable comparison between local practices and formulation of generic lessons. Conferences, workshops, technical journals, proceedings, and newsletters play a major role therein
The supposed learners and/or their characteristics	Practitioners: any type of actor that is interested in transition experiments from a practically-oriented (non-theoretical) point of view
Paper: first author, year, title	**Porter, 2015,** *Transition experiments in Amsterdam: Conceptual and empirical analysis of two transition experiments in the WATERgraafsmeer program*
Concepts on learning, and the learning process	Deepening, broadening, and scaling up. Learning experiences that are gained in a specific context or niche (deepening) can be used for experiments in other contexts (broadening), and contribute to fundamentally changing the dominant practice into a more sustainable practice (scaling up)
Modes, methodologies, and/or conditions for learning	- Facilitate an open search and learning process: network events, workshops with stakeholders from specific projects - Have a small, stable group of participants - Monitor the actual learning, developing a monitoring approach that supports the steering of the search and learning process - Formulate learning goals and changes in culture, practice, and structure - Set-up an explicit learning trajectory, continual process-monitoring, and context-specific steering through the continual involvement of a group of key stakeholders
The supposed learners and/or their characteristics	Project participants who show ownership, have open minds, are willing to learn, and have the capacity to balance organizational accountability with societal responsibility.

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