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Reflexive use of methods: a framework for navigating different types of knowledge and power in transformative research

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Abstract

In transformative sustainability science, reflexivity is considered critical for ethically sound and socially relevant research. In practice, many transdisciplinary knowledge co-production processes have faced problems in mitigating power hierarchies among the participating actors and the different types of knowledge. In this paper, we develop and test a reflexive framework that enables transdisciplinary researchers to convey more explicitly how their methodological choices play a role in im/balancing power relations in knowledge co-production. The reflexive framework allows researchers to distinguish the different types of knowledge co-produced by the methods, as well as tracking the movements between them. We utilize the framework to reflect upon the methodological choices made through the application of three different transformative methods, namely the Transition Arena, Theory of Change, and Participatory Food Sustainability Assessment and Transformation Framework in different contexts. The results illuminate how the agility between the knowledge types is critical for navigating tensions in power imbalances, as well as producing transformative knowledge. Moreover, the results call further attention to the co-production of critical knowledge in sustainability science.

Keywords Transdisciplinary research · Knowledge co-production · Power · Reflexivity · Methodology

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Introduction

Transformative research on sustainability is committed to engage with inequalities in distribution of power and knowledge. Recently, an increasing number of researchers have focused on the ways in which power inequalities and tensions between actors could—and indeed should—be better considered as part of the multifaceted knowledge co-production in sustainability science (e.g., Bartels and Wittmayer 2018; Chambers et al. 2022; Klenk 2018; Staffa et al. 2022; Turnhout et al. 2020). Such iteration requires a self-critical reflection on how research and its methods take part in the co-production of transformative knowledge and navigation of power im/balances (Kaljonen et al. 2019; Popa et al. 2015; Schneider et al. 2019a; Wittmayer and Schäpke 2014).

Transformative research necessitates transdisciplinary and action-oriented approaches, where researchers take more active stands in solving sustainability problems together with practitioners (Caniglia et al. 2020; Chambers et al. 2022; Hirsch Hadorn et al. 2006). Studies on transdisciplinary practice have drawn attention to the various roles that researchers can—or should take—in knowledge co-production (Bulten et al. 2021; Korhonen-Kurki 2022; Peltola et al. 2023; Pohl et al. 2010; Wittmayer and Schäpke 2014). Apart from the traditional role of providing knowledge, researchers can act as knowledge brokers, process agents, and change agents (Wittmayer and Schäpke 2014)—or process designers, capacity builders, and critical researchers (Peltola et al. 2023). By taking on more active roles, these transdisciplinary researchers can attempt to make an impact, as well as assume power. The various roles taken by the researchers, however, may allow different routes for such attempts. As knowledge brokers, researchers are assumed to remain neutral regarding their own values, while holding a potentially powerful role in guiding the process. As change agents or capacity builders, researchers may actively pursue change according to their own values and navigate the power relations in knowledge co-production accordingly. When acting as process agents or designers, researchers may facilitate mediation between different actors, and, by doing so, support more inclusive knowledge co-production processes and institutions. As critical researchers, researchers may strive to challenge the mainstream policy or action by assessing prevailing ideas and aspirations, envisioning alternative ways of thinking and acting, and nurturing critical publics (Horkheimer 1939).

The studies on the research praxis underline tensions between these researchers' roles, the actual shaping of the research process, and the transformations achieved (Bulten et al. 2021; Peltola et al. 2023; Turnhout 2013; West and Schill 2022; Wittmayer and Schäpke 2014). The tensions derive from the different assumptions about what is right, valid, and reliable knowledge behind the various roles of researchers (Kaljonen et al. 2019; West and Schill 2022). Despite the growing interest in the changing roles of the researchers, the methodological choices and the praxis of methods have received surprisingly little attention in the literature. In this paper, we call more attention to the practical methodological choices that researchers make during their research, as well as the selection and use of methods. These methodological choices can play a critical role in mitigating the power im/balances in knowledge co-production and mobilizing transformative knowledge for action.

Chambers et al. (2022) have introduced the concept of co-productive agility to study the actual processes in navigating tensions between different kinds of actors in knowledge co-production processes. The concept of co-productive agility puts power relations at the center of knowledge co-production, and investigates multiple ways by which these emergent tensions can be harnessed for transformative action (see also Avelino 2017). Co-productive agility may differ considerably, depending on how the position of actors and their knowledge are navigated during the process. In this paper, we develop the understanding of co-productive agility one step further into a reflexive framework that can assist researchers in becoming more attentive to the ways in which their methods and methodological choices lend a hand in navigating tensions between different types of knowledge (Caniglia et al. 2020). This addition is critical, as it helps to explain how the methodological choices of producing particular types of knowledge and the movements between them matter for co-producing transformative knowledge.

In the following section, we introduce the reflexive framework and examine how it enables to track down the movement between the different types of knowledge in the application of three different methods, which have been developed to mobilize transformative knowledge for sustainability. The methods under scrutiny are Transition Arena (TA) (Frantzeskaki et al. 2018), Theory of Change (ToC) (Deutsch et al. 2019; Oberlack et al. 2019), and Participatory Food Sustainability Assessment and Transformation Framework (FoodSAT) (Rist et al. 2021). Although all these methods are oriented towards sustainability transformation, they differ in their methodological assumptions on the types of knowledge required for transformation action. The results of the ex-post evaluation of the methods highlight the different combinations by which transformative knowledge could be co-produced or resisted. We close the paper by discussing how the reflexive framework could be utilized to harness the fuller potential of critical knowledge in sustainability science.

Reflexive framework

Methods function as researchers' tools to collect and organize knowledge systematically. Scientists' and societies' assumptions on what reality is (ontology) and what adequate knowledge is (epistemology) guide their approaches and methods for acquiring knowledge (West and Schill 2022). Transformative methods actively seek solutions to real-life problems and contribute toward a more sustainable society. In this respect, they take a performative position to ontology and knowledge production. In such an understanding, the methods should also be developed and applied to allow iteration, learning and acting upon the subject of research. Reflexivity, i.e., the "ability to reflect critically on our methodological choices, our aims and intentions in our research, and the kinds of social effects and realities that our research might help to bring about" (Montana et al. 2020, cited in West and Schill 2022, p. 9), becomes a crucial skill in the production of transformative knowledge. Reflexivity holds significance in dealing with epistemological differences in knowledge and values underpinning assumptions in sustainability problems, along with perpetuating power imbalances (Bartels and Wittmayer 2018; Fazey et al. 2018; Finlay 2002; Morris et al. 2021; Popa et al. 2015; Schneider et al. 2019b; West and Schill 2022). In transformative research reflexivity is a fundamental source of innovation, novel values, and knowledge for real-life problems (see also Caniglia et al. 2023).

Chambers et al. (2022) have introduced a concept of co-productive agility to foster the understanding of such knowledge co-production processes. Co-productive agility draws attention to the actual processes and roles in navigating the tensions between different actors in knowledge co-production. The concept of agility puts power relations at the center of knowledge co-production, and investigates multiple ways by which the emergent tensions can be turned into transformations. The co-productive agility may differ considerably, depending on how the different positions of actors are navigated during the knowledge co-production. In their examination, Chambers et al. have not focused on methods as such. In what follows, we develop the understanding of co-productive agility further into a framework that allows researchers to become more reflective upon how they participate in the navigation of tensions with their methodological choices.

In explicating the reflexive framework, it is first important to define the understanding of transformative knowledge and transformative power. Chambers et al. define the co-productive agility as "the constructive exploration of tensions that support transformation in roles, paradigms, relationships and structures" (Chambers et al. 2022, p. 3).

Importantly, from the perspective of Chambers et al., tensions are productive for transformation. The understanding of tensions builds on the concept of agonistic public space by Mouffe (2013), where the primary purpose of politics is not to seek consensus, but rather to learn to stay with the trouble and discomfort it brings (see also Harraway 2016). The co-productive agility directly examines these interactions by asking how to navigate "tensions and power dynamics among diverse actors to create broad ownership and action for transformative social-ecological change" (Chambers et al. 2022, p. 2).

The understanding of co-productive agility put forward by Chambers et al. resonates with Avelino's (2017) relational understanding of transformative power (see also Avelino 2021; Barnes 1988). For Avelino, transformative power refers to the actors' capacity to develop new structures and institutions. Avelino underlines how the new structures and institutions should be understood in terms of renewed and reconfigured, i.e., significantly challenging, altering and/or replacing existing institutions and structures (ibid. p. 509). She distinguishes the capacity to transform structures as something qualitatively different from the power to reinforce structures. Transformative power relies upon the "capacity of actors to mobilize resources and institutions to achieve a goal" with the others (ibid. p. 507). Avelino also introduces innovative power, which refers to the capacity to create new resources, such as knowledge with others. Innovation, in this thinking, refers to Arendt's (1958, p. 200, cited in Avelino 2017, p. 509) notion of the capacity of humans to be original and create something new "in concert" with others. Importantly, a new resource is powerless if it is not visible to plural actors.

Transformative and innovative perspectives regarding power are important for understanding co-productive agility and transformative knowledge. Transformative knowledge can be realized only with others, and by navigating social relations. Based on 32 international case studies, Chambers et al. (2022) have distinguished between four different pathways for co-productive agility, which all navigate the tensions between actors and power in distinct ways (Table 1). Firstly, in *elevating marginalized agendas*, knowledge is used to make voices heard, which might not be heard in current decision-making processes. This pathway challenges power distribution through questions, such as: who is marginalized and should be heard, who decides about that, and what would happen with changed power dynamics? Therefore, the pathway of *elevating marginalized agendas* is especially important in settings characterized by social inequalities and injustices. Secondly, *questioning dominant agendas* raises critique, in addition to deep reflections with powerful actors about how to initiate more inclusive actions in dominant systems. Self-reflection and learning are at the core of this pathway, which pertains to the task of determining

Table 1 Collaborative pathways for co-productive agility (Chambers et al. 2022)

Pathway for co-productive agility	Description
Elevating marginalized agendas	Supports marginalized actors to elevate their own perspectives and claims in ways that maintain integrity while broadening the struggles for justice
Questioning dominant agendas	Deeply engages actors who hold stakes in dominant systems by reflecting on their agendas and exploring more inclusive actions
Navigating conflicting agendas	Embraces the political aspect of bringing actors together to decide upon and undertake transformations to interlinked paradigms, relations, practices, policies, and institutions
Exploring diverse agendas	Connects actors through exploratory processes that do not aim to empower any particular agenda, but rather foster a mutual understanding and respect for a plurality of perspectives

Table 2 Types of knowledge supporting actions for sustainability (Caniglia et al. 2020, p. 96)

Purposes of action-oriented knowledge	Types of knowledge	Description
Knowledge informing intentional design	Generative	Knowledge that draws upon and engages with multiple perspectives for the creation of alternative social–ecological, institutional, and cultural arrangements
	Prescriptive	Knowledge that informs recommendations about more desirable options to realize intentions, which guides and inspires actors in creating change
	Strategic	Knowledge that defines the priorities of action for the realization of intentions
Knowledge enhancing shared agency	Critical	Knowledge that questions existing institutions, interrogates prevailing power asymmetries, and contests conventional assumptions and values
	Empowering	Knowledge that enables an agency, builds capacities, and supports actors to realize intentions in favor of new alternative social and political orders
	Co-produced	Knowledge that emerges from collective processes, includes different actors, and incorporates their diverse and divergent perspectives, views, and interests
Knowledge enabling contextual realization	Emergent	Knowledge generated in open-ended and exploratory cycles of intervention, reflection, and evaluation to identify action pathways, while also improving an understanding of how to respond to new experiences, altered interpretations, and changed circumstances
	Tactical	Knowledge that supports actors in advancing toward the realization of change by creating alliances, capitalizing on existing resources and opportunities, and adapting to the realities of local contexts while considering the short and long-term effects of interventions
	Situated	Knowledge that emerges from and is often tailored to specific contexts, which is essential for taking action adaptively in response to changing circumstances

which dominant agendas currently create unjust power relations. Thirdly, when *navigating conflicting agendas*, the knowledge co-production aims at bringing conflicting views and agendas of different actors together to promote sustainability transformations. This pathway engages in questions around how unjust relations are created and how different actors can become accustomed to contestation in change processes. Lastly, *exploring diverse agendas* focuses on a mutual understanding of different ways of knowing and doing, as well as joint learning.

The differentiation between the pathways highlights well how transformative power and knowledge can be achieved by differently navigating the tensions between the actors and their agendas. The roles of different types of knowledge, however—and somewhat surprisingly—are not explicitly addressed in the pathways introduced by Chambers et al. We suggest that a more detailed classification of different types of knowledge is essential if we are to become more reflexive upon how our methodological choices engage in and affect the navigation of power im/balances. The classification between different purposes of action-oriented knowledge, as introduced by Caniglia et al. (2020), is useful for such reflexive exercise.

Caniglia et al. underline that action-oriented, transformative research should produce knowledge that (1) inform an intentional design, (2) enhance a shared agency, and (3) enable a contextual realization (Table 2). Caniglia et al. underline that knowledge enhancing shared agency is the
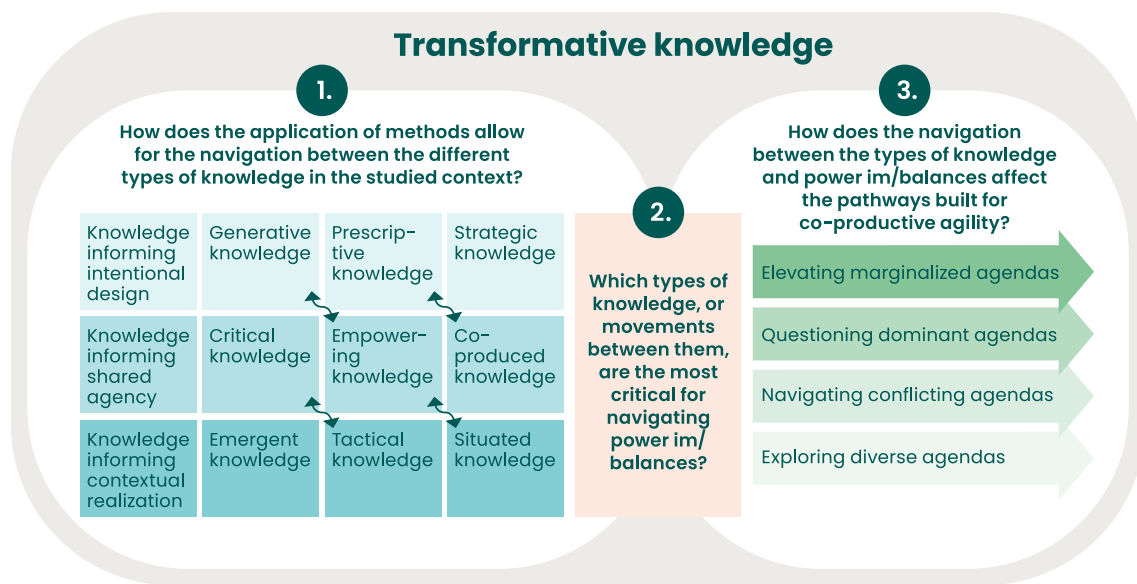
Fig. 1 Reflexive framework

most critical in addressing power im/balances in sustainability science. Knowledge enhancing shared agency can navigate power im/balances by being critical, empowering, or co-produced. Critical knowledge aims to question the existing institutions, empowering knowledge aims to give voice to the less powerful and build capacities, whereas co-produced knowledge aims to incorporate diverse and divergent perspectives and interests. All these types of knowledge may perform transformative power, but with different motivations. The transformativeness of knowledge for enabling shared agency may be strengthened if it can align with other types of knowledge informing intentional design and enabling contextual realization. Knowledge informing intentional design may be either generative, prescriptive or strategic; whereas knowledge enabling contextual realization may be emergent, tactical or situated by nature. Movement between these types of knowledges requires methodological choices by the researchers. In the meantime, researchers need to consider how their methods navigate the power im/balances at stake. The methodological choices may alter the power constellations decisively.

In what follows, we bring the frameworks developed by Chambers et al. (2022) and Caniglia et al. (2020) into a reflexive framework that aims to assist researchers in becoming more reflexive about how their methodological choices matter for the navigation of power im/balances in transformative research. The reflexive framework (Fig. 1) lays out the following questions for researchers to reflect upon: (1) how does the application of methods allow for the navigation between the different types of knowledge in the studied context?, (2) which types of knowledge, or movements between them, are the most critical for navigating and balancing power imbalances?, and (3) how does this affect the pathways built for co-productive agility?

The reflexive framework is meant to pay more specific attention to the different types of knowledge in the navigation of power im/balances. The reflection and ability to move between the different types of knowledge is essential for choosing the right method for the right purpose, and in adapting the methods to the power imbalances at play in different contexts. We want to highlight that a clear distinction of the knowledge types and their forms will be challenging, as they overlap and the transitions from one to the other can be fluid. As also Caniglia et al. (2020) stress, it is important to treat the knowledge types as interwoven and multiple rather than singular or separate. The movement between the different types of knowledge may eventually become the most important function of the methods in navigating the power im/balances for transformative knowledge.

Description of the transformative methods reflected upon

In this paper, we test and utilize the reflexive framework in assessing how the application of three different transformative methods allowed the navigation between different types of knowledge in the various case study contexts. The methods scrutinized below are chosen to represent different orientations towards the co-productive agilities. We reflect on the Transition Arena (TA), Participatory Food System Sustainability Assessment and Transformation (FoodSAT),

Table 3 The transformative methods and the case study contexts

Method	Transition Arena (TA)	FoodSAT	Theory of Change (ToC)
Background of the method	Sustainability transitions research	Participatory action research	Project management and impact
Research project	Collaborative remedies for fragmented societies	Towards food sustainability	Managing telecoupled landscapes
Location of research	Finland	Bolivia, Brazil, Colombia, Ghana, Kenya, Zambia	Madagascar, Myanmar, Laos
Duration	1/2020–9/2020	1/2018–8/2021	1/2015–6/2021
Why the method was utilized	To provide a systemic understanding of different stakeholder positions in engaging citizens to energy transition in Finland. To develop policy recommendations and to navigate the roles of key ministries	To provide evidence-based empirical knowledge on practical and policy options to make specific food systems more sustainable	To enhance learning and foster North–South partnerships and societal effects of transdisciplinary research. To systematically scrutinize and design pathways to impacts
Researchers' role in utilizing the method	To initiate dialogue between stakeholders, adapt the method to the context of citizen energy, invite participants, facilitate the process, synthesize and communicate the main messages	To facilitate a co-creation process with local actors directly involved in a specific food system for the collective action to implement solutions that contribute to as many dimensions of food sustainability as possible	To define an overall theory of change for the project, to design and monitor the progress, reflect and re-design the contextualized versions adapted to different situations in each country together with researchers of the three case study countries
Participants	Seventeen stakeholders representing civil society, public sector, business and ten researchers as facilitators. The participants were invited as individuals, not representatives of organizations. The key ministries acted as a host of the citizen energy TA	Actors along the agri-food value chains, whose livelihoods depend directly on the respective food systems. Supporting actors, e.g., policy makers, NGOs, or business representatives. Participants were different in each context, but generally 15–50 people connected to and interested in the local food system	Researchers associated with the project in Myanmar, Laos, Madagascar, and Switzerland

and Theory of Change (ToC) methods (Table 3).[1] The three methods have their origins in different disciplinary backgrounds, but they all share the aim in co-producing transformative knowledge for sustainability.

Originating from sustainability transition and transition management studies (Köhler et al. 2019), the Transition Arena method has been developed to explore and create momentum for innovations in sustainability transitions (Beers et al. 2019; Loorbach et al. 2015; Lukkarinen et al. 2023; van Poeck et al. 2017). Rooted in participatory action research (Chevalier and Buckles 2019; Wakeford and Sanchez Rodriguez 2018), the FoodSAT methodology has been developed to bring academic and non-academic actors together in fostering the sustainability of a specific food system (Llanque et al. 2021). Although Theory of Change was originally developed as a project management tool for creating an impact (Oberlack et al. 2019), it has also been applied to research lately (Deutsch et al. 2019; Rajala et al. 2021; Tribaldos and Schneider 2021). In research, Theory of Change has been used to enhance the learnings about promising impact pathways by exploring and emphasizing the epistemological and ontological assumptions of researchers about how research can contribute to sustainability transformations, as well as support the evaluation of effective impacts.

Lukkarinen and Peltomaa applied the Transition Arena method in early 2020 in a scientist-initiated process, where they explored Finnish citizens' roles in the ongoing energy transition (Lukkarinen et al. 2023; Lähteenoja et al. 2022). Transition Arena was established to deliberate upon the diverse positions the citizens may have in the production, saving, and consumption of sustainable energy. The Transition Arena included stakeholders across civil society, businesses, and the public sector. It was hosted by the Ministry of the Environment and the Ministry of Economic Affairs and Employment and facilitated by researchers. The main role of researchers in the process was to mediate the participants' different views toward a shared vision and action, providing a balanced space for voicing critical views and synthesizing the main outputs. The Ministries were engaged in the process to foster the tactical realization of the transition pathways.

Jacobi tested and developed the FoodSAT method in 13 different case studies of food systems that were part of the "Towards Food Sustainability" project between the years 2015 and 2021. In all cases, the group was formed with actors who were already involved in some critical discussions about their food systems and where some of their initial transformational efforts took place. Local actors, such as farmers, food workers, land owners, local politicians, restaurant owners, market vendors, and people involved in processing food, just to name a few, were involved from the start. Higher-ranking politicians, larger civil society groups, or private sector related individuals were sometimes involved at later stages. Scientists brought in state-of-the-art data on food systems from a global perspective, provided a comparison with other similar processes, and networked with other actors. In this sense, the role of the scientists in the process can be described as process agents or designers. Methods in the process included a participatory food system mapping, rating of specific food system indicators, and collective deliberation on the problems and actions required (Jacobi et al. 2019; Llanque et al. 2021). A policy coherence discussion was added to some of the cases to identify which policies were helpful and which were detrimental to the sustainability of the food system. The outputs of the process consisted of an implementation plan and the collective action that arose from (or had already started before) the reflective process (Rist et al. 2021).

Schneider and Zaehringer applied the Theory of Change approach in a six-year, transdisciplinary research project on "Managing telecoupled landscapes" in Madagascar, Laos, and Myanmar.[2] Throughout the project, the Switzerland-based research team worked closely with research partners in these three countries, with the goal to devise and test innovative strategies and institutional arrangements for securing ecosystem service flows and human well-being within and between telecoupled landscapes. ToC was applied at several stages during the project: firstly, in the proposal stage, the researchers from Swiss institutions drafted a ToC based on existing theories and literature about transformative change, which was applied to interventions in telecoupled social–ecological systems in forest frontier contexts. Secondly, with the research partners from the countries, the overall ToC was contextualized within the specific situation in each of the three countries and concretized by specific participatory research activities. This step was informed by the local knowledge of the partners, and later refined by the empirical insights gained throughout the research process. The implemented activities were systematically monitored and the outcomes were reflected in the country teams, as well as the international consortium. Thirdly, the ToCs were further concretized to identify, co-design, and test specific transformative actions, which were based on the previous research insights. In two countries, this process was repeated for additional follow-up transformative actions.

In what follows, we evaluate how the use of our methods allowed us to navigate power relations by mobilizing and

navigating between distinct types of knowledge in these case study contexts. Each of the researchers reflect the navigation between the types of knowledge with the help of the questions posed by the reflexive framework (Fig. 1). The questions are used as guides for ex-post reflection, leaving room for meaningful contextualization. The ex-post reflection of the cases was carried out by researchers in several iterative rounds, including discussions between the researchers and the comparison of the cases.

Navigating tensions with methodological choices in different research settings

Exploring diverse agendas with the help of the Transition Arena

The Transition Arena method has been developed to elevate marginalized agendas and for empowering niche actors for sustainability transition. The method is based on the description of different pathways (or agendas) for change and backcasting actions in relation to these. The contextual realization of pathways has, however, remained an ongoing challenge. Moving from emergent to tactical and situated knowledge is often not as easy as it would be envisioned. This was also the case in our citizen energy transition arena.

Navigating between different types of knowledge and power imbalances

We started off the Transition Arena with a collective problem-mapping, after which we moved to a co-creation of transition pathways, and finally to a joint deliberation of key policy messages. In the first step, the participants were given room to share their individual views regarding the main drivers and barriers of citizen engagement in the energy transitions. The task was further specified to the role of housing companies, as they hold significant potential for supporting energy actions in housing, as well as the citizens' energy actions (see Laakso and Lukkarinen 2022). While we researchers suggested a quantified target for the share of citizen energy in energy production in 2035,[3] approximately half of the participants challenged this and preferred to set the target for a number of housing companies engaged in energy action in Finland. Eventually, we decided to include both these complementary targets to navigate between the different strategies. In the second step, the participants were split into four groups that constructed their own transition pathways, explicating the actions required for achieving the goals. The groups were formed to include different

stakeholders and viewpoints. In this way, the conflicting statements could be navigated as policy challenges needing attention in the respective pathways.

Despite working toward the same targets, the pathways produced by the groups turned out very different in the end. The four pathways described the roles of knowledge, state, markets, and land-use planning in transitions in a very different manner.[4] The pathways provided important generative and prescriptive knowledge for informing the intentional design of citizen energy actions. In the final step, as we defined the policy recommendations and directions for future actions, the generative and prescriptive knowledge became interlinked with the strategic and emergent knowledge informing the contextual realization of transition pathways. The policy recommendations that were formulated underlined the need for a systemic steering of action at the individual level with respect to citizens' skills, capacities, and knowledge, as well as coordinating policy support. Effectively, this pointed toward a gap in strategic action and the need to further develop the energy service markets and tailored support and capacity building for citizens. It needs to be pointed out, however, that toward the end of the process, the engagement of the representatives of ministries and business advocacy coalitions lessened and some even dropped out. This obviously affected the final policy recommendations.

Reflection on outcomes

In citizen energy arena, the generative and prescriptive knowledges co-produced by exploring the diverse pathways were important in grasping the new policy problem at hand. This observation was also supported by the participant interviews (Lähteenoja et al. 2022). The complex and systemic nature of the envisioned change required agility from us researchers in accommodating the generative, prescriptive, and emergent knowledges in the building of pathways. This agility clearly supported the institutional reflexivity and building of the intentional design for citizen energy action.

With regard to contextual realization, the Transition Arena was, however, only able to co-produce emergent knowledge. This was partly due to the predetermined structure of the methodology. Moreover, despite the strategic intent of the process, the participating actors were not

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[3] 2035 is the target year for Finnish carbon neutrality defined first in the Government Plan from 2019.

[4] Each pathway had generated their own transition logic—firstly, favoring the development of energy service through public intervention in the education of skilled labor and better information support; secondly, focusing on a strongly coordinated top-down policy steering and the development of step-by-step roadmaps for transitions; thirdly, emphasizing the emergence of digital data and data-driven market developments in the transitioning energy markets; and lastly, illustrating the needed changes in the local practices and land-use policies to enable action.

open to taking a strong initiative on advancing the transition, resulting in the lack of tactical knowledge essential for practical interventions and resource mobilization. To some extent, this is also due to the incumbent actors representing their policy sectors and having limited possibilities to alter the official policies. In this respect, the co-produced knowledge was not able to support contextual realization as far as it was envisioned in the beginning. Exploring different agendas revealed the conflicting agendas, but the process merely dissolved them into competing policy challenges rather than managing to enhance a shared agency through co-produced or empowering knowledge. The generative and prescriptive knowledges were not compatible enough to dismantle the dominant technical narratives on energy system changes and the promotion of alternative frames. In this respect, the power imbalances stayed intact.

Elevating marginalized agendas with FoodSAT

The FoodSAT methodology has been explicitly developed to empower marginalized agendas for the food system transformation. This necessitates working directly with actors and groups who already have a common problem or goal. In our case, we worked with actors who already held critical knowledge on their food systems and applied the transdisciplinary FoodSAT methodology with an aim to empower their goal, leading to transformative action. During the process, we learned that prescriptive knowledge is also necessary to co-create reflective collective action. The multiple phases of FoodSAT should be tailored in order to navigate between these different types of knowledge for elevating marginalized agendas.

Navigation between different types of knowledge and power imbalances

From the different applications of the FoodSAT framework (Llanque et al. 2021), we saw that knowledge supporting a shared agency was incipient or partly existent in all contexts where the framework was used because we worked with initiatives that had already formed or were about to start, and the respective actors knew, at least partly, what they wanted to achieve. In particular, we encountered situated knowledge—which is important for the contextual realization of sustainability transformations—and prescriptive knowledge on desirable options and with narratives of change, which can inform an intentional design. During the reflexive process of the FoodSAT assessment, in which different actors jointly analyzed and took action over the course of six months regarding the food system and relevant needs, the participants adjusted priorities and added aspects of a different food sustainability dimension that was not previously

noted, e.g., the link between traditional cheese production and diversified cultural and resilient landscapes.

In Santa Catarina, Brazil, we studied the local food system with family farmers who advocated for their traditional raw-milk cheese to be legalized in the local food market. The production, distribution, and consumption of this food heritage was prohibited due to food safety concerns, disadvantaging local, diversified family farmers and benefiting industrialized, non-local products. What the FoodSAT activities added was a joint critical reflection on actors, root causes, possibilities, and synergies in the transformation process toward legalization. This reflection and consolidation of (preexisting) critical knowledge was followed by a co-production process of empowering knowledge, where the actors visited different key stakeholders of the local food system beyond farming (e.g., shops, policy makers, Slow Food members), thereby completing their cognitive map of the food system by better understanding its structures and influencing factors. The next step, the review of the framework indicators of the five dimensions (right to food, food security, poverty and inequality, resilience, and environmental performance), contextualized the tool, making it applicable and meaningful to the food system around the topic of raw milk cheese as a symbol for family farmers' struggles in the south of Brazil. The collective rating of the indicators helped to search for strategies to tackle root causes of unsustainability, thereby strengthening the linkages from critical to empowering knowledge. By building alliances, creating awareness through events and social media, and advocating with policy makers at different levels, the group eventually achieved their goal, and the discriminatory law was changed in 2019.

Another example of how the FoodSAT method influenced co-productive agility was the application of the framework in the Municipality of Samaipata, located between the Amboró National Park in the tropical Andes and Bolivia's largest city, Santa Cruz de la Sierra, which is also known for its predominant soybean production and agribusiness sector. The process accompanied a development project by the municipal government, consisting in the widespread installation of rainwater harvesting and irrigation systems in all 14 communities of the Municipality. Our joint activity focused on strengthening the resulting productive capacity toward agroecological methods for improving local food sovereignty, e.g., by using farmers' seeds and avoiding pesticides or synthetic fertilizers.

An important co-produced component of this FoodSAT-process consisted in establishing and improving the links with consumers (referring to individuals, households, restaurants, and the public sector) in the nearby metropole of Santa Cruz de la Sierra, where the demand for organic food has been growing. Another form of knowledge that was also important from the start, but not as clearly shaped as

in the above-mentioned example from Brazil, was again the prescriptive knowledge on desirable options and intentions. While the producers knew that the new infrastructures would open up productive possibilities, and that the governmental program "mi Agua" required the implementation and usage to be in harmony with Mother Earth (in accomplishment of the 2012 framework law on the rights of Mother Earth), the rejection of pesticides was brought up by some community members, but later adopted by the whole group when designing their collective action package together. It consisted in courses on agroecological methods, improving connections with buyers in Santa Cruz, and exchanging visits with other Municipalities that shared similar interests and projects, e.g., on apple production or on the maintenance of the water harvesting infrastructures.

Discussing and refining together what a sustainable food system should look like, in addition to the common vision that the participants chose to pursue, was an integral part of every process, leading to an examination of dominant narratives, e.g., about the economic superiority of agro-extractivism or export-oriented production over local food sovereignty. We interpret this development as a convergence of the prescriptive, strategic, and situated knowledge from previous activities with the emergent knowledge from the FoodSAT process, resulting in a co-produced gain in agility.

Reflection on outcomes

The main learnings for the academic researchers from the overall project can be summarized in a threefold manner. Firstly, in the different contexts of the project, we clearly saw how the biophysical problems of food systems (malnutrition, production, even climate impacts) take root in socio-economic factors that cause vulnerability and undermine resilience-building. This can be interpreted as critical knowledge enhancing a shared agency. These factors often had to do with women's rights and possibilities, as well as traditional food and local seeds (Jacobi et al. 2021). Secondly, local food system actors are not necessarily powerless, as they can become voiceful actors when they organize, build allies with other stages of the value chain, and make their claim. On several occasions, we witnessed that once an activity started, other actors joined or supported them, i.e., financially. We interpret this as empowering knowledge, which is crucial to shared agency. And thirdly, early in the project, at least some prescriptive knowledge regarding the problems of today's food systems is necessary to co-create a reflective collective action process that can transform a food system (more precisely, an aspect thereof), bringing the prescriptive, critical, and empowering knowledge together. Each context brought different ways of knowing, different learnings, and different collective action outcomes, but the economic pressure and the local movements pertaining to their resistance and

struggle for food sovereignty were shared, and sometimes co-addressed among the different project areas.

From exploring diverse agendas to multiple co-productive pathways with Theory of Change

A Theory of Change approach can be used to envision, implement, and reflect each of the four pathways for co-productive agilities (Table 1). By doing so, the ToC approach aims to generate knowledge informing the intentional design of research and transformative action by definition, as well as a shared agency and contextual realization, the latter namely through its adaptation to the contexts and its cycles of intervention, reflection, and evaluation. A shared agency can either be created as a result of the ToC creation process, or created through the implementation of a properly designed ToC in a different context. However, as we will show in the following, these knowledge outputs can be challenging to achieve and need to be seen as part of a step-by-step, iterative process (Schneider et al. 2022).

Navigation between the different types of knowledge and power imbalances

In the beginning of the "Managing telecoupled landscapes" project, the project leaders generated a ToC built on "exploring diverse agendas," with the assumption that from there, a shift in the transformative agency, increased capacity, newly-formed networks, and finally a transformative change would happen. In Madagascar, the Swiss and the Malagasy researchers shared a common understanding of social learning as a basis to establish communities of practice. Nevertheless, they diverged on the type of intervention that would allow them to test the innovative strategies and institutional arrangements aiming for emergent knowledge. Consequently, they developed two different (local) ToCs and related intervention strategies to be applied in the same context. The Malagasy researchers favored a co-production pathway based on supporting the marginalized actors in their desire to diversify crops. This ToC was framed around the assumption that farmers' increased access to agricultural production knowledge provided by agricultural extension agents, as well as sharing their experiences with other farmers in their communities, will lead to more sustainable land management. This assumption might have developed among the researchers due to recommendations provided by available scientific studies on the topic, i.e., a sort of prescriptive knowledge. By monitoring the impact, it showed that empowering and situated knowledge was fostered through the intervention. In contrast, the Swiss researchers preferred a co-production pathway navigating conflicting agendas in the vanilla sector (in the end, affecting the same farmers diversifying their crops). Their ToC aimed to tackle the

processes of power imbalances in value chains and revenues from the high-value cash crop. Again, their thinking was influenced by the emerging concept of telecoupling, and the related scholarly debate, showing how prescriptive knowledge was mobilized in the process. A documentary showing the concerns and priorities of actors along the vanilla value chain was produced and screened in a stakeholder workshop at the district level, together with facilitated discussions on priorities for action. As the subsequent interviews with these actors showed, this assisted in producing generative, prescriptive, strategic, and empowering knowledge through identifying new action opportunities and building new alliances between different actors in the vanilla sector.

In Myanmar, the Swiss researchers quickly learned from the Myanmar researchers that the overall ToC based on exploring diverse agendas needed to be adapted due to the highly conflictive political situation (tactical and situated knowledge). At the time of the project,—shortly after turning to a semi-civilian government and before the 2021 military coup—Myanmar's tumultuous history with a powerful military elite, various rebel groups, and crony (or otherwise profiting) companies was so close, making it impossible and dangerous to organize a multi-stakeholder process and to bring together actors with conflicting agendas (situated knowledge). Instead, the research team jointly developed a new co-production pathway aiming to elevate the marginalized agenda of the farming population. Learning that only seemingly "unpolitical" topics can be debated in public (prescriptive, emergent, and situated knowledge), they started to co-design actions around the topic of sustainable agriculture. Supporting the farmers in their struggle to become more financially independent, the researchers' activities involved the creation of local sustainable development groups, the identification of action opportunities (prescriptive and co-produced knowledge), and the establishment of linkages to a revolving fund system, all supported by a number of targeted training courses (empowering knowledge).

In Laos, Swiss and Lao research partners began with different assumptions about how changes toward more sustainable land systems may unfold, which were strongly linked to the different political systems in place. In a one-party system, such as the one in place in Lao PDR (Lao People's Democratic Republic), exploring diverse agendas is not an easy possibility; it can even be seen as a subversive activity, as only one official policy doctrine is allowed. Hence, the contextual realization of interventions could not adhere to the overall ToC of the project. Their attempt to adapt the ToC to local circumstances, however, did not result in a shared agency between the Swiss and Lao researchers, eventually leading to the creation of two different ToCs. Both ToCs strived to generate empowering and co-produced knowledge. However, the Swiss researchers turned to the international level, planning to organize a multi-stakeholder event bringing Lao and Chinese actors together to exchange knowledge (farmers, traders, government agents, and researchers), while the Lao researchers brought together stakeholders from different sectors at the provincial level in Laos to align their tax collection strategies from export crops. Due to the COVID-19 pandemic, the international workshops planned in China had to be canceled. The workshops at the provincial level led mainly to prescriptive and strategic knowledge. However, with some distance to the ToC exercise, both Lao and Swiss researchers reported substantial learnings that emerged from this experience of applying a ToC approach, changing their understanding of how transformative interventions could be designed and what role social learning can play (generative and prescriptive knowledge).

Reflection on outcomes

The ToC method proved to be very useful in navigating power relations, both within the team of international researchers and the transformative initiatives to be implemented in different national contexts. While the initial ToC built on the "exploring diverse agendas" pathway had to be partly revised due to contextually inadequate assumptions and the differing perspectives of involved researchers, the very method allowed the researchers to reflect upon this situation and make their assumptions explicit and debatable. Throughout the course of the multi-country collaboration in the project, as the team (researchers from all countries visited their partner countries) was exposed to different contexts in Madagascar, Laos, and Myanmar, along with implementing the envisioned actions, the ToCs were expanded; we realized that we would have to move beyond merely exploring diverse agendas, instead tackling the navigation of conflicting agendas or the elevation of marginalized agendas (prescriptive and strategic knowledge). However, this turned out very differently, depending on the specific political context in which the research and implementation took place (emergent and tactical knowledge). It became evident that cultivating safe spaces for learning between stakeholders from different administrative levels and sectors can be a powerful approach in certain contexts, but less so in others.

Discussion

Distinguishing between the different types of knowledge can assist researchers in becoming more attentive to how their methods navigate power imbalances in transformative research. The case studies reflected in this paper show how the navigation between the knowledge types is never linear or predetermined. In fact, it is rather the opposite: the agility to modify the methods in and for the context

is key for accommodating different understandings, positions, and expectations of the participating actors, as well as navigating the power imbalances between them. The navigation between the types of knowledge directly affects the co-productive agilities produced, and may change them accordingly.

Utilizing the reflexive framework can assist researchers in becoming aware of one's own role as a researcher in power dynamics, and how this can change the underlying assumptions of contexts and causal chains (Wittmayer and Schäpke 2014). Power imbalances can also take different shapes, and actors can have different kinds of power, depending on the context and situation. In the application of the Food-SAT method, for example, where power imbalances were more prominent between the different societal actors, the case reflection shows that in addition to empowering knowledge, the elevation of marginalized agendas also required prescriptive and critical knowledge. The FoodSAT method has been designed so that it explicitly allows for the movement between these types of knowledge, and supports critical deliberation processes necessary for jointly determining "what is right and what is wrong" for a specific context and group of actors (Fazey et al. 2018). The reflection on the co-produced knowledge types shows how the knowledge enabling contextual realization benefits from prescriptive and critical knowledge. The combination of these types of knowledge proved especially relevant for navigating power imbalances in knowledge co-production; whilst supporting the building of a wider critical understanding of the context studied and acted upon.

The navigation between the different types of knowledge may also work the other way around, as was the case in the Citizen Energy Transition Arena. In this case, the unrealized move from the generative and prescriptive knowledge to emergent and tactical knowledge proved detrimental to the contextual realization of the diverse agendas. Most importantly, sticking with the emergent knowledge with respect to contextual realization left the existing power imbalances intact. The co-produced emergent knowledge was not able to challenge the prevailing technology-led assumptions, nor to reformulate the role of citizens in energy transitions. The institutionalization of collaborations for transformation has also been recognized as a challenging process by Chambers et al. (2022), when too much emphasis is put solely on knowledge production and confined learning. The learnings from the Transition Arena can help researchers in setting more realistic expectations on what can be achieved with different types of knowledge co-produced with specific methods. Without explicit investments in tactical and situated knowledge, the contextual realization of pathways cannot be achieved. The production of tactical and situated knowledge also requires methodological choices with respect to power relations in place.

The Theory of Change methodology, by definition, seeks to explicate pathways to impact. In this manner, it appears well-equipped for moving between different knowledge types from an intentional design to contextual realization. The ex-post reflection of utilizing the methodology makes this explicit. As the envisioned pathways for co-productive agility changed, the researchers were forced to shift the priorities between the different types of knowledge as well. The political realities in the applied contexts called upon subtle shifts in the uses of knowledge, and in the theories of change. Being attentive to the different types of knowledge co-produced increased the reflexivity of the researchers on these political prerequisites and uses of knowledge in the various contexts. Besides the power issues due to the political context, there was also disagreement between the researchers from different contexts. The resulting theories of change also led to a learning process, which was acknowledged in the ex-post reflection process, and mandated for critical and ethically sound research (Bartels and Wittmayer 2018).

Caniglia et al. (2020) have underlined the importance of critical, empowering, and co-produced knowledge when enhancing a shared agency and navigating power imbalances in knowledge co-production. Our ex-post reflections also draw attention to the role of other types of knowledge in this endeavor. Empowering knowledge may become stronger if supported by prescriptive knowledge. Likewise, the lack of tactical knowledge may hamper the realization of alternative visions or the empowering of marginalized groups.

The ex-post reflection on the methodological choices also reveals how critical knowledge was the most difficult type of knowledge to co-produce in the studied contexts. There is an ongoing debate on whether transdisciplinary research is able to produce critical knowledge together with actionable knowledge, and the results thus far show only little evidence (e.g., Jagannathan et al. 2020). In the cases studied, only the FoodSAT method, which is explicitly aimed at elevating marginalized agendas, was able to co-produce critical knowledge with carefully selected and committed groups of people. In one of the ToC cases, critical knowledge was explicitly declined due to the existing political conflicts. Where the political situation directly risks the life of actors who produce critical knowledge, such a process seems impossible. In other cases, the perceived role of researchers, as well as the degree of self-organization of the societal actors, influenced how much critical knowledge could be co-produced. In cases such as Santa Catarina in Brazil or Samaipata in Bolivia, where strong resistance to the corporate agri-food regime (McMichael 2012) is already in place and the involved societal actors have already engaged in questions of change, producing critical knowledge seems more feasible. In the Transition Arena case, the institutional setting, where the ministry hosted the process, and

the diverse set of societal actors, who participated in the process as individuals and were not self-organized in any way, complicated the co-production of tactical knowledge for contextual realization.

Chambers et al. (2022) underline how, especially in questioning dominant agendas, a prior examination of power relations within systems is critical "to ensure that research questions and designs are not co-opted by powerful actors, thereby further marginalizing groups whose lives are often most affected" (p. 11). The accountability also requires that the shifts in dominant agendas are examined carefully (ibid.), highlighting again the interlinkages between critical and prescriptive knowledge. Staying on track between the movements between the different types of knowledge can aid transformative research and researchers in becoming more equipped and salient in the co-production of critical knowledge. Monitoring the shifts in the problem frames, tracked down by prescriptive knowledge, is an essential part of producing critical knowledge and elevating marginal agendas.

The reflexive framework developed and tested in this paper underlines that in transformative research, we should stop talking about co-produced knowledge in a singular manner. Rather, attention should be directed to the reflexive navigation between the various types of knowledge as they become combined for different contexts with different methods, both by researchers and societal actors. In this respect, the reflexive framework developed in this paper has proven its ability to assist researchers in reflecting on the use and capacities of their methods in this navigation exercise. It needs to be noted, however, that identifying different types of knowledge and navigating between them are not easy feats. It was not an easy exercise for us researchers engaged in this paper as well. The application of the reflexive framework, however, helped us to track down the most critical movements and combinations of knowledge for balancing the power im/balances. In this manner, it proved to be a helpful tool for reflexivity and positioning oneself as a researcher between criticality and relationality (Bartels and Wittmayer 2018).

Conclusion

In this paper, we have developed and tested a reflexive framework that assists sustainability researchers in becoming more explicit in how their methodological choices play a part in navigating power im/balances in knowledge co-production. The reflexive framework allows researchers to track down movements between different types of knowledge in knowledge co-production. Depending on the movements and alignments, knowledge co-production can either succeed or fail in addressing the power im/balances in knowledge co-production. The reflection on the three transformative

methods show how these movements affect the transformative knowledge co-produced.

Such relational understanding between transformative knowledge and power is critically needed in sustainability science. The reflexive framework tested in this paper is developed to assist researchers in distinguishing what kind of knowledge is needed to tackle the power im/balances in transformative questions in place, and how to combine the different types of knowledge for transforming power. The framework can be utilized in the planning stage of research to distinguish the right methods for co-producing the right combinations of knowledge, but also in the implementation phase of the research to keep track of how the different parties claim and utilize knowledge for their interests. For the ex-post evaluation of research, the framework offers tools to analyze how the movements between the different types of knowledge navigate the power im/balances and the transformative knowledge co-produced. Importantly, the framework should be tested for transdisciplinary planning and reflection on methods. Such a move is critical to balance the power positions between researchers and other societal actors in knowledge co-production.

In future, the reflexive framework should be applied to scrutinize more carefully the role of critical knowledge in transformative research. As the results, also presented in this paper, indicate, this type of knowledge appears especially difficult to achieve in collaborative knowledge co-production processes. The results gained from the reflexive evaluation of methods suggest that critical knowledge can become the most transformative in combination with other types of knowledge. These combinations will most likely differ from one pathway of co-productive agility to another. In future, the reflexive framework should be applied further to investigate these combinations in knowledge co-production in order to support sustainability science in its commitment to deliver critical and transformative knowledge.

Declarations

Conflict of 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.

Informed consent The authors of the paper took part in the reflection exercise and carry the responsibility of their interpretations. In the case studies, the consent of the participants was confirmed according

to the scientific ethical principles of the respective country. We have no declaration of interest.

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