A tool for reflecting on research stances to support sustainability transitions

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The success of transdisciplinary approaches to address sustainability problems largely depends on the compatibility between the research stances of the researchers involved. A research stance depends on strategic choices that researchers make doing their research regarding epistemology, methodology and implementation. We present a heuristic tool for researchers to reflect on the choices that define their own research stances. Designed and tested as part of doctoral training, this tool uncovers how research choices can lead to a wide range of research stances about a situation that requires action. Our tool allows researchers to articulate and discuss their research stances, to facilitate their management within a project. It is also useful to understand the relevance for action of the knowledge they generate.

Sustainability transitions aim to improve a way of life that is no longer considered sustainable. Unsustainability is a property of many situations in which human activities have created economic, environmental and/or social deadlocks. They are considered indeterminate situations in the sense of the pragmatist philosopher John Dewey[1]: we know that we cannot keep doing things the same way but we don't know how to do them differently. These situations are complex, uncertain and ambiguous[2–4]. Ambiguity refers to the controversies arising from multiple interpretations of the problem and its potential solutions[5]. These situations cannot easily be translated into well-defined problems that can be dealt with using proven methods. They are what Rittel and Webber call wicked problems[6] which, in addition, are context-dependent and require tailor-made solutions [2–4].

Indeterminate situations are challenging for issue-driven research. They allows researchers to investigate what is at stake in sustainability transitions and to tackle wicked problems. To investigate these situations, researchers design their research in line with what Thomas Kuhn calls a 'disciplinary matrix'[7], i.e., the commitment by scientists to the consensual theories, values, instruments and methods of their disciplines. Each disciplinary matrix involves specific ways of problem framing, investigating, and/or considering proof. The difference between these "matrices" is commonly illustrated by differences between life and social sciences. For example and in simplified terms, regarding a local crisis in water management, ecologists will start their investigation focusing on ecosystems. They will quantify the impact of human practices on their functioning, with experimental and/or modelling approaches, to produce indicators as references for management. Sociologists will focus on social relationships. They will proceed by identifying the actors involved, their position regarding the problem, helping them to redefine the problem and its solutions by dealing with the social process, even if technical knowledge is also involved. Due to these differences, scientific experts, who are expected to ‘speak the truth’ built on objective scientific knowledge, often disagree when it comes to wicked problems[8]. The emergence of such controversies can lead to the rejection of science. Recognition of scientific pluralism is therefore essential to tackle wicked problems so that controversies become a driver of change and not an obstacle[9,10].

To promote scientific pluralism in action, we provide researchers with a tool to enable them to explain their modes of knowledge production (in the sense of Kuhn's disciplinary matrices) in relation to how they envisage such knowledge could be used. This tool enables exploration of what we call “research stances towards action”. We illustrate how it works using the example of a project undertaken with students whose PhD thesis concerns the ecological transition of agriculture (Box 1).

The tool is a heuristic based on extensively debated concepts (explained below). Its originality lies in its ability to get researchers to discover and discuss these concepts, their articulation and the stances they take. Following Donald Schön, the tool invites them to be a *Reflective Practitioner*[11] who questions his or her practices in and on action, and the relevance of the scientific knowledge he or she produces to those who take action. The tool makes it possible to discuss two epistemic uncertainties: the first due to the imperfection of the translation of wicked problems into a scientific issue, and the second due to the hard-to-predict impact of the scientific knowledge used to tackle these wicked problems[12]. It facilitates also debating how to articulate scientific knowledge together with other forms of knowledge. Finally, it lays the foundation for a reflexion on the scientist’s engagement in societal transformations for sustainable transitions.

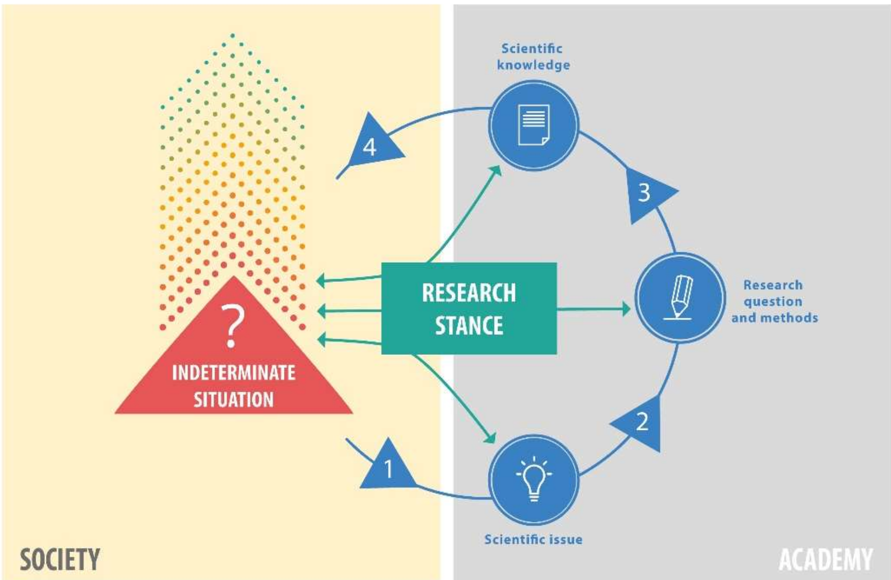

Fig. 1 │ Relationship between a problematic situation in a changing world and scientific investigation. A research stance towards action is the research strategy used to deal with an indeterminate situation. It aims to fulfil both academic requirements and those of the society dealing with wicked problems. It involves the choices made concerning the given situation at all steps in the process of knowledge production, *i.e.* (1) the translation of real-life problems into a scientific issue, (2) the choice of appropriate methods to tackle an addressable question, (3) the production of scientific knowledge, and (4) the use of scientific knowledge to transform the situation.

A heuristic tool to reflect on research stances
The tool questions the interactions between the different steps involved in a scientific approach and the indeterminate situation it studies. At stake is the fulfilment of both academic requirements to produce scientific knowledge and society's requirements for tackling wicked problems by taking relevant actions (Fig. 1). The choices behind these interactions are organised in three main fields: epistemology, methodology and implementation. In each of these areas, a researcher makes choices, which are detailed below and summed up in the heuristic tool (Fig. 2). How the tool works is illustrated using the example of PhD projects conducted by students working on adapting farming to climate change (Box 1).

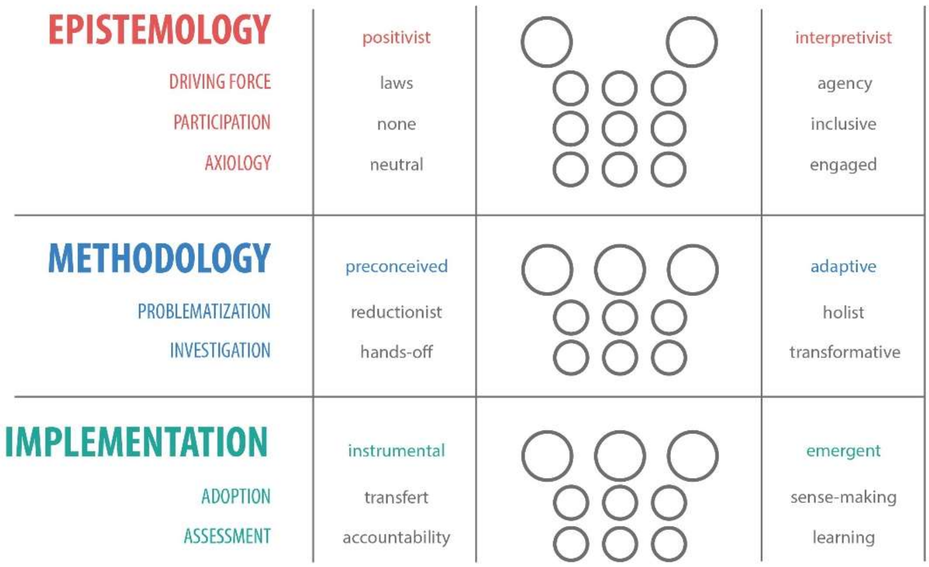

Fig. 2 │ Heuristic tool for discussing a research stance. The different choices which define a research stance are organised in three main fields: epistemology (the nature of the knowledge), methodology (the method of producing the knowledge) and implementation (the use to which the knowledge will be put).

Epistemology
According to Piaget, epistemology refers to what constitutes valuable knowledge[13]. Epistemological frameworks are diverse and they guide most of the choices which determine a research stance[14]. However there is no agreement among scholars on how to classify them[15]. In our tool, the entryway to discuss epistemology is the distinction between two conceptions of scientific knowing based on the investigator's place, which has important methodological implications: positivism vs. interpretivism (Fig. 2). Positivism claims that there is a knowable reality independent of the observer. Scientific investigation then produces a knowledge considered as a univocal description of the world as it exists independently of us. Epistemological frameworks that do not believe in a reality independent of the observer (pragmatism, constructivism, constructionism, relativism, etc.) can be grouped under the term 'interpretivist'[16]. They consider reality as a mind construct derived from the interpretation of each individual's experience. In this case, scientific investigation produces socially constructed knowledge considered as a plausible interpretation of the world that fits lived experience[15]. The choice of an epistemological framework encompasses the researcher's motivation to conduct his/her research (driving force), the place given to others in the process (participation) and to the values (axiology) (Fig. 2).

Driving force. Scientific investigation is a process of objectivizing that is an attempt to produce knowledge about an object that is free from the subjectivity of the investigator. This process varies depending on whether the research aims to reveal universal laws governing the observed phenomena, or to foster agency – that is, the stakeholders' ability to take appropriate action in the indeterminate situation in which they are involved.[17] The search for natural laws invites the researcher to separate facts and value judgements and concentrate on the facts. From this perspective, 'science never disputes matters of value, only matters of facts'[18]. Objectivizing therefore involves creating *matters of facts* for comparison with a theoretical framework, either to challenge it or to confirm it. The strategy for producing general laws is to seek invariants across diverse situations using reproducible protocols. The primary aim of such a mode of knowledge production is to fulfil the conditions of the academic world rather than those of society (Fig. 1).

Fostering agency involves producing an understanding of a given situation in order to define how stakeholders might act in it. The knowledge produced is therefore highly contextualized, but relevant to taking action and assessing its consequences. The methodology aims to make the indeterminate situation intelligible for its stakeholders. Such intelligibility is developed through inter-subjectivation processes among the participants before leading to a qualification of the situation which supports problem framing and action-taking[19]. The production of generic scientific knowledge can then take the inductive form of a generalization through the accumulation of concordant facts and the production of a theory giving sense to a variety of these facts[15].

Participation. Sustainability transitions involve multiple domains and require investigation that transcends disciplinary and professional boundaries[2–4]. Participation in a scientific inquiry can be discussed along two lines: (i) from an epistemic point of view by considering who are the relevant participants to contribute to the production of scientific knowledge and how their knowledge is taken on board, and (ii) from a political point of view by considering their involvement in the definition of the direction of research likely to impact their lives in the long term[20].

Disciplinary approaches usually favour participants who comply with the standards of the scientific discipline. Interdisciplinary approaches acknowledge the pluralism of science and bring together researchers from different disciplines to work together. Transdisciplinary approaches are even more inclusive, as they involve non-researchers, such as experts, representatives (of groups of stakeholders, citizens, etc.), and individual stakeholders struggling with or concerned by the indeterminate situation. Transdisciplinarity therefore requires that various types of knowledge, practices, and values of the participants – researchers from different disciplines, experts, citizens concerned about their future, and/or stakeholders seeking solutions – be articulated[22]. There is also a need not only to describe who is to be invited to participate in the investigation but also to identify the way participants' knowledge will be taken into consideration. According to the positivist approach, participation is understood as the extraction of people's knowledge in order to produce scientific knowledge and/or to test and implement scientific innovations in the real world. Interpretivist approaches tend to involve people more directly in the scientific investigation, as is the case in *extended peer community* approaches[21].

Axiology. Issue-driven research raises an axiological issue. It is not only the validity and credibility of the knowledge it produces that is important, but also its value with respect to the desires and interests of the people seeking solutions[23]. Despite this issue, researchers typically try to be as neutral as possible. This may lead them to limit their involvement in the situation they are studying. Being neutral, researchers avoid any form of engagement with and responsibility for the situation's stakeholders. Alternatively, researchers can choose to produce scientific knowledge by interacting with the stakeholders[2,4]. They are then directly exposed to stakeholders' values, desires and interests. Their engagement creates a commitment to these stakeholders, and hence a responsibility[20]. This commitment leads the researcher to manage the power relations that exist within academy, within society and between academy and society. As pointed out by Marta Struminska-Kutra, managing these power relations requires adjusting one's research posture to guard against opportunism, paternalism or relativism and paralysis [24].

Methodology

Jonker and Bartjan define methodology as the way in which researchers conduct their research, i.e., defining a research question (problematization) and the research design to work on it (investigation)[25]. Researchers can adopt the preconceived way of project planning – both the research question and design are established at the beginning of the project, leaving little room for adjustments – or else their research work can be adaptive, with goals and means reviewed based on the dynamics of the situation and the relevance of the obtained results. In addition to this choice, it is possible to make more explicit the problematization, which led to the definition of a research question and the choice of a method of investigation (Fig. 2).

Problematization. Scientific problematization differs from stakeholders' problem framing of the situation being studied since it aims to identify a scientific issue, which meets the scientific concerns of the researcher's community. This issue is then translated into an addressable research question (Fig. 1). Such problematization can be reductionist when the complexity of the situation is broken down into basic parts which are studied separately. This allows the properties of the basic parts taken separately to be investigated analytically, while assuming that everything else remains unchanged. In contrast, holism aims to consider and study the situation as a whole[26]. The complexity of the studied situation is usually translated into a systemic representation with interrelated components. The components are considered as defining each other, so that modifying one of them will change everything else. The whole is thought to be greater than the sum of the parts, and the complex system to have emergent properties.

Investigation. Researchers can engage with the situation they are studying in different ways. They can interact with it simply in order to generate their research question. What would follow would then be an *ex situ* investigation, such as control experiments or computer modelling, but could also involve observations of the situation without interacting with it. These analytical[27] or descriptive-analytical[28] approaches aim to understand the situation as it is and/or its genesis. We refer to them as 'hands-off' approaches to distinguish them from approaches involving interaction with the situation, such as participant observation, or even participation in the transformation of the situation as part of a 'transformative' research. The latter method of investigation is based on the principle that 'acting is knowing'. Knowledge production is thus an integral part of the transformation[4,29]. Research can take place in real action conditions[28] through instruments specially designed for the purpose such as transition experiments[30].

Implementation

The researcher engaged in issue-driven research has a more or less clear idea of how to put scientific knowledge into practice. The two extreme visions of this implementation are, at one extremity, 'instrumental', and at the other, 'emergent'. The 'instrumental' implementation views scientific knowledge as an instrument for solving problems. Scientific knowledge is transformed into recommendations to be implemented to solve the problem. In a more democratic way, scientific knowledge can be introduced into debates concerning problem solving. In this 'emergent' implementation, scientific knowledge is then challenged in a dialogic interaction between its process of production and its implementation. It is put to the test in situations where it is thought that it could be useful[31]. The scientific knowledge is then combined with other types of knowledge and rationalities at work in the situation to produce tailor-made solutions. Putting scientific knowledge into action involves a conception of how actors adopt scientific knowledge. It also necessitates choosing a way of evaluating this implementation.

Adoption. If it is to be used, scientific knowledge should be adopted by those taking action. Convincing people that scientific knowledge should be applied in order to improve the action they are taking is the basis of the prevailing strategy of 'transfer' of knowledge[32]. Not using scientific authority argument to persuade, encourages deliberation and critical thinking, which allows people to discuss how scientific knowledge makes sense for them and could be used (or not) in the situation. Scientific knowledge is then embedded in a sense-making process that constructs an intelligibility of the situation. Each participant contributes to and is transformed by this construction[33].

Evaluation. Evaluation could be designed for accountability and/or for learning[34]. In the most rationalist-technocratic tradition, implementation projects are evaluated by considering the achievement of the stated goals (goal-based evaluation). In that case, monitoring or *ex-post* evaluation pursues the same goal: examining whether the action is functioning as planned and producing the expected outcomes[35]. It produces evidence that the implemented solution works and can be promoted. An evaluation designed for learning is more 'responsive'[36]. First, it attempts to identify and analyse the diverse outcomes of implementation projects, both expected and not expected. Second, it is revised as the action progresses. The evaluation criteria and methods change each time goals and means are redefined while the action is taking place[37]. This method of evaluation aims to create tailor-made solutions. It is the method of evaluation that is generic, not the implemented solutions.

Box 1 │ Reflecting on research stances with PhD students

The tool presented in this article was developed and tested during a training scheme for PhD students in INRA's 'Science for Action and Development' Department. The majority of PhD students in this department conduct issue-driven research as part of participatory and interdisciplinary projects. We work with these students on their research stances. This helps them report on their work, design responsible research, and become aware of the skills they used during their thesis work. The students produced an account of how they conduct their research, which was collectively analysed using this tool. Below, we illustrate how this tool encouraged three PhD students working on the adaptation of forage resources to climate change to reflect on their practices.

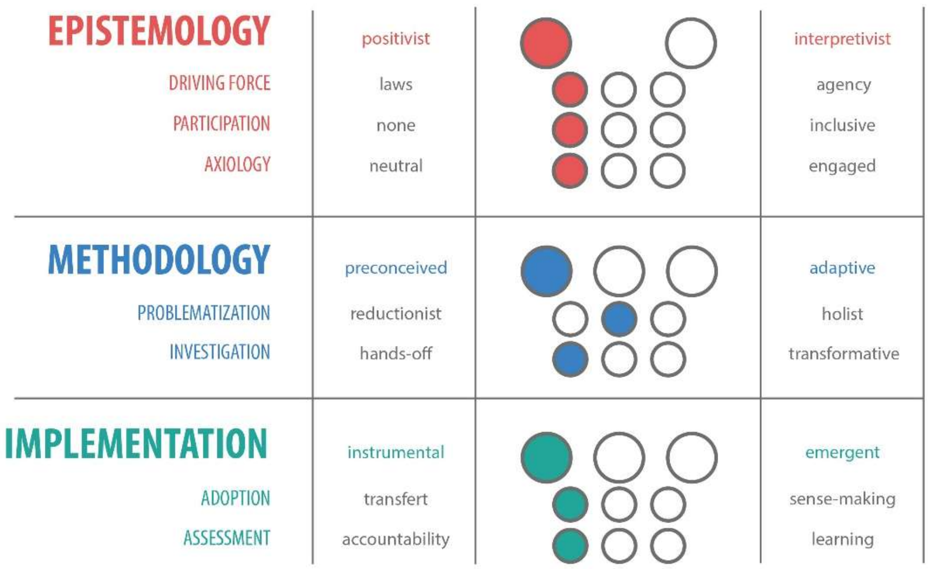

Fig. 3a│AG stance.

AG chose to do her PhD in Ecology to produce knowledge about a fungal–plant symbiosis in order to use it to improve the drought tolerance of plant cultivars. Her research stance was typical in natural science, and the scientific knowledge produced was intended to be used as a means of creating new cultivars (Fig. 3a). Nevertheless, the originality of her work was revealed by her stance: she designed a research project aimed at explaining the world as it is, but with the idea that it should be useful for the purpose of transforming it. She therefore studied symbiosis using a systemic approach without dismantling it[38] whereas the traditional approach taken by agronomists was more reductionist, *i.e.*, separating symbionts from their hosts to understand how the symbiosis works. The reflective work she carried out with the tool revealed to her the originality of her stance, which was not over-reductionist as is usually the case in the community of researchers working on plant endophytes. She then became aware of the very originality of her work as well as the origin of the difficulty she had in dialoguing with the researchers of the 'disciplinary matrix' to which she belonged.

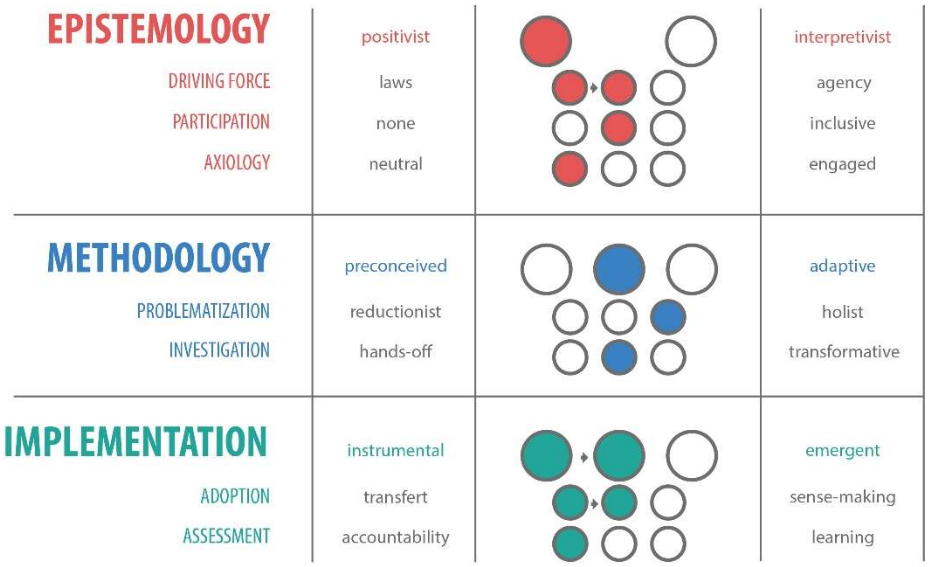

Fig. 3b │MS stance.

MS did her PhD in Agronomy in order to design grassland management methods that respond to climate change. Her stance evolved during her work. Its primary objective was originally to model climate change, its impact on forage resources and changes in livestock producers' practices based on an optimisation process, therefore following a positivist, preconceived and instrumental logic. However, in order to understand how farmers came to make their decisions, she organised participatory workshops[39]. She then realised that her workshops were places where farmers exchanged, learned and transformed themselves. However, she did not incorporate these findings into her PhD work because the workshops were not designed to capture them. She was not able to fully embrace the 'emergent' view of Implementation (Fig. 3b). Nevertheless, this reflective work contributed towards her choice to do a post-doctoral fellowship in social science in order to build on her understanding of farmers' agency.

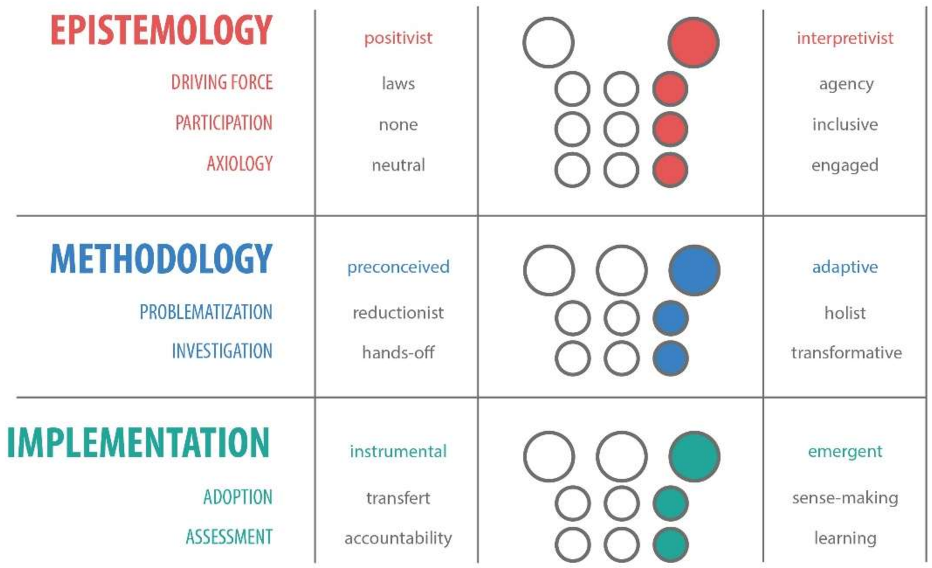

Fig. 3c │ CL Stance.

CL had a background in agronomy and did a PhD that combined aspects of agronomy and management sciences. Reflecting on her stance led her to fully adopt and pursue a transformative and engaged research project at a time when she was questioning the relevance of this stance (Fig. 3c). She therefore became involved in a project being run by a group of livestock farmers who, after several years of drought, wished to increase their forage autonomy. She started by helping them co-design their own diagnostic tool, thus fostering their agency. She went on to develop with them a type of workshop to redesign their agricultural systems[40]. While her methodology was highly adaptive, the implementation was, from the beginning of the project, emergent: the farmer's group qualified itself as a 'progress group' whose members learned from deliberation and assessment to improve their situation.

At an individual level, the use of this tool allows the coherence of the research process to be tested and statements to be aligned with practices. It also makes it possible for researchers to adopt or develop the stance that appears the most appropriate in their own particular case. Finally, tensions between researchers, or communities of researchers, with different stances can be identified. Tensions may arise, for example, between a PhD student and his/her supervisor, or between his/her different supervisors. At a collective level, the tool highlights a wide range of stances to a given problematic situation, and above all, the different rationales and practices that underlie these stances. Highlighting them and discussing them with young researchers is a way of making their diversity acceptable. It fosters the responsibility and respect required when adopting the transdisciplinary approaches indispensable for sustainable transitions.

At first glance, the tool produces two opposing caricatural stances: a positivist, reductionist stance producing recommendations, and an interpretivist systemic stance leading to the emergence and co-production of knowledge and solutions. The tool nevertheless proposes an in-between space. This in-between space reveals its importance when analysing how the researcher really interacts with the studied situation. The sterile debate between positivism being too normative and interpretivism not being sound enough is quickly overshadowed by the image of a more complex reality: the existence of arrangements between poles proposed by the tool for example, in an evaluation coupling accountability and learning[34], positive knowledge that makes sense in a participatory process of problem solving[41], the recognition that recommendations made by scientists cannot be value free[42], etc. A diversity of stances then emerges (box 1). The tool allows researchers to better justify their practices regarding both knowledge production within Academy and the implication for action within Society (Fig. 1).

Managing the double epistemic uncertainty

The tool is particularly useful to help researchers reflect on the production and implementation of scientific knowledge when the problem is ill-defined, which is often the case given the complexity of sustainability transitions[2–4]. The positivist, reductionist and instrumental stance has proved its ability to solve well-defined problems. When tackling wicked-problems, the scientific approach, whatever the stance, must integrate and manage a double epistemic uncertainty[12]. The first is the result of the imperfection with which science tackles societal problems: a single original and clear research question cannot adequately represent the fuzziness of an indeterminate situation (Fig. 1). The second uncertainty arises from the unpredictability of the effects of scientific knowledge when introduced in a complex situation. Due to these two uncertainties, implementing scientific knowledge in an instrumental way often produces disappointing results[43].

The first uncertainty could be partially resolved by combining different points of view to make the indeterminate situation more intelligible. This could easily be done at the beginning of the investigation to define the problem or, in a more challenging way, though a transdisciplinary approach which involves the situation's stakeholders throughout the process of research investigation[2–4]. It combines scientific and empirical points of view raised during a process of intermediation[19].

The second uncertainty could be reduced by closing the gap between the environment in which knowledge is produced and the environment in which it will be applied. The strategy that prevailed in the 20th century was to transform the environment in which knowledge will be used so that it resembles the knowledge production environment[44]. However, this strategy proved to be unsustainable, as demonstrated by agricultural intensification[45]. Sustainable strategies tend to involve steering endogenous processes already at work in the situation rather than replacing them with exogenous ones, which are better known and consequently thought to be more manageable. Such situation-based management means working with the situation's stakeholders. It maximises the chances of the knowledge being useful, used, thereby contributing to sustainable transitions[41]. It is nevertheless still possible that the knowledge implemented in a complex situation will produce unexpected outcomes. Only long-term experience accompanied by a thorough assessment will enable identification of these effects.

Framing the problem with stakeholders is clearly a necessary condition when it comes to identifying which piece of scientific knowledge or research strategy is relevant to their situation. However, alone, this condition is not sufficient: if it is to work in an indeterminate situation, such knowledge must continue to be shaped and reshaped over the course of long-term interactions between researchers and stakeholders[41].

Engaging in sustainable transitions

Our tool helps overcome the illusion that it is necessary to accompany the entry of scientific knowledge into society in order to guarantee its proper use. In our opinion, the researchers' responsibility lies in explaining the research stance, which led to the production of this scientific knowledge. Be that as it may, researchers who wish to participate in the implementation of scientific knowledge will have to choose between two major strategies. This choice depends whether they think that knowledge precedes action and informs the decision, or that it is an integral part of the action. Both options involve collective action for a process of either advocacy or inquiry. Advocacy involves raising citizens' awareness of a problem and proposing solutions based on evidence. Inquiry refers to the pragmatist philosophy: it is a critical investigation of the indeterminate situation carried out collectively by the situation's stakeholders, in which researchers can participate in producing or in making use of scientific knowledge.

Advocacy. The goal of advocacy is to get stakeholders to hear the alerts issued by scientists and to follow their recommendations. However, in order to comply with scientific recommendations, a stakeholder takes a wide range of information into account, not only the recommendation[46]. Each stakeholder, through his/her experience, values and access to information, develops his/her own rationale. The implementation of scientific knowledge is therefore confronted with this diversity of rationales at work in the situation.[47] The 'speaking truth to power' strategy therefore shifts towards 'sharing truths with multiple actors of influence'[48]. 'Evidence-based' strategies become 'evidence-informed' ones, opening the way for the recognition that many other factors influence decision-making beyond scientific evidence alone. Seen in this light, advocacy is influencing, *i.e.*, trying to ensure scientific knowledge is taken into account in the decision-making process. This leads to the creation of 'epistemic communities' which bring together researchers and a wide range of stakeholders who share the same convictions based on scientific facts[49]. The role played by these epistemic communities involves raising awareness, framing the way of posing problems, and helping to defining new standards and regulations.

Inquiry. A pragmatist inquiry is a deliberative and experiential process to deal with the discomfort of stakeholders who realize that they can no longer go on doing what they do in the same way[50]. First, participants in an inquiry exchange experiences and produce a collective understanding of the situation. During this first phase, researchers can provide scientific knowledge to support this process. This may help generate the hypotheses to be tested to improve the situation[42]. The scientific approach itself can then be used to design the test, provided it involves all the inquiry's participants. Collective inquiries aim to promote learning-by-doing so that the participants transform themselves at the same time as the situation, thereby achieving a real transition to an acceptable situation[51]. This learning requires reflexivity on the acceptability of both the expected and unexpected effects of the action taken[52]. Being in a position outside the situation, the researcher can organise this reflection and/or propose his/her interpretation of what has been experienced. All this occurs in a highly dynamic situation. The situation being studied 'does not remain static through the application of the research process':[53] Actions taken transform the situation, stakeholders learn from these changes, their points of view change, and what is acceptable one day may not be acceptable the next. Even though being at the heart of these changes is one advantage of the approach for researchers, they should develop their own reflective activity which will allow them to conduct their research wisely and be able to identify potential scientific outcomes[41].

Conclusion

The goal of the tool we describe here is to question and reflect on researchers' choices and their strategy for producing scientific knowledge for social transformations such as sustainable transitions. The tool can also be used to design and justify responsible research. It helps understand the diversity of scientific practices and their justification, thereby contributing to recognise scientific pluralism. This recognition and understanding will help acknowledge different research stances in inter- and transdisciplinary projects needed to tackle wicked problems[2]. This tool and the facets of the scientific activity it makes available for exploration are original; researchers tended to reflect on their work by showing their results, whose relevance is usually discussed in terms of the quality of the data collection and analysis.

Being accountable to society should mean paying the same degree of attention to research stances in issue-driven research, as to the discussion of the results. However, some may infer from this paper that researchers bear the full responsibility for the interaction between science and society, which is not the case. Stakeholders, who often consider themselves clients of research, also have their own conceptions of what knowledge is, what research needs to produce and how. Just like research stances that are not epistemologically compatible, the views held by stakeholders on what action to take and how, may not be compatible either. A field consultant, for instance, can view his/her activity as knowledge brokerage, fostering end-user's innovation, or as technical advisory promoting their adoption of ready-to-use innovations. The tool presented here could certainly be adapted to shed light on these views that exist in society.

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Author contributions
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