S.A.P.I.EN.S
Surveys and Perspectives Integrating Environment and Society

3.1 | 2010
Vol.3 / n°1

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Anne Blanchard et Jean-Paul Vanderlinden

Minh Ha-Duong (éd.)

Édition électronique
URL : http://journals.openedition.org/sapiens/990
ISBN : 978-2-8218-0818-8
ISSN : 1993-3819

Éditeur
Institut Veolia

Référence électronique
Anne Blanchard and Jean-Paul Vanderlinden, « Dissipating the fuzziness around interdisciplinarity: The case of climate change research », *S.A.P.I.EN.S* [Online], 3.1 | 2010, Online since 19 July 2010, connection on 01 May 2019. URL : http://journals.openedition.org/sapiens/990

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S·A·P·I·EN·S
VOLUME 3 ISSUE 1 2010

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Dissipating the fuzziness around interdisciplinarity: the case of climate change research

Anne Blanchard, Jean-Paul Vanderlinden

Laboratoire REEDS, Université de Versailles Saint-Quentin, Quartier des Garennes, 11, Boulevard d'Alembert, 78280 Guyancourt

Correspondence to: anne.blanchard@reeds.uvsq.fr

Abstract

Late last century saw an increasing realisation of significant environmental changes on a global scale, characterised by high levels of dynamism and complexity, and important stakes. Perhaps foremost among these global changes is the issue of climate change, which will form the context of this paper. The complexity that accompanies climate change translates into a need for scientific interdisciplinary approaches, first to achieve a more integrated and comprehensive vision of the issues, and second to better inform the decision-making processes. However, achieving an interdisciplinary setting can be an elusive goal, owing particularly to the contextual nature of interdisciplinary dynamics, which makes it difficult to follow any means of 'best-practice'. Nevertheless, a common understanding of interdisciplinarity is important for researchers and practitioners to ask comparable questions and explore similar hypotheses, thus enabling them to build on what they already know, and advance the practice and scholarship of interdisciplinarity. To this end, both the scholarship and practice of interdisciplinarity have shown the need for actors who commit to interdisciplinarity to reflect on four complex features. They are its definition, origins, objectives and means. The purpose of this paper is to explore and clarify these four features in order to provide route-markers to a more effective and long-lasting implementation and structuring of complex interdisciplinary dynamics. Mobilising dialogue between theory and practice, this paper will draw from both an overview of the literature, and qualitative research undertaken in the Ile-de-France region within the Scientific Consortium for Climate, Environment and Society (GIS CES), which is attempting to conduct interdisciplinary research on the impact of climate change on society.

Keywords: Interdisciplinarity, complexity, reflexivity, climate change.

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Published: 19 July 2010.
Edited by: Minh Ha-Duong – This paper has been reviewed by Philippe Terral and another anonymous referee

1. INTRODUCTION: FOUR COMPLEX FEATURES OF INTERDISCIPLINARITY

Researchers and practitioners who commit to interdisciplinarity know that its definitions, origins, objectives and means are surrounded by fuzziness and complexity. Exploring these four complex features is an essential prerequisite for those involved in interdisciplinary projects. To help researchers and practitioners with this, the paper tries to dissipate the fuzziness around these complex features of interdisciplinarity by provoking at times a dialogue between literature and practice. Qualitative research undertaken in the Ile-de-France region in March 2009 within the Scientific Consortium for Climate, Environment and Society (GIS CES), provides some insights into the representations and experiences of 15 scientists who are working on different aspects of climate change (climatology, hydrology, ecology, health, social sciences and humanities), and have been brought together for research projects on the impact of climate change[1].

2. DEFINITION: FOUR LEVELS OF INTERACTION

The first stage for researchers and practitioners who commit to a cross-disciplinary project is to define and situate the degree of interaction among disciplines involved, and reflect on a harmonised definition of interdisciplinarity. Complexity is added by the fact that the degree of interactions demanded between disciplines depends on the purpose of the interdisciplinary project. Indeed, the degree of cross-disciplinary interaction chosen will first influence the specific rules and values to structure the interactions, and second shape the objectives of the project, whether they are substantive, procedural or contextual.

Cross-disciplinary interactions can be characterised across four different levels of integration (Figure 1), among which practitioners and researchers must differentiate. First, pluridisciplinarity encourages several disciplines to coexist within the same entity (e.g., a university), without necessarily requiring exchanges among them. Cross-fertilisation does not exist. Multidisciplinarity is the meeting of distinct disciplines around a common study theme, although each is permitted to retain its specific rules, methods and tools. This can be illustrated by the organisation of the IPCC research on climate change around three working groups that study different aspects of the same object: (i) its scientific dimensions, (ii) its impact on the social, economic and environmental spheres, and (iii) the development of adaptation and mitigation policies. Between the IPCC working groups and for multidisciplinarity in general, cross-fertilisation is limited. Interdisciplinarity allows the exchange of concepts, rules, methods and tools among different disciplines in order to achieve a global understanding of a common theme. Again, an example can be drawn from the IPCC experience, where the 'Special Report on Emissions Scenarios' (SRES) provides prospective scenarios as a result of dialogue between climate scientists and economists. In this case, cross fertilisation leads to a progressive blurring of disciplinary boundaries. Transdisciplinarity is a process of integration that overcomes disciplinary boundaries for a more complete understanding of a complex world. The 'Earth System' models illustrate transdisciplinarity, in the way they aim to integrate the environmental, social and economic dimensions required to understand the functioning of the Earth, to better anchor science in social and political realities, and to respond to their expectations. It differs from interdisciplinarity to the extent that a new discipline is created, with its own codes and tools.

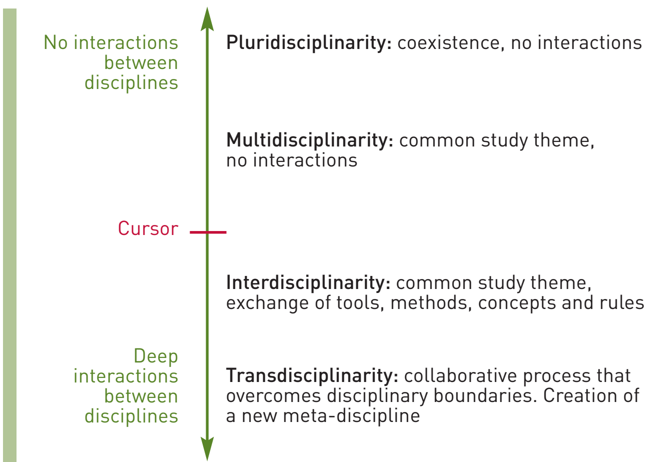

Figure 1. Four levels of cross-disciplinary interaction. The interactions between disciplines can be classified according to four points on a scale, along which researchers have to explicitly place their cursor. Source: Inspired by Klein (1996) and Jakobsen (2004)

Having differentiated among four degrees of integration, this paper focuses on describing interdisciplinarity, beginning with a reflection on the notion of disciplines.

According to the literature, even if disciplines are not stable areas, they are characterised by specific particularities. Klein (1996) defines disciplines as "dynamic systems" that evolve and adapt to changing environments, ideas and influences, by producing reformulations of their knowledge. These dynamic systems differ from each other by specific values, language and rules, where practitioners have different attitudes, habits, and practices. Disciplines are thus compared by Bauer (1990) and Ferris (2003) to different cultural groups. By seeing disciplines as cultures, disciplinary knowledge — its methods and approaches, cannot be isolated either from the history and practice of the field or from its practitioner (Kuhn 1962).

This leads us to draw a definition of interdisciplinarity that is structured around four main dimensions. First, interdisciplinarity aims to structure different sources of knowledge around a common topic. For Klein (2004) interdisciplinarity is a process that begins with an issue of concern to approach complex questions that specialised disciplines cannot answer. Jakobsen (2004) and Keesey (1988) evoke the second dimension of interdisciplinarity — the sharing of tools, methods and

1 As the purpose of the paper is to explore and clarify the complex features of interdisciplinarity, the detailed context and results of the qualitative research are not presented here in depth. Nevertheless, while waiting for their publication, parts of the research are accessible on the GIS CES website: http://www.gisclimat.fr.

approaches across disciplines — as an evolving process of knowledge construction. The more distant and divergent the disciplines are, the more time practitioners need in which to learn about each other's language and methods. To achieve this interfacing of different disciplines, there is a need for cooperation, as the third dimension, which is emphasised by Hunt (1994). She defines interdisciplinarity as a negotiation, in which disciplines must "learn to understand each other and give up some territory in the interest of long-term balance, without giving up their individual identities". Recognition that every discipline brings a valuable perspective, and horizontality in the participation, contribution and efforts made by the disciplines, are the basis to a cross-disciplinary cooperation. Finally, the fourth dimension, reflexivity, is illustrated by Romm (1998). Being reflexive on one's own discipline is necessary to implement interdisciplinarity. The fifth section will illustrate these points with experiences of the GIS CES scientists.

The objectives of an interdisciplinary project are associated with how actors define interdisciplinarity. If there is no agreement on a definition, actors may raise conflicting objectives that will impede the progress of the project. Once an exploration of the complex notion of interdisciplinarity is led, and the 'cursor' placed along the interaction line, the construction of objectives that are coherent with the degree of interaction between disciplines involved should become more straightforward.

3. ORIGINS: THREE MAIN UNDERLYING PURPOSES

Having defined interdisciplinarity, a second complex feature of it is its origins. Indeed, knowing where interdisciplinarity comes from and why it has emerged, provides insights into its philosophical and theoretical underpinnings. As we will see, the participants within the GIS CES were often confronted by issues that forced them to reflect on the origins of interdisciplinarity.

According to Gusdorf (1983), Klein (1990) and Berger (1972), interdisciplinarity emerged in the Middle-Ages with the creation of the university and its specialised academic branches, introducing the need to build bridges between them to answer complex questions. Ferris (2003) believes that the Enlightenment period has then led to a deeper questioning of the representation of knowledge and its disciplinary divisions. Such questioning was developed by GIS CES climate scientists who studied the impact of climate change on grape harvesting dates: "Not taking into account historical elements in our climate models was leading to biased results. Indeed, drawing from a 300-year set of data, 30% of the harvest times had an anthropic origin: wars and epidemics for instance. The forcing of our models was completely erasing the human dimension".

As Sarewitz (2004) argues, scientific disciplines have become so specialised that they lose their coherence. No perspective is 'wrong' by its own measures, however they are all incomplete without the other perspectives. Indeed, Jorgensen, Patten and Straskraba (1999) describe how the emergence of quantum physics in the early 20th century provided a scientific basis for such pluralism. "Due to observational limitations, two or more different views could be equally valid. There is not one true, unambiguous picture of nature, but many pictures based on different observations".

Consequently, post-modernism has encouraged the establishment of interdisciplinarity by providing a critique of the notion of universal knowledge, by focusing on the complex and uncertain nature of reality, and by highlighting and interrogating the social, political, economic and cultural dimensions of science (see e.g., Henrickson (2002) and Rudel (1999)). Funtowicz and Ravetz (1990) showed how a complex system can lead to significant uncertainties that force society to turn to an alternative and inclusive science that seeks an integrated view beyond reductionist disciplinary boundaries to include alternative knowledge systems. For the scientists of a GIS CES project that traverses health, climate sciences and physics, the reduction of uncertainties is one of the main reasons that led them to work together. "It is very difficult to quantify the exact, direct impact of pollution on pregnancy. Therefore, to promote preventative policies and limit the risks to pregnant women, health data must be absolutely reinforced by strong physical and climatic data".

From the origins of interdisciplinarity, researchers and practitioners gain insights of its foundation statements and assumptions. First, complex issues require multiple perspectives to be explored and anchored in social and political realities. Second, some knowledge falls between disciplines, and can only be approached through an interdisciplinary perspective. Third, there is no universal knowledge, and multiple valid perspectives exist. In the following section, a classification of these objectives is proposed.

4. OBJECTIVES: TWO POLES, THREE TYPES

The exploration of the definition and origins of interdisciplinarity has already provided insights into its objectives, the third complex feature. Reflection and deliberation on the objectives of an interdisciplinary project enable researchers and practitioners to more clearly and legibly design the means to enact these objectives.

While this may seem relatively intuitive, researchers and practitioners must be aware of the multi-classification of objectives. Van Den Hove (2006) proposes a classification into three types — substantive, procedural and contextual. These three types of objectives and their combinations depend on the project's design, i.e., the disciplines involved, the length of the project, and the frequency of the meetings.

Substantive objectives follow the idea of improving the scientific knowledge around a complex problem, dissipating the uncertainties around it, and exploring the "black holes" that it may contain to achieve a better understanding of the cross-object.

Again, the IPCC can be used by way of illustration. The IPCC as a scientific institution is in pursuit of substantive objectives. IPCC scientists try to achieve a more comprehensive vision of climate and attempt to reduce uncertainties regarding climate projections, in order to implement effective policies.

Procedural objectives seek to rethink the ways to work across disciplines, and to establish a framework for interdisciplinary cooperation. Both substantive and procedural objectives are goals at the project scale. The IPCC's working groups that explore "cross-cutting issues" constitute examples of procedural objectives, because they aim to implement new frameworks and methodologies to work across disciplines on specific issues that require the insights of several disciplines, such as ice sheets and sea-level rise, or the evaluation of uncertainties and risks inherent in climate change.

Contextual objectives are goals on a larger scale. They aim to change the global context of action and interaction, for instance, by pursuing changes in institutional functioning. Typically, the GIS CES is an example of contextual objectives, in the way in which it intends to change the global change research environment, by fostering interdisciplinary interactions, and by seeking to build networks that change the scientific landscape.

Creutzer (2002) proposes a second way of classifying these substantive, procedural and contextual objectives, by proposing an organisation along two poles — the social and epistemological poles. The social pole tends to redefine the role of science within society, particularly by anchoring scientific research in social and political realities. At the other end of the scale, the epistemological pole attempts to achieve a certain unity of science, to better understand complexity, or to improve comprehension at the boundaries of disciplines, for example. The number of possible motivations along the scale between those two poles is almost infinite.

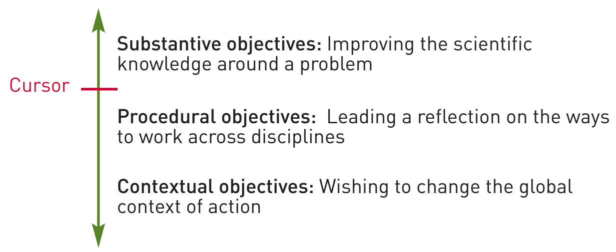

Figure 2. Objectives: three types. Example of a classification of research objectives according to their nature.
Source: Inspired by Van Den Hove, 2006

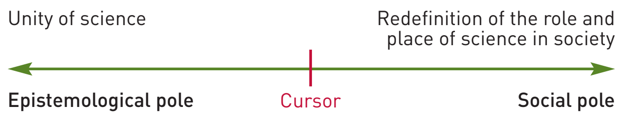

Figure 3. Objectives: two poles. Example of a classification of research objectives along the social and epistemological poles.
Source: Inspired by Creutzer, 2002

In both classifications, an explicit position of the 'cursor' along the line of the objectives is important to enable researchers and practitioners to implement means that are coherent with their objectives.

The practical GIS CES experience, and particularly one of the interdisciplinary projects on the impact of climate change on the frequency of skin cancer, highlights the importance for those who are committing to interdisciplinarity of reflecting on and making explicit the objectives of their project. Indeed, the project, by gathering together medical doctors, physicists and climatologists, reveals the coexistence of the two poles and two of the three types of objectives, without an explicit placing of the 'cursor'.

The objectives situated around the epistemological pole are simultaneously substantial and procedural. They are expressed by a desire to restructure and establish a better network of communication among scientific fields to respond to complex problematic. The medical doctors, physicists and climatologists showed a willingness to generate new synergies between their disciplines; implement a "shared culture", an interface where their "communities can take inspiration from data, results, or methods of the other disciplines involved, to design more effective and comprehensive approaches to complex topics". Moreover, the desire to integrate different disciplines is a way to gain credibility, and to help researchers to "reinforce the qualitative data from the medical or social fields with quantitative data from physics and climatology", thus allowing their contextualisation through multiple perspectives and constructions.

Around the social pole, procedural and contextual objectives are found. Procedural objectives mainly found expression in the willingness of the medical doctors, physicists and climatologists to open their disciplines to socially-rooted questions, an objective being to take part in a movement that responds to the "fears of policymakers and society regarding the increase of skin cancers", through scientific collaborations that strengthen the nature of the results and give them more depth. For the GIS CES scientists, the achievement of an effective social and political message would be one of the successes of the project; "One of our objectives is to draw risk maps, informing people and decision-makers of the dangerous periods". Thus, interdisciplinarity is considered to be a means by which to reflect on the role and responsibilities of science regarding society, one respondent noting, "linking my scientific research on climate to social aspects reminds me why I am a researcher". Contextual objectives translate into a wish to be at the core of interdisciplinary dynamics on a larger scale (e.g., "Our project will be successful if it allows other interdisciplinary projects to take root in ours"). Most of the current GIS CES projects are intended to form the bases for future projects and launch deep interdisciplinary interactions on a larger, European or world-wide scale, to address a broader social demand.

Having different types of objectives within the same project does not impede interdisciplinary dynamics, however problems arise when the nature of the objectives is not made explicit. Indeed, it is the main source of "misunderstanding and disagreement over the ends of the project, and therefore the means to such ends". For instance, it took one year for the medical doctors to "finally understand the objectives and motivations of the physicists". This highlights the importance for researchers and practitioners to reflect on and agree on objectives that are appropriate to their research design. The following section explores the means to achieve interdisciplinary objectives.

5. MEANS: TWO ESSENTIAL VALUES

The means to accomplish cooperation between actors and integration of knowledge across disciplines are nearly infinite. Indeed, mechanisms or means to achieve interdisciplinarity strongly depend on the project's structure and design — the scope, size, and political context of the project, as well as differences in national culture (Jakobsen, Hels et al. 2004). For instance, Bramsnæs et al. (1997) found that working across disciplinary boundaries the first time takes much longer than on subsequent occasions, and Hatch (1997) assumes that a larger group makes it more likely for subgroups to form, and thus impede the interdisciplinary dynamic at the project scale. Hence, the fourth and last complex feature of interdisciplinarity that researchers and practitioners need to explore is the means to implement interdisciplinarity that are adapted to their particular project context.

The literature provides some formalised frameworks on the ways to implement interdisciplinarity. For instance, Davis (1988) identifies four steps to obtaining interdisciplinarity: (1) Agreeing to abstain from approaching the topic along the lines of their disciplinary method alone; (2) Trying to formulate the global question together; (3) Translating the global question into the specific language of each participating discipline; (4) Agreeing-upon an answer that must integrate all particular answers available. However, as previously noted, the paths to follow in order to implement interdisciplinarity are strongly dependant on human and environmental criteria, or capacities, that will facilitate or limit the implementation of cross-disciplinary practices.

The GIS CES experience highlights two critical values that might help researchers and practitioners involved in interdisciplinarity to structure their project in a more systematic way. They are confidence and reflexivity.

According to the GIS CES scientists, confidence seems to be an important requirement for interdisciplinarity. Building confidence starts with an exploration phase at the beginning of the project, from 6 months to one year, where the feasibility of the project is evaluated and the scientific question formulated. More importantly, this period is an opportunity "to get to know each other in the personal and disciplinary dimensions", and hence foster an area of trust and openness to collaboratively reflect on and discuss the tensions that may occur in intercultural and interdisciplinary settings. From a practical point of view, this means that an interdisciplinary project must permit participatory management of logistical questions (i.e., the frequency and place of the meetings and the practical roles of every participant) in order to facilitate communication among the group members, and create a permissive atmosphere that fosters lively dialogues.

The second value that is important in building interdisciplinarity is reflexivity. To avoid "reinventing the wheel for each new project and for each new problem", which is a frequent problem, documentation on the construction and evolution of the collective dynamics within a group, as in a logbook for example, seems to be useful. A logbook can permit researchers and practitioners to return to previous steps and change their orientation, if necessary, thereby creating precious roadmaps for future projects or other researchers. As well, it allows researchers and practitioners to reflect constantly and explicitly on the interactions between the group members and the impact of the projects on the problem explored. Reflexivity also acknowledges that an interdisciplinary project evolves over time, meaning that researchers and practitioners should reflect on "alternative means that help the project adapt to new settings", and achieve its objectives.

6. ONE CONCLUDING LESSON: REFLEXIVITY

In light of the GIS CES experience, this paper has shown the importance for researchers and practitioners of being reflexive on the four complex features of interdisciplinarity to implement long-lasting and effective interdisciplinary dynamics. Furthermore, interdisciplinarity implies an acknowledgement that disciplines not only have different subjects and methods, but also different visions of truth and the world. Researchers and practitioners must therefore transcend unconscious thinking processes by reflecting on their personal habits, values, interests and representations. A tool that fosters and structures reflections on interdisciplinarity is the use of metaphors. It permits, according to Ferris (2004) and Klein (2004), the representation of disciplines and their links in an integrated way. By using metaphors, the representation of knowledge is not objective, but based on experiences and expectations. Therefore, inter-disciplinarity must be strongly linked with a process of reflexivity from the researchers and practitioner.

Finally, being involved in a cross-disciplinary dialogue and learning about methods, data, and values of other disciplines, helps researchers and practitioners to reflect on their own discipline and from the rules that define it. Interdisciplinarity and reflexivity are thus an intertwined, evolving relationship, with Hunt (1994) observing, "Once the language of the other discipline is learned, the relationship to the home discipline is never again the same". Indeed, the interdisciplinary co-construction of knowledge has repercussions in the various disciplines involved in a project, thus instilling changes in the scientific research towards the integration of different kinds of knowledge — a necessary step in responding to social expectations towards climate change.

Acknowledgements

The authors wish to thank the Scientific Consortium for Climate, Environment and Society for its support through the RAMONS project, and for the access given to the interviewees. The authors thank as well the interviewees for their participation.

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