Investigating Interdisciplinary Practice: Methodological Challenges (Introduction)

Miles MacLeod
University of Twente

Martina Merz
University of Klagenfurt

Uskali Mäki
University of Helsinki

Michiru Nagatsu
University of Helsinki

Interdisciplinarity (ID) is one of the most prominent ideas driving science and research policy today.[1] It is applied widely as a conception of what particularly creative and socially relevant research processes should consist of, whether in the natural sciences, the social sciences, the humanities, or elsewhere. Its advocates, many of whom are located in current science and research administration themselves, are using ideas of interdisciplinarity to reshape university organization and research funding. For the last 40 years, researchers studying interdisciplinarity have built up a substantial body of literature constructing various visions of what it should be and how to taxonomize the different forms it can take, putting a distinct emphasis on a theoretical approach to conceptualizing and understanding interdisciplinarity. However, the need for empirically substantiated knowledge has only

1. See for instance high-level policy reports: National Science Foundation (2008), *Impact of Transformative Interdisciplinary Research and Graduate Education on Academic Institutions*, Workshop Report; National Academy of Sciences (2006), *Facilitating Interdisciplinary Research*. Report; European Union Research Advisory Board (2004), *Interdisciplinarity in Research*. Each report places a strong imperative on interdisciplinary research and promoting the kinds of institutional regimes needed to support it. The European Research Council, among others, explicitly targets its funding at interdisciplinary projects. In addition, countless papers have been written advocating the importance of interdisciplinarity (see particularly the notion of Mode 2 science, Gibbons et al. 1994; Nowotny et al. 2001).

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recently attracted wider attention (see Huutoniemi et al. 2010; Klein 2000, 2017). Moreover, our understanding of what the critical constraints on interdisciplinary interactions are is very limited, even though this knowledge is very relevant to the rather strong expectations associated with ID. Interdisciplinary approaches to knowledge production may indeed be beneficial for tackling certain problems such as the systemic uncertainties and ethical issues addressed within the realm of "Responsible Research and Innovation," which matches ID agendas in many ways (see Wickson and Carew 2014). At the same time, it is far from clear whether and to what extent the theoretical representations of ID given in interdisciplinary studies, science policy, and other areas of scholarship actually match what is happening, or if they are even possible in practice (see MacLeod and Nagatsu 2018).

Interdisciplinary interactions in science are challenging—in many cases more situated, distributed, and dynamic than within-discipline interactions. They take many forms and varieties, from the occasional transfer of models and methods across disciplinary boundaries to the resources of one field being used for criticizing assumptions in another (Mäki 2013, 2016). Interdisciplinarity can also be a matter of intensive ongoing collaboration addressing complex problems with novel approaches. This type of collaboration requires negotiation of epistemic standards, trust and reliability, the coordination of expertise, and the distribution of tasks. Interdisciplinarity is thus a multidimensional and multi-scale phenomenon involving a rich interplay of established and novel scientific methodologies, expert and social cognition, disciplinary preferences and values, academic pecking orders and extra-academic pressures, historical relationships, and institutional and policy frameworks. Understanding how these interactions unfold does not seem to be based on strict regularities enabling reliable anticipation in advance, but rather requires empirical investigation that provides systematic ways of tracking various aspects of the process.

In this special issue[2] we thus advocate a much more concerted effort to empirically observe, document, and analyze interdisciplinary practices. We believe that, at this point, it is important to step back and shine the torch on the different approaches committed to such empirical analysis within science studies of different orientation (History and Philosophy of Science, Science and Technology Studies, and others). In particular, we ask what different methodological perspectives have on offer, and what they each

2. This special issue builds on the Workshop "Investigating Interdisciplinary Practice: Methodological Challenges" that we organized at the University of Helsinki 15–17 June 2015 with the financial support of the Academy of Finland. Earlier versions of two of the three chapters were presented at the Workshop as invited lectures.

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can contribute to our knowledge of ID, but also to our evaluations and expectations of it. This is important insofar as there is evidence that many interdisciplinary relationships fail (MacLeod 2018).

A comparative analysis of this kind needs to begin by noting that methodological approaches and the phenomena under investigation are not independent but shape one another, in different ways. Two directions in this relationship can be identified. On the one hand, the selected methodological approach and associated method(s) frame the phenomena under investigation in particular ways, rendering visible certain features while hiding others. Consider an example. Reflecting on qualitative interviews, Lamont and Swidler (2014) emphasize the merits of qualitative interviewing, e.g. when compared to ethnographic approaches, while they also identify a number of blind spots. In their view, qualitative interviews are less suitable for in-depth consideration of the historical dimension and of limited use only when analyzing institutional patterns (Lamont and Swidler 2014). In similar ways, alternative methodological approaches each have their affordances and limitations. An ethnographic approach to science is particularly apt for in-depth exploration of embodied skills and step-by-step reconstructions of knowledge generation (cf. the laboratory studies approach in STS, e.g., Knorr Cetina 1995). Scientometric studies can trace large-sized networks of ideas and researchers while being sensitive to change in time as well as to the specificity of fields. Qualitative historical analyses can counter premature claims to novelty, progress and singularity without downplaying the specific features and affordances of different contexts considered over time. In a similar vein, as this Special Issue will show, different methodological perspectives can and do generate distinct narratives about interdisciplinarity and, in this process, configure the object of investigation in particular ways. Such narratives concern, among other things, the development, type and role of ID in past and contemporary scholarship, the social forms and epistemic features of interdisciplinary practice, the practical problems encountered and solutions sought in specific local contexts or epistemic cultures, and the development of new fields of scholarship in interdisciplinary boundary areas.

On the other hand, as a phenomenon of investigation, ID challenges established methodological approaches and methods. One reason is that it constitutes a rather ill-defined phenomenon, with its reference to "disciplines" and what happens between ("inter") them. Another is that it concerns a complex body of practices, cognitive structures, and social forms, which vary widely from one case to another. This calls for a twofold reflection: First, what exactly is to be empirically investigated—where and when is inter-disciplinarity? Second, which approaches are suitable for addressing the selected "object"? Taking these two questions as guidance,

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we have asked the authors of the three contributions to explicitly address the methodological challenges raised within their respective empirical studies and how these were handled, and to provide an insight into their methods toolbox and methodological considerations.

Our selection covers a range of empirical methodologies, including both quantitative (scientometric) and qualitative (cognitive-ethnographic, historical) approaches. Each of these have the character of being outside most of the mainstream discussion on interdisciplinarity in science policy, although scientometric studies are sometimes relied on (Yegros-Yegros et al. 2015). But each does provide perspectives that can lead to genuine novel insights into interdisciplinary practices. Each approach takes the stance that a purely theoretical or intuitive account of ID is likely to fail to understand the processes of interdisciplinary research and the outcomes of funding policy interventions favoring ID. The approaches presented in this Special Issue have the resources to illuminate at least some aspects of the complex relationships between institutional contexts and goals, disciplinary methodological structures and standards, and problem-solving environments, which emerge in day-to-day interdisciplinary activity, but can remain impartial with respect to whether ID is necessary or desirable. These approaches provide possible methodological options for those seeking to study ID empirically and critically. To a large extent, they are not rival options, they rather complement one another in asking different questions about ID and highlighting different aspects. Our authors have been asked to reflect on both the necessity and value, and limitations of their respective methodological approaches for studying interdisciplinary research.

As such, the concept underlying the Special Issue is that of methodological pluralism (also see Kellert et al. 2006). We do not believe in the existence of a royal road toward understanding interdisciplinarity, i.e., that one particular methodological approach be much better suited than all others for all purposes. At the same time, we are skeptical about the prospects of triangulating methodological approaches in unproblematic ways aiming at systematic integration of results. Instead, we side with the picture of a "collage" (Kalthoff 2010), i.e., the idea that the distinct approaches and corresponding methods "mobilize different relevancies" (Kalthoff 2010, p. 363, our translation), with the potential of contradicting or irritating one another in addition to complementing each other. Thereby further investigation is stimulated and, as a consequence, a richer understanding of interdisciplinary practice is engendered.

Our Contributions

The three papers have been selected to cover a spectrum of methods and methodologies. The first from Nancy Nersessian introduces an ethnographic

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approach to the study of ID, in particular a cognitive-ethnographic approach. STS scholars, by applying an ethnographic perspective, have helped to unpack many aspects of interdisciplinary relationships (see e.g., Rhoten 2003; Barry et al. 2008; Haapasaari et al. 2012; Merz 2015). But, typically, such studies have put aside the nature and structure of the cognitive problem-solving systems that individuals and groups build out of the background institutional, material, and epistemological resources they operate with. Studying these cognitive systems requires one to ask questions about the reasoning processes and practices of individuals, and the role of often distributed representations in those processes and practices. Cognitive ethnography provides a methodology and conceptual framework (relying on concepts like distributed cognition and model-based reasoning) for a fine-grained analysis of such problem-solving practices. This empirical work seems especially important in the context of ID, as Nersessian suggests, since it is the coordination or integration of different situated cognitive processes and practices through the construction of shared representations that characterize interdisciplinary relationships, contributing significantly to their success or failure. In her analysis, Nersessian discusses examples of interdisciplinary integration in bio-medical engineering.

A second paper from Alan L. Porter and his co-authors proposes an approach to the analysis of interdisciplinary practice that combines bibliometrics with tech mining. The notion of ID underlying such quantitative analysis refers to the integration of knowledge (bodies of specialized knowledge, research practices) with a focus on how knowledge is being interchanged between research fields. Quantitative analyses of interdisciplinary research come with a number of methodological challenges and choices. A first challenge points to the necessity of explicitly addressing discipline as a precondition for identifying, and thus being able to investigate, interdisciplinary research. Categorizing disciplinarity of research output (e.g., a journal article) can be done in several ways. For example, an article can be assigned a disciplinary category in view of its content (e.g., concepts) or, instead, of its source (e.g., journal). Each level of categorization has its own benefits and weaknesses, as the authors discuss in detail. A second challenge concerns the issue of how (the degree of) interdisciplinarity is to be measured in view of particular research concerns. Scores of integration, specialization or diffusion, for example, each measure changes in ID in distinct ways. Devising a bibliometric study of this kind thus requires one to make difficult choices: "The upshot is that the researcher should not simply apply a standard set of metrics and visualizations to address all interdisciplinary research (IDR) questions; rather the data treatment/methods/metrics/visualizations should be tailored to the study's research questions" (Porter et al. 2019, p. 600 in this volume). While the research design needs to be adapted to the particular case addressed, this

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methodological approach has the benefit that it affords wide comparison—across time and across fields—while addressing the integration of knowledge at different levels of granularity.

The third contribution from Mitchell Ash provides a historical analysis of interdisciplinary practices. One drawback of current discussion is the lack of historical perspective on ID, treating disciplines as somehow stable structures, rather than moving entities. "It should be clear that institutionalized practices of ID cannot be taken as given, but also need to be historicized. This means that they need to be queried as to the circumstances in which they came into being, are or are not stabilized, and pass away or develop in new directions" (Ash 2019, p. 622 in this volume). Taxonomies or definitions of interdisciplinarity in this regard, which lump together cases of ID across time, have little analytic use. Disciplines are not permanent structures, but have constantly shifted, and this implies changes to what counts as interdisciplinary practices and the motivation for it. It should be noted however that much writing on ID seems to imply that ID is a new development in science, associated with the Mode 2 knowledge movement that emerged in the mid-nineties in response to modern environmental and social problems. This feeds the impression that ID must be singular and transformative. But Ash argues that interdisciplinary practices as well as policies favoring interdisciplinarity are much older than this. Historical institutions have favored problem-centered research since the early twentieth century, the Manhattan project being a major example, and science has seen plenty of interdisciplinary practice since. Critically, Ash notes that modern policy movements appear not only to encourage, but to mandate problem-oriented inter- and multidisciplinarity, with the aim of shifting funding priorities toward perceived policy imperatives without asking whether such work actually produces better science or scholarship. He therefore asks whether such policies have actually produced epistemically better science or scholarship, or rather created incentives for scientists to simulate interdisciplinary practices in order to get funding, without engaging in substantive interdisciplinary work. Historical comparison helps to reveal such disjunctions between modern and historical practices, and helps to make visible that the shape that ID takes depends very much on context-specific forces.

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