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On the nature of cross-disciplinary integration: A philosophical framework

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ABSTRACT

Meeting grand challenges requires responses that constructively combine multiple forms of expertise, both academic and non-academic; that is, it requires cross-disciplinary integration. But just what is cross-disciplinary integration? In this paper, we supply a preliminary answer by reviewing prominent accounts of cross-disciplinary integration from two literatures that are rarely brought together: cross-disciplinarity and philosophy of biology. Reflecting on similarities and differences in these accounts, we develop a framework that integrates their insights—integration as a generic combination process the details of which are determined by the specific contexts in which particular integrations occur. One such context is cross-disciplinary research, which yields cross-disciplinary integration. We close by reflecting on the potential applicability of this framework to research efforts aimed at meeting grand challenges.

1. Introduction

Research efforts around the world are increasingly organized around *grand challenges* (Brooks, Leach, Lucas, & Millstone, 2009; Efstathiou, this issue). Classifying a problem as a "grand challenge" indicates that (a) the problem is exceedingly complex—either as a fundamental problem "with broad applications" (e.g., advanced new materials—NSF, 2011, p. xiv) or as a socio-technical problem manifesting at various scales (e.g., poverty, climate change)—and (b) there is interest in mobilizing political and financial will behind research aimed at a solution. Significant global attention has been paid to grand challenges involving the biological and biomedical sciences, including maternal health and child mortality (WHO, 2014), food security (EUFPRI, 2014), and sixteen challenges related to global health identified by the Gates Foundation in partnership with the NIH (BMGF/NIH, 2013). Each of these efforts is associated with substantial funding for research conducted by "an international community of scientists towards predefined global goals with socio-political as well as technical dimensions" (Brooks et al., 2009, p. 8).

Given their complexity, meeting grand challenges will require multiple forms of expertise. At a minimum, experts from multiple academic disciplines are necessary; typically, however, a broader range of expertise is needed, including stakeholder, private sector, and governmental expertise. Further, it will be important that the complexity of a challenge be met with complexity in response. That will require the constructive combination—or *integration*—of perspectives. Meeting grand challenges, then, requires cross-

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disciplinary[1] responses that constructively combine multiple forms of expertise, or what we shall refer to as *cross-disciplinary integration*. But this motivates a prior question: just what is cross-disciplinary integration?[2]

In this paper, we supply a preliminary answer to this question. As we note below, the centrality of integration to cross-disciplinary research has made it a topic of investigation across multiple literatures, but few authors offer reviews that integrate these distributed discussions. Philosophy of biology stands out as a literature in which integration has received sophisticated treatment (e.g., Brigandt, 2013), and the same can be said for the literature on cross-disciplinarity. We detail prominent accounts of cross-disciplinary integration found in these literatures, noting similarities and differences. After addressing methodological preliminaries, we outline a framework that integrates the insights of these accounts. We close by reflecting on the potential applicability of this framework to research efforts aimed at meeting grand challenges.

2. Accounting for integration

In this section, we take an initial step toward an integrated review by providing information about several prominent accounts of cross-disciplinary integration. First, though, a few words are in order about the selection of accounts and the organization of this discussion. There are multiple, overlapping literatures in which ostensibly relevant notions of integration arise: cross-disciplinarity, science of team science, philosophy, communication studies, management, education, and others.[3] As we noted above, we limit our survey in this short article to two literatures: cross-disciplinarity and philosophy of biology. The cross-disciplinarity literature stands out because the notion of integration is a central tool for much work in this area; further, by exploring integration in a more abstract way, this literature provides a "view from above" on integration as it functions in a wide range of cross-disciplinary activities. For a "view from below", we turn to philosophy of science, and specifically, philosophy of biology. Philosophers of science have long reflected on integration, or at least integration-like phenomena (e.g., Oppenheim & Putnam, 1958), but contemporary philosophy of biology stands out for its close and explicit attention to integration across biological disciplines and at multiple scales (O'Malley, 2013). Together, these literatures provide views on cross-disciplinary integration in both theory and practice.

We begin by considering the views of integration developed by a number of contributors to each literature. The views we have selected are prominent within their respective literatures, and they also illustrate a range of approaches to integration that have been developed in each. We then note similarities and differences among the views, focusing on the major points of difference that emerge.

2.1. Integration in cross-disciplinarity

The theorists we consider in this section—William Newell, Allen Repko, Julie Thompson Klein, Gabriele Bammer, and Matthias Bergmann and colleagues—can be classified as *integrationists* because they regard integration as central to cross-disciplinary activity.[4] Klein, for example, observes that "[i]ntegration is widely regarded as the primary methodology of interdisciplinarity" (Klein, 2012, p. 283), while Bergmann et al. (2012) remark that "the importance of integration work … can hardly be overestimated for transdisciplinary research" (p. 42). In a similar spirit, Newell asserts, "By definition, interdisciplinary study draws insights from relevant disciplines and integrates those insights into a more comprehensive understanding" (Newell, 2001, p. 2).[5] A widespread commitment to integration as a central feature of cross-disciplinarity, however, does not entail agreement on just what integration is. Newell remarks that it is "not even clear … exactly what is *meant* by integration" (Newell, 2001, p. 19), while Repko contends that "the lack of clarity on precisely *what* to integrate and *how* to integrate" has been the "Achilles' heel of interdisciplinarity" (Repko, 2007, p. 7).

With a view to rectifying this situation, Newell (2001, 2007), and Repko (2007, 2012) follow Klein (1990) in developing systematic, step-by-step accounts of how to *do* interdisciplinarity, with integration appearing in the later steps (Newell, 2001; Repko, 2012). Set in the context of interdisciplinary studies, these accounts are designed to leverage cognitive insights developed in helping individuals (in particular, students) achieve integrative research success. As an illustration of this approach, consider the algorithmic accounts put forward in Newell (2001, 2007) and Repko (2007, 2012). Both are set against a background of disciplinary conflict and tension. Integration, Repko tells us, "arises out of conflict, controversy, and difference. Without them, integration would be unnecessary" (Repko, 2012, p. 294). Interdisciplinary success is achieved only when disciplinary investigators attain common ground on which "conflicting insights … can be integrated" (Repko, 2012, p. 268). But Newell cautions, "The goal of creating common ground is not to remove the tension between the insights of different disciplines, but to reduce their conflict" (Newell, 2007, p. 260). Conflict reduction is facilitated by various techniques that link disciplinary concepts and assumptions, including "redefinition, extension, organization, and transformation" (Newell, 2007, p. 258). On the algorithmic approach, then, integration is a type of stepwise combination that generates a more comprehensive whole comprising disciplinary parts that have been rendered harmonious by various conceptual techniques.

Some integrationists deny that there is something in common to every instance of integration. Klein (2012), for example, develops a comprehensive account of cross-disciplinary integration that reveals the operation of several general principles, one of which is the

[1] We use 'cross-disciplinary' as a cover term for both interdisciplinary and transdisciplinary activity. When the context requires more specificity—as in Section 2—we will use 'interdisciplinary' to mean the integrative combination of disciplinary perspectives and 'transdisciplinary' to mean the integrative combination of disciplinary and stakeholder perspectives. For discussion of these modes of research, see Klein (2010).

[2] This is consonant with O'Malley's (2013) call for identifying "what is meant by [integration] and whether different interpretations can be combined coherently into a general use of the concept" (p. 552).

[3] See Klein (2013) for consideration of integration in each of these domains, set in the context of concern about communication across disciplines and professions.

[4] See Repko (2007) for details. Klein (1990) is an early source for this idea and Repko (2012), ch. 9, provides a more general discussion of the integrationist position. Bammer (2013) goes beyond interdisciplinarity but the core commitment to integration remains the same. Bergmann et al. (2012) is devoted to working out integration methods, strategies, and supportive aspects for use by transdisciplinary researchers. Repko contrasts integrationists with what he calls *generalists*, such as Lattuca (2001) and Moran (2002), who de-emphasize the role of integration in characterizing interdisciplinarity while emphasizing the roles played by questions or dialog. A more detailed account of integration in cross-disciplinarity would contrast its methodological role with the methods employed by theorists like Lattuca and Moran, but that is beyond the scope of this article.

[5] For a contrary view, see Holbrook (2013). Holbrook associates integration with a mode of interdisciplinary communication that emphasizes inter-translatability and communicative rationality under the banner of the "Klein–Habermas thesis". The other modes of interdisciplinary communication he describes do not involve integration, viz., acquiring a second disciplinary language understood to be incommensurable with your first, or invention of a new language via "strong communication" (p. 1876). We believe that Holbrook's conception of integration is too limited and fails to accommodate the essentially integrative aspects of the other modes of interdisciplinary communication. Unfortunately, we don't have the space here for full consideration of his critique.