# An Introduction to Interdisciplinary Research

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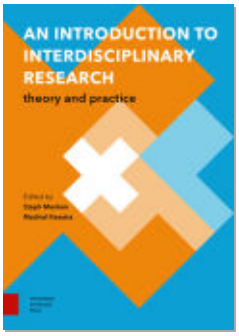


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# 6 Interdisciplinary integration

When we distinguished between multidisciplinarity and interdisciplinarity in chapter 4, we pointed out that the synthesis or integration of disciplinary insights is the defining characteristic of interdisciplinarity. Subsequently, we gave an overview of possible drivers of interdisciplinary research in chapter 5. Once groups of scientists from different disciplines or fields bring their respective disciplinary expertise to the table, the question arises how to integrate these with each other. This is not an easy task, as different disciplinary academics tend to think and do research in different ways as a consequence of their different disciplinary educations.
So let us now zoom in on interdisciplinary integration itself. What exactly does integration mean? And how can insights from different academic disciplines be integrated, especially when they appear to be incommensurate or in conflict with each other? In this chapter, we will introduce the process of interdisciplinary integration, and how and when it is done. Moreover, we will provide a set of different approaches to integration. In box 3 we give an example (ADHD in school-aged children) that illustrates the added value of an integrated interdisciplinary approach.

Box 3

## ADHD in school-aged children

Attention deficit hyperactive disorder (ADHD) is a mental disorder and, at the same time, a societal problem of significant proportions. In the US, for example, between two and four million school-aged children are affected by the disorder, showing symptoms such as hyperactivity, lack of concentration, and impulsivity. However, a thorough understanding of ADHD has not yet been arrived at. This drove Lauren Dean, a student at Miami University, to conduct an interdisciplinary study to unravel what is preventing us from understanding the causes of ADHD (Newell, 2006).
To start, Dean mapped out the different assumptions and views on ADHD from the different disciplines that provide insights into the problem. She found that scientists from the fields of biology, psychology, and medicine tend to categorize ADHD as a biological disorder that needs biological intervention in the form of medication, although they realize that it cannot be diagnosed by physical tests alone, like other disorders of biological origin. Academics with a background in sociology, social history, or culture

studies, in contrast, think the causes of ADHD are social and cultural, and often reject a physiological explanation of ADHD. Scholars from the field of educational science agree with the first group that ADHD is a medical problem, but also converge with the social causes of ADHD, as some hypothesize that parenting behavior is the main cause of the onset of ADHD, rather than biological factors. In other words, Dean found that the different disciplinary explanations of ADHD are a perfect example of the nature-nurture debate: the debate on whether something is caused by genes (nature) or by the social environment (nurture).

Moreover, Dean found that the concept of childhood had changed over the last couple of centuries and that it is primarily a socially and culturally constructed concept. As a consequence of the increase in employment of women during the last half century, the concept of childhood has undergone changes, as children are placed in kindergartens and pre-schools. Therefore, the definitions of 'normal' and 'deviant' behavior of children have also shifted accordingly. In these educational spaces, behavior now classified as typical of ADHD has become increasingly problematic. Subsequently, children who do not fit the ideals of their parents and do not concur with contemporary educational ideology are increasingly labeled ADHD.

The main problem, Dean states, is that the disciplines concerned with ADHD use different definitions of ADHD-type behavior and often employ different definitions for the terms 'normal', 'deviant', and 'childhood'. As a consequence, a comprehensive understanding of ADHD is still lacking. Through interdisciplinary integration and by redefining key concepts, one can move toward a better understanding of this disorder.

The example above illustrates the need for and value of interdisciplinary integration. But what is meant by integration? Interdisciplinary integration can be defined as the synthesis of two or more disciplinary insights – drawn from different perspectives – into new knowledge. An important step in integration is to identify which disciplines are necessary for a complete understanding of the problem. Then, one has to uncover which assumptions underlie each discipline. More generally, what are the disciplines' paradigms? Disciplinary academics are largely unaware of some of their assumptions, and interdisciplinary dialogue helps to reveal those assumptions.

Note that in today's research practice, interdisciplinary integration often occurs but is rarely described. As researchers are asked to report on the results of their interdisciplinary endeavor – and not so much the process that has led them to integrate the different findings – they are usually not focused on this process. Although integration is common practice at DRIFT, Loorbach, for example, has trouble stating when exactly it happens: "It is hard to pinpoint when and where

interdisciplinary integration happens, since it's a normal condition for us. I don't recognize when it happens exactly; I'd only recognize it if it didn't happen. And that never happens in practice, because it's the core of our work."

Although it is usually not described, interdisciplinary integration often forms the basis for a new and more comprehensive understanding of the problem being studied. Integration is primarily a cognitive process enabling scientists to combine different (disciplinary) concepts, methodologies, or theories that, at first glance, have no readily apparent connection or commonality.

## 6.1 Communication as a first step to integration

Interdisciplinary integration begins with communication across disciplinary boundaries, revealing differences but also highlighting similarities between the insights derived from different disciplines. This can be a challenge. There are plentiful examples of scientists who argue against each other (often from within the safe borders of their own discipline) instead of creating a productive dialogue. This is often the result of their making various implicit assumptions pertaining to their respective disciplines. Inexplicit misunderstandings may then arise concerning what is deemed a valuable question, what are valid data, what kind of result (publication, intervention, technology) should emerge from the research project, and so on. Clearly, as scientists are often unaware of the implicit assumptions of their discipline, such assumptions will only become explicit when they engage with each other in an open and extended dialogue with each other based upon mutual trust and respect.

An open mind and the courage to step outside of one's comfort zone are essential characteristics for a productive dialogue. Jeroen van Dongen, professor of History of Science at Utrecht University and the University of Amsterdam (pers. comm., 4 December 2013): "When you study, you submerge yourself in the culture of that discipline. You learn not only its knowledge, but also its cultural values and norms. In interdisciplinary research, talking with someone from another discipline means you are meeting someone from another culture. When doing so, you have to 'a-culturalize' from your disciplinary backgrounds." Julie Thompson-Klein (1996) even contends that interdisciplinarians, as members of a new social and cognitive community, form a new, shared language, a creole. When you study a topic that falls within a specific interdisciplinary field, you have to learn the creole of that field as well.

In the example of ADHD, psychologists, sociologists, and biologists had to overcome several challenges in order to come to a fruitful dialogue. Psychologists and biologists tend to categorize ADHD as a biological disorder, whereas academics from the fields of sociology and cultural studies think the causes of ADHD are social and cultural. In addition to these differences, both views also have similarities – they share 'common ground' – as biologists, for example, realize that the disorder is diagnosed in a social context and psychologists are aware of the biological processes underlying a patient's behavior and cognition. In order to overcome the differences arising from the different disciplines, certain components (that are relevant to the research problem) of the participating disciplines need to be modified. As you can

see in the example of ADHD, the different disciplinary definitions of 'normal', 'deviant' and 'childhood' needed adjustment. Such modification of components can be accomplished in various ways and on various levels (corresponding with different research phases), as is explained below.
There have been specific questionnaires and dialogue techniques developed in order to guide interdisciplinary team communication and collaboration (see the list with further readings and websites for some references). Once the differences and similarities between disciplinary contributions are examined, one can move on to the next challenge: creating common ground. By this we mean reinterpreting these differences in order to bring out commonalities between the disciplines. This forms the preparation for interdisciplinary integration.

## 6.2 Integration techniques

Recalling our discussion in chapter 2 of the Science Cycle and the main ingredients that determine what science is: starting with pre-existing theories and laws a scientist engages in the reasoning processes deduction and induction and comes up with new predictions and conjectures. These are then operationalized and investigated by turning toward the world or reality. After the process of data collection and observation of facts, the scientist might think that inductive reasoning toward an adjusted or new theory is warranted. During all of this, the scientist would best articulate relevant implicit assumptions and acknowledge the theoretical and methodological pluralism involved. We will observe that several of these ingredients and phases in the Science Cycle turn out to be important for the process of interdisciplinary integration.

As touched upon above, integration may take place in different ways and at different levels. Newell (2006) introduced a set of integrative techniques to carry out trans- and interdisciplinary integration. We categorize this concrete set of techniques into three broader classes of integration methods. First, one can add one or more elements from another discipline to a certain disciplinary theory, method, or result. Second, disciplinary theories, methods, or results can be adjusted using insights from other disciplines and, third, in some cases it is possible to connect several disciplines around a central idea. Note that in practice a combination of these techniques is not uncommon. We present them here separately, but in practice – as you will experience while engaging in interdisciplinary research yourself – they form a continuum, as integration usually takes place at multiple stages of the research process (illustrated in figure 7).

### Add

One can add an element from another discipline to a disciplinary theory, for example by using the technique of extension. Differences or oppositions in disciplinary concepts can sometimes be addressed when one extends the meaning of an idea beyond the domain of the discipline into the domain of another discipline. Robert Frank (as reported in Newell, 2007), for instance, extended the meaning of 'self-interest' in economics from its short-term context. He included the long

term, because, as he argued, someone who acts out of self-interest in the short term may create a reputation that is not beneficial to self-interest in the long term. In other words, he extended the economic meaning of self-interest with insights from sociology and evolutionary biology. As a result, the scope of his theory of self-interest was much larger than that of previous economic theories and so was the domain in which the theory was applicable.

### Adjust

When commonalities in concepts or assumptions are obscured by discipline-specific terminology, you can adjust the concept by giving it a new name and a meaning that does justice to your interdisciplinary insight. In other words, you will create a new term that captures the commonality in the current terms.

To adjust a concept, one can use the technique of redefinition. An example is the research by Janet Delph, as described by Repko (2007). She identified three disciplines that are most relevant for crime investigation: criminal investigation (justice), forensic science (biology, chemistry), and forensic psychology. A source of differences or conflict between these sub-disciplines is their preference for two different investigatory methods and reliance on two kinds of evidence: physical evidence (forensic science), and intuition born of extensive experience and insights from crime scene analysis (forensic psychology). By redefining these methods together as 'profiling', Delph was able to bridge the natural sciences (i.e. forensic science) and the behavioral sciences (i.e. forensic psychology and criminal investigation). She was then able to demonstrate how specialists from the fields of criminal investigation, forensic science, and forensic psychology could integrate their knowledge. This implies that when no adequate traces are available to forensic scientists for analysis, 'profiling' can still move on by, for example, using a combination of 'intuition' born of extensive experience and insights derived from crime scene analysis.

When concepts or assumptions appear to be diametrically opposed, the technique of transformation can be used. For example, economists traditionally define humans as rational agents, whereas most sociologists hold humans as irrational. This difference, or conflict, between disciplinary perspectives can be resolved by changing a dichotomous assumption about rationality into a continuous variable. As a result, the notion of (ir)rationality becomes a variable instead of an assumption; instead of either/or, we are now able to determine different degrees of rationality in humans, partly influenced by their social conditions – as was shown with the example on poverty above.

### Connect

When key concepts have the same name but different meanings in different disciplines, it is helpful to draw a concept map and define and connect the different meanings of the particular concept. The technique of organization can help to capture the different conceptualizations of the term and thus integrate them in a global interdisciplinary way. Newell (2007), for example, describes how Boulding recognized that both benevolent behavior (studied by sociologists) and malevolent

behavior (studied by political scientists) can be understood as other-regarding behavior (studied by political scientists). He connected the concepts by placing them along a continuum of other-regarding behavior, with the self-interested behavior studied by economists as the midpoint, because its degree of other-regarding behavior is zero. Boulding used the technique of organization to integrate differing conceptions of human nature underlying economics, sociology, and political science, and transformed the debate about whether human nature in general is selfish or altruistic into a choice of where on the continuum of motivations people are likely to fall in the particular complex problem under study.

In many cases, integration relies upon a mixture of the three categories of integration techniques and has implication for theories, methods as well as results. Environmental sciences and other sustainability related studies, for example, often employ optimization functions in order to determine a solution for a particular problem that is sustainable both in economic, social, and ecological terms and not just in either one of these. Adding and connecting theoretical insights into the relevant variables will help to develop the complex optimization function necessary for such calculations. When scientists use these optimization functions they may also use the figures or graphs result from them, providing an additional and visual mode of presentation that can be helpful for a team discussion.

### Other options for integration

Obviously, these three categories are not exhausting all options for integration of insights. Another and long-standing technique for combining insights from two or more disciplines into a problem, is reasoning by analogy or metaphor. Some cognitive scientists, for example, describe thinking as a form of computing. Consequently, they can use some principles of digital computing to formulate hypotheses on thought processes or employ other insights or methods from computational science in their study of human cognition.

Apart from distinguishing between techniques of integration, we can also distinguish between different levels at which such integration can take place. Newell (pers. comm., 3 December 2013), for example, states that integration can take place at the level of concepts, theories, and methods. All these levels involve parts of disciplinary paradigms, and when creating common ground between them, one can subsequently truly integrate and form new, interdisciplinary insights. However, we would argue that in broad interdisciplinary research projects, integration may also take place at the level of results, as illustrated by the example of a research project on sustainable energy on p. 98, in which disciplines as unrelated as political science and physics come together. The three levels (or research phases) are included in figure 7: theory (which here includes concepts), methods, and results.

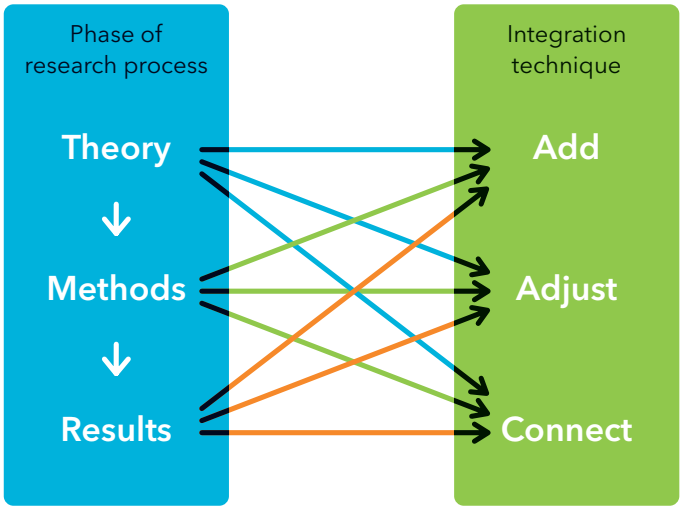


*Figure 7 Overview of integration techniques*

These different strategies to achieve integration are further examined in part 2, but first let us try to clarify these strategies by means of the example on sustainable fisheries in box 4.

Box 4

## Sustainable fisheries

Managing fisheries was traditionally a matter of landing as many fish as possible. The focus was on controlling the amount of fish, in order to secure, or even increase, profit margins. This mode of management can be classified as management-as-control, and its resources (e.g. fish) were considered commodities. Moreover, the ecosystem and the social system were viewed as completely separate (Berkes, 2003).

This approach inevitably led to the overexploitation of fish stocks, causing collapses in fish populations all over the world. Different stakeholders started to clash when conflicts between ecological, economic, social, and cultural interests emerged (Charles, 1994). Thus, the need arose for a renewed and integrated approach to fishery management. In response, a new approach to fishery management was developed, in which certain key elements were redefined. There were no longer two separate systems (fish ecosystem and human social system), but one integrated socio-ecological system.

The type of integration occurring here can be described as connecting theories (in this case from the fields of ecology and social sciences). Moreover, fish stocks were redefined as ecosystem components with their

own niches and functions instead of simply as a commodity. In effect, a concept (which is a component of a theory) was adjusted. Lastly, the management-as-control approach was replaced by an approach focusing on managing for resilience (Berkes, 2003), thus constituting an adjustment of a method. As a result, fisheries have become more sustainable and the social benefits linked to them have become more stable.

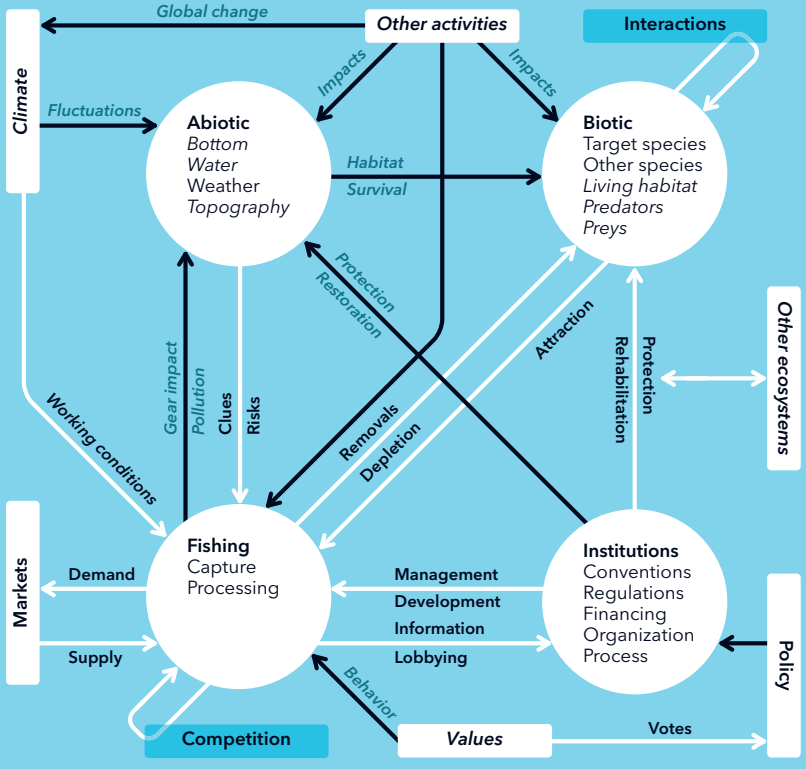


*Figure 8* *An integrated model of the socio-ecological system around fisheries (Garcia & Cochrane, 2005). Reprinted with permission from the publisher*

Thus, many problems that require an interdisciplinary research approach encompass a range of interrelated systems/subsystems, mechanisms, and/or processes. Interdisciplinary research on these problems involves analyzing how these different components are related to each other. A conceptual model can therefore be a valuable tool. In figure 8, a conceptual model of the socio-ecological system of fisheries is displayed. As you can see, the various subsystems are the different research areas of disciplines ranging from ecology, climatology, and earth sciences, to economics, political science, and jurisprudence. Their theories are connected and this visualization makes clear how they are related and influence each other.

The above example of sustainable fisheries also shows that integration of scientific insights can be carried out with other means than by focusing on science ingredients like theories, concepts, laws, and the like. Indeed, visual means can often be very useful in facilitating and specifying such integration, as graphs, tables, and schemas often involve a specific alignment of different features of a particular phenomenon, which then invites further reasoning about the apparent structure of this alignment. A famous example is the 'hockey-stick curve' published in 1999 by climate scientists Mann, Bradley, and Hughes in which temperature variations over time since the year 1000 are shown, indicating a strong increase in rising temperatures since the nineteenth century. Further alignment of this figure with data about industrialization subsequently suggested that it may be useful to investigate an explanatory mechanism that would allow integration of these data. A still different mode of integrating insights occurs when engineers develop constructions that are both in accordance with scientific insights and with ergonomic requirements or when a social policy is developed that takes into account the cultural norms of a specific target group. In other words, developing an interdisciplinary (or transdisciplinary) integration of insights not only requires knowledge in pertinent insights but can often also depend upon an interdisciplinary team's creative imagination.

You have now completed the first part and have gained an initial understanding of interdisciplinarity. You have learned what science is, how academia is organized into different disciplines and what these disciplines can accomplish. You have also learned that the complex nature of many problems demands an interdisciplinary research approach. And finally, you have learned that integration is a key aspect of interdisciplinary research.
In part 2, we will present a model on how to perform interdisciplinary research. We will guide you through the interdisciplinary research process step by step. We will give you tips, teach you tricks, and show you examples of interdisciplinary research projects that we believe will provide a solid basis for your own interdisciplinary research project.