An introduction to Interdisciplinary Research

2nd revised edition

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Amsterdam University Press

Volume 2 of the Series Perspectives on Interdisciplinarity

Cover design and lay-out: Matterhorn Amsterdam

ISBN 978 94 6372 469 2
e-ISBN 978 90 4855 759 2
DOI 10.5117/9789463724692
NUR 143

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Acknowledgments

This handbook is based on almost 20 years of experience with interdisciplinary studies accumulated by the authors, editors, and others involved in writing this book. The approach we have adopted relies heavily on the materials and practices used by the Institute for Interdisciplinary Studies (IIS) at the University of Amsterdam (UvA). A first edition of this handbook, edited by Menken & Keestra and written by Rutting, Post, Keestra, de Roo, Blad and De Greef, appeared in 2016 and has been used in various courses at the IIS and elsewhere, which has provided us with a wealth of experience and feedback from both students and faculty members who have worked with it. For this second edition, therefore, we have extensively revised the text and several key elements of the interdisciplinary research process, which is the cornerstone of this handbook.

The first part has in fact been almost entirely rewritten by the handbook's first author. The chapter on interdisciplinary integration has been conceived anew – given that it is the key ingredient of interdisciplinary research – and is now more in line with the practice of interdisciplinary research than in the previous edition. It now presents a toolbox with a wide variety of integration techniques and explains why many research projects might apply a plurality of such techniques in parallel. This type of plurality is now addressed more explicitly in other chapters as well. For example, more attention is given to transdisciplinarity, as the inclusion of extra-academic stakeholders in research projects has become more prevalent and important in recent years. In addition, this edition makes explicit the multiple dimensions on which cases of interdisciplinary research can vary from each other. Although the second part of the handbook is less extensively revised, we have made some changes to the structure of the interdisciplinary research process to better reflect how this process works in practice, based on what we and our students and colleagues have observed. This edition also offers some insights on collaboration provided by members of an interdisciplinary research team, given that most interdisciplinary research is in fact carried out in teams. Finally, in contrast to the first edition which did not include references to projects involving the humanities, we have now included examples and observations from a wider range of disciplines and fields of research.

The first edition benefitted from feedback and commentary from a large number of (international) colleagues and students. Given the extensive revisions of this edition, we are grateful to the many people – from the IIS and elsewhere – who were this time willing to read our drafts and provide useful feedback and critical commentary. In alphabetical order, they are:

- Prof. L. Bertolini – IIS, Faculty of Science, UvA
- Ms. L. de Greef, MSc – IIS, Faculty of Science, UvA
- Dr. P.D. Hirsch – Department of Environmental Studies, SUNY College of Environmental Science and Forestry
- Dr. L. Jans – Environmental Psychology, Faculty of Behavioral and Social Sciences, Rijksuniversiteit Groningen
- Dr. E.F. Strange – Institute for Environmental Science (CML), Faculty of Science, Leiden University
- Prof. J. Thompson Klein – Emeritus professor of Humanities, Wayne State University
- Dr. J.C. Tromp – IIS, Faculty of Science, UvA

We would like to take this opportunity to thank the interdisciplinary researchers who shared their stories about interdisciplinary careers in Chapter 12:

- Dr. B. Vienni Baptista – Department of Environmental Systems Science, ETH Zürich
- Dr. A. Beukenhorst – Strategic Lead & Academic Liaison, Leyden Labs
- Prof. C. Lyall – School of Social and Political Science, University of Edinburgh
- Dr. J. Swart – Science, Technology, and Society, Michigan Institute of Technology

We are also grateful for the support and feedback of the lecturers and students of various bachelor's and master's programs, in particular:

- Ms. J. Libert, MSc – IIS, Faculty of Science, UvA
- Mr. A.N. van Woerden, MA – IIS, Faculty of Science, UvA
- Mr. M.H. Strømme, MSc – IIS, Faculty of Science, UvA
- Mr. I.P. Oostrom, MA – IIS, Faculty of Science, UvA
- Dr. E.D.A. van Duin – Parnassia Groep
- Mr. W. van der Hoeven, BSc – Alumnus of Beta-Gamma Studies
- Ms. L. van Eck – Alumna of Beta-Gamma Studies
- Ms. N. van de Water, BSc – Alumna of Beta-Gamma Studies
- Ms. N. Rijneveldshoek, BSc – Alumna of Beta-Gamma Studies
- Mr. N. van Stee, BSc – Alumnus of Future Planet Studies
- Ms. F. Mostert, BSc – Alumna of Future Planet Studies
- Ms. F. de Haan – Student of Beta-Gamma Studies
- Ms. N. Kasirga – Student of Future Planet Studies
- Ms. A. Mul – Student of Beta-Gamma Studies

Finally, we thank our colleagues for their coordination of the writing process and for their comments regarding the improvements from the first print:

- Dr. Y. Hartman – IIS, Faculty of Science, UvA
- Ms. J. Conemans, MA – IIS, Faculty of Science, UvA
- Ms. E. Krooshof, MSc – IIS, Faculty of Science, UvA
- Ms. L. Dokter, BSc – IIS, Faculty of Science, UvA

Preface

An Introduction to Interdisciplinary Research is a handbook on interdisciplinarity and a manual on how to conduct interdisciplinary research. Although several books have already been written about interdisciplinary research that have provided rich theoretical descriptions of and hands-on approaches to this topic, this handbook is a more condensed resource focusing on students in the social and natural sciences. The most relevant comparison to draw here is with Allen Repko's seminal *Interdisciplinary Research: Process and Theory* (now in its third edition, with Rick Szostak, 2017). Repko's book served as an important source of inspiration and information for us. Having used Repko's book for several years in our interdisciplinary research seminars, we felt the need for another book that would differ in several respects from Repko's valuable book. While Repko primarily addresses undergraduate students of the liberal arts and sciences in the United States and Canada, our book mainly focuses on (European) undergraduate and graduate students with more experience in disciplinary research. This is why our book primarily contains examples of research carried out in European interdisciplinary programs. Furthermore, our book has probably more to offer to students of the social and natural sciences. We have also included a thorough description of the concept of complexity, which we – and others – consider to be a main driving force behind interdisciplinarity. A related and not insignificant difference to Repko's manual concerns size: we explicitly aimed to produce a more condensed book that is practical, to the point, and clear.

The book is divided into three parts. The first part – *The Handbook* – presents a brief overview of interdisciplinarity and provides more conceptual insights into the origins of and reasons for interdisciplinary research, what its key features are, when it can be applied, and why it should be applied. This is all in preparation for the second part of the book – *The Manual* – which focuses on the step-by-step process of interdisciplinary research, setting out instructions on how to undertake this type of research. The third part contains a model example of an interdisciplinary project and a chapter highlighting the careers and experiences of some interdisciplinary scholars.

Many questions surround interdisciplinary research. How does it differ from disciplinary research? What does it demand of the interdisciplinary researcher? What possibilities does it have that disciplinary research does not offer? It is important to note that interdisciplinary research builds on disciplinary research. When dealing

with complex problems, however, an approach that is merely disciplinary will not suffice. Such problems require an interdisciplinary approach to arrive at scientifically and socially robust answers.

The interdisciplinary research process is not an easy journey. In fact, it is a challenge for undergraduate/graduate students and experienced senior researchers alike. The aim of this book is to make the process more accessible. We provide many examples of interdisciplinary research projects, obstacles that researchers encountered during their academic journey, and the solutions they came up with. Moreover, we interviewed researchers who are experienced in applying an interdisciplinary approach, and we share their expert insights in this book.

As mentioned, it would have been impossible for us to write this book without the contributions of the experts, lecturers, students, and other individuals affiliated with the Institute for Interdisciplinary Studies (IIS) at the University of Amsterdam (UvA). We hope you learn much from reading this book and that you are able to put into practice any insights you obtain. We do welcome your feedback, so if you have any suggestions on how to improve this book (perhaps for a next edition), please get in touch with us at Onderwijslab-iis@uva.nl.

Chapter guide

The first part of the handbook begins with a short introduction that also explains why interdisciplinary research has been gaining in prominence (Chapter 1). We then briefly delve into the philosophy of science and offer a description of the science cycle, which is used later in the book to explain the nature of interdisciplinarity (Chapter 2). Chapter 3 continues with a philosophical and historical account of the emergence of disciplines and interdisciplinarity as well as a brief look at attempts at unification and pluralism. Pluralism is also covered in Chapter 4, which describes interdisciplinarity's variations and the drivers behind them. It includes sections on complex and wicked problems, transdisciplinarity, and action research. Chapter 5 introduces a toolbox of techniques for interdisciplinary integration – essential to interdisciplinary research – while following the structure of the science cycle that was presented in Chapter 2.

After reading Part 1, you will have acquired enough insight into and understanding of scientific research – interdisciplinary and otherwise – to start your own interdisciplinary research project. Part 2 will guide you through this process by means of a model of interdisciplinary research introduced in Chapter 6. The chapter points out where monodisciplinary and interdisciplinary research approaches differ and gives a step-by-step explanation of the process – from the definition of the problem (Chapter 7), the formulation of the research question (Chapter 8), and data collection and analysis (Chapter 9) to the discussion and conclusion (Chapter 10).

In Part 3, we provide an example of an interdisciplinary research project (Chapter 11) carried out by a team of students following the steps outlined by the model introduced in Part 2. Furthermore, we ask four interdisciplinary scholars to share their experiences with interdisciplinarity in Chapter 12.

Part 1
The Handbook
'The What'

1 Introduction

Half a century ago, philosopher of science Karl Popper famously observed: 'We are not students of some subject matter, but students of problems. And problems may cut right across the boundaries of any subject matter or discipline.' (Popper, 2002). Academic disciplines like anthropology, economics, history, mathematics, neuroscience, and physics are traditionally organized around the kinds of things that they investigate. Yet this division of disciplines assumes that we can understand or explain the properties of a specific 'kind of thing' or phenomenon from the perspective of a single discipline. As soon as we focus on a particular question or research problem that involves such things, however, we often find ourselves forced to collaborate across these traditional disciplinary boundaries.

Unsurprisingly, Popper's statement has become increasingly relevant. Today, many of the phenomena and problems that we are trying to understand and solve do indeed 'cut across' the traditional boundaries of academic disciplines. Whether we are focusing on phenomena as wide-ranging as cross-cultural communication, climate change, the financial crisis, genetic modification, an interpretation of a religious text, the Covid-19 pandemic, or life satisfaction, we will find scientists* from a wide range of disciplines working together to understand these phenomena and to develop responses to the challenges they pose. Such collaborations are a result not only of the growth of our knowledge, laying bare the connections between phenomena, but also of the growing complexity of our world, which creates more and more interdependencies. Both these developments – our growing knowledge as well as the increasing complexity of reality – compel us to give an ever-greater role to interdisciplinary approaches to research.

This growing importance of interdisciplinary knowledge was signaled by a groundbreaking 1972 report by the Organisation for Economic Co-operation and Development (OECD) called 'Interdisciplinarity: problems of teaching and

* Unfortunately, there is not a single word in English that refers to academic researchers in general, unlike in the Dutch language ('wetenschappers') or in German ('Wissenschaftler'). Although the word 'scientists' is generally understood to refer to those working in the exact and life sciences only, we will use it here in the more general sense of those engaged in some form of academic or scholarly research, including those in the arts and humanities and in the social sciences.

research at universities' (Apostel, Berger, Briggs, & Machaud, 1972). Since then, numerous interdisciplinary research and educational programs have emerged at universities and similar institutions across the globe. These developments are further fostered by academic institutions and funding agencies specifically aiming to support interdisciplinary research in a growing recognition of the added value of interdisciplinary research alongside disciplinary research. The European Commission – responsible for large international research funding programs – wrote in 2004, for example 'It is also seen in the fact that the academic world has an urgent need to adapt to the interdisciplinary character of the fields opened up by society's major problems, such as sustainable development, the new medical scourges and risk management.' However, the commission acknowledged that universities – and other organizations, we might add – find it difficult to adapt to this need for interdisciplinarity: 'Yet the activities of the universities, particularly when it comes to teaching, tend to remain organized within the traditional disciplinary framework' (European Commission, 2004, 11-12).

Given this prevalence of a disciplinary framework, how are we to understand the growing prominence of interdisciplinarity? As mentioned, it is not exceptional for a phenomenon to be determined by many different factors and for changes in the context to also have an impact, making it challenging to investigate the phenomenon and to seek to explain, predict, or intervene in it. Scientists often work hard to create a situation in which they can focus on one single factor – or only a few factors – contributing to the phenomenon. To this end, they have developed research methods that allow them to focus exclusively on one or several factors, for example in the laboratory where they can control the circumstances. Such focused research can lead to separate theories that describe – and possibly also explain – the relation between the phenomenon at stake and a single specific factor or a few such factors. However, and this is an important point, in our messy world, the same phenomenon might be affected by a multitude of factors, making it more difficult to investigate. If scientists succeed in accounting for all relevant determining factors as well as the interactions between these factors, they will be better able to understand, predict, explain, and perhaps even control that phenomenon.

Let's look briefly at an example to illustrate this. The link between alcohol and aggressive behavior has been known to mankind for a long time, as ancient texts and art works testify. However, more recent studies have made visible the causal pluralism involved in this connection, several of which are reviewed by Heinz and colleagues (Heinz, Beck, Meyer-Lindenberg, Sterzer, & Heinz, 2011). Instead of a monocausal link between the consumption of alcohol and aggression, the authors argue that a more comprehensive explanation involves multiple determining factors that also work in different forms. Some factors even play more than a single role in this connection. For example, there are various cognitive processes involved. As is well known, alcohol reduces the control that a subject is able to exert over his cognitive and behavioral processes, making him more liable to impulsive actions. Another cognitive effect of alcohol is a reduction in the subject's ability to steer his attention, which may result in a limited overview of a situation. Furthermore, alcohol impedes threat-related information processing, which can lead to wrong interpretations of another person's behavior. Finally, some individuals expect to become more aggressive upon alcohol consumption, which makes them act in a more hostile manner after being merely exposed to alcohol-related priming stimuli.

Although the analysis above focuses on cognitive processes and foregrounds relevant disciplines, other fields of research that Heinz et al. leave out could also have an effect. For example, the expectations about the effect of alcohol consumption on an individual are partly based on socio-cultural information and education. For example, the ancient Greek god Dionysus, who represented wine and theater as well as ecstasy, was also considered a liberator. However, as liberating as wine consumption and other forms of ecstasy might be, these often lead to violent and even tragic events as generations of spectators have learned from ancient and modern theatre plays. Looking at neurobiological factors, geneticists have shown that some individuals are more at risk of displaying aggression when drinking alcohol because their genotype specifically affects the functioning of their amygdala and hence emotion processing. Interdisciplinary research can further enrich our insights into the link between alcohol and aggression beyond those mentioned above. Although it may appear that we are unnecessarily complicating an already complex relationship, the hope is that adding such insights will help us explain additional variations in the aggression that some individuals demonstrate upon consuming alcohol. Moreover – and related to this – interventions developed to mitigate aggressive behavior in alcohol users must take such complexity into account if they are to provide a robust response that works not only under controlled clinical conditions but also in real life.

This example demonstrates that an interdisciplinary approach to alcohol-related aggression is necessary if we aim to develop explanations and predictions that are robust – i.e., that are valid under various conditions. We must be able to explain the relation between alcohol and aggression as it pertains to not just a very limited and specific group – for example, those who share a particular genotype and who are prone to specific cognitive responses – but also a broader group, and this means we must understand how the variations in response patterns are determined by multiple factors. Hence the need to invoke a plurality of theories and methods and to integrate multiple sets of data. If this proves insufficient, we could take a transdisciplinary approach. In transdisciplinary research, the net is widened to include not only scientists from different disciplines but also extra-academic stakeholders (Hirsch Hadorn et al., 2008). In this example, alcohol users and their family members and colleagues might be invited to participate in a project that aims to develop an intervention that is effective not just in controlled settings but also in real-world situations.

Designing a socially robust measure obliges us to consider the perceptions, priorities, and interests of all these stakeholders from the moment the initial research question is formulated up to when an adequate intervention is developed. Since

the effectiveness of any intervention generally depends on the adequate compliance and collaboration of the target group and those in their environment, including stakeholders in the research project turns out to be crucial. If we look at Figure 1, we see how the perspective of an extra-academic stakeholder can help increase the robustness and relevance of scientific research. Although this undeniably puts additional demands and constraints on such projects, especially when performing such transdisciplinary research, we consider this transdisciplinarity sufficiently important to include it in this handbook on interdisciplinary research. For this reason, we will strive to prepare the users of this handbook for a wide variety of projects in which multiple boundaries are crossed – not just between disciplines but also between science and the world of lived experience.

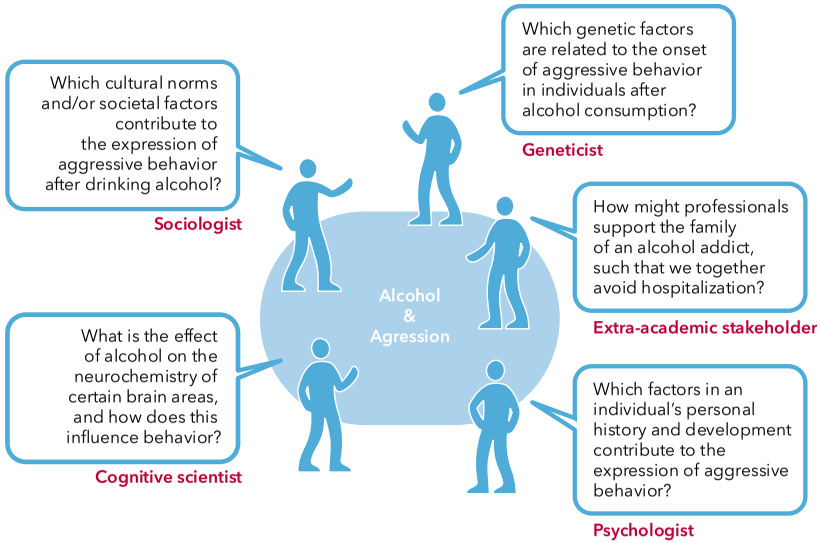

Figure 1 Different perspectives on the relationship between alcohol intake and aggression

Scientists conducting interdisciplinary research must have a theoretical and philosophical understanding of what a discipline is and how science in general operates. Such philosophical insights will help them to recognize and understand disciplinary differences and similarities and to grasp what integrating different disciplinary perspectives implies. Chapter 2 offers a tailored introduction to the philosophy of science and takes a close look at the science cycle, which most scientists employ implicitly or explicitly. The chapter includes a brief discussion of the theoretical and methodological pluralism that is common in science nowadays, which can facilitate interdisciplinary collaboration. It closes with an exposition of ontological, epistemological, methodological, and normative assumptions that are at stake in every research project, the articulation of which can help researchers remove obstacles and build bridges to interdisciplinary collaboration.

Chapter 3 then offers an account of the way in which disciplines have come to be categorized. This categorization is partly the result of historical and at times coincidental developments, which is why disciplinary boundaries might require revision – as Popper's quote implies. In line with Popper's student Thomas Kuhn, we argue that a discipline is not just characterized by its shared body of knowledge and methods but also by its social and institutional manifestations, including textbooks, conferences, and educational programs. These social and institutional structures engender both disciplinary specialization and isolation, which presents challenges to scientists investigating the complex topics mentioned above. Chapter 3 closes with a brief discussion of the movement to unify science – a failed attempt to overcome disciplinary specialization and isolation.

The concepts of multidisciplinarity, interdisciplinarity, and transdisciplinarity are defined in Chapter 4, which then goes on to delineate the several dimensions on which interdisciplinary projects can be distinguished from each other, such as: narrow or broad interdisciplinarity; the number and relevance of the disciplines involved; case-based or theory-driven interdisciplinarity; and their levels of integration. The chapter continues with an explanation of the increasing prevalence of interdisciplinarity and ends with a brief look at some recent developments affecting interdisciplinary research both in terms of content and methodology: complexity, wicked problems, transdisciplinary research, and action research. By showing these variants of interdisciplinarity as well as the latest developments in this field, we hope to help you reflect on the possible shape of your own interdisciplinary project and make informed decisions about this.

Finally, the more foundational part of this book (the 'what') closes with Chapter 5, which deals with the essential ingredient of interdisciplinarity: the integration of different disciplinary contributions. In line with the theoretical and methodological pluralisms discussed in Chapter 2, we present a toolbox of integration methods ranging from conceptual integration to the development of an interdisciplinary intervention or instrument. Importantly, a given interdisciplinary research project might employ multiple integration methods in parallel or during different stages of the project.

After having familiarized yourself in Part 1 with the structure and process of science and the ways in which disciplinary perspectives might be integrated with each other, you are now ready to incorporate these insights into your own project. Part 2, 'The Manual', presents our model of the interdisciplinary research process and its nine steps. Distinguishing the research trajectory into the orientation phase, the theoretical analysis phase, the data acquisition and analysis phase, and the completion phase, Chapters 6 to 10 guide you through the interdisciplinary research process – from adequately determining your research problem to interpreting your results and drawing conclusions. Each chapter presents several examples from the research literature to illustrate the steps to be taken and decisions to be made. The accompanying reflection questions help you to understand these steps and to make

decisions together as a team. It is worth emphasizing here that, given that this is an 'iterative decision-making process' (Newell, 2007), during your interdisciplinary research you may need to revisit a previous step in light of the insights you have gained along the way. Indeed, interdisciplinary research is sometimes more time-consuming and frustrating than disciplinary research, but this should not surprise you considering its richness and complexity.

Since this book is based on the authors' shared expertise in supervising hundreds of undergraduate and graduate interdisciplinary teams, it also addresses the issue of team collaboration. Although it is not impossible for one individual researcher to integrate different disciplinary perspectives, disciplinary specialization and isolation make this the exception rather than the rule nowadays. Unfortunately, disciplinary training does not always prepare students sufficiently for working together with colleagues from other disciplines. Assuming that all are sufficiently curious about other perspectives and open-minded about crossing boundaries between disciplines, we will offer insights and practical advice on how best to work in a team. We are confident that, upon reading this handbook and applying its contents in practice, interdisciplinary research teams will be able to develop adequate solutions to the challenging problems Popper was referring to.

2 What is science? A brief philosophy of science

2.1 What is science?

Alcohol consumption leads to more aggression: this seems to be a no-brainer. However, in the previous chapter we discovered that even such an apparently simple causal connection can give way to a more complex interaction of factors. The interaction between genes, cognitive processes, and behavior might not be as surprising as the insight that cultural information – about the 'liberating' role of alcohol – might influence someone's behavior by merely nourishing their expectations before they have even consumed any alcohol. When taking a closer scientific look at the simple link between alcohol and aggression, we see that it is mediated by a host of extremely heterogeneous factors like genetic disposition, cognitive processes, forms of behavior, social relations, environmental factors, the interpretation of cultural information, and the many interactions between these factors. Investigating all these factors scientifically requires that we consider a broad variety of relevant theories and concepts, employ extremely heterogeneous methods, and interpret a wide range of results regarding these factors' contribution to explaining this link between alcohol and aggression. How can we make sense of all of this?

For navigating and integrating such a divergent set of theories, methods, and insights, it is extremely useful to make use of the conceptual 'toolbox' that philosophy of science provides. As scholars engaging in a 'second-order activity', philosophers of science reflect on the first-order activity that scientists from theologians to urban planners undertake. A philosophical analysis allows us to examine their activities at a more abstract level and, for example, make explicit the assumptions that many scientists take for granted while doing their job – assumptions about the correct research methods, about whether quantitative or qualitative data are adequate, about the real-world applicability of scientific insights, and so on. After articulating such assumptions, we are also able to consider the similarities and differences between scientific disciplines. The ability to see connections is necessary if we intend to bring several disciplines together in our work. For example, each discipline implicitly foregrounds some factors it deems relevant and presents corresponding methods to investigate these factors, while other factors are relegated to the background and treated as contingent factors. Cognitive neuroscientists will assume that behavior is always dependent on cognitive processes and might prefer to investigate these using a combination of psychological