## Contents

Acknowledgements 8

Preface 10

Chapter guides 11

### Part 1 The Handbook - ‘The What’

1 Introduction 13

2 What is science? A brief philosophy of science 17

   2.1 What is science? 17
   2.2 Moving through the Science Cycle 18

3 The disciplines 25

   3.1 Academic disciplines: A brief history 25
   3.2 Our definition of a discipline 27
   3.3 Classification of academic disciplines 29

4 Interdisciplinarity 31

5 Complexity: the main driving force behind interdisciplinarity 34

   5.1 Complex (adaptive) systems 35
   5.2 Complexity broken down into drivers of interdisciplinarity 38

6 Interdisciplinary integration 41

   6.1 Communication as a first step to integration 43
   6.2 Integration techniques 44
   7  The interdisciplinary research process  51
      7.1  The IIS model of interdisciplinary research  51
      7.2  Planning your research project  56
   8  The problem  57
      Step 1  Identify problem or topic  57
      Step 2  Formulate preliminary research question  65
   9  Theoretical framework and research question  68
      Step 3  Develop theoretical framework  70
      Step 4  Finalize research question  88
      Step 5  Formulate sub-questions  88
   10  How to collect and analyze your data  89
      Step 6  Develop research methods and design  89
      Step 7  Data collection and analysis  94
   11  Discussion and conclusion(s)  96
      Step 8  Interpret results, discuss research & draw conclusion(s)  97

Part 3  Interdisciplinary research in practice  102
   12  Interdisciplinary research example: fogponics  103
      Step 1  Identify problem or topic  103
      Step 2  Formulate preliminary research question  104
      Step 3  Develop theoretical framework  104
      Step 4  Finalize research question  105
      Step 5  Formulate sub-questions  105
      Step 6  Develop research methods and design  106
      Step 7  Data collection and analysis  107
      Step 8  Interpret results, discuss research & draw conclusion(s)  108
   13  Interdisciplinary careers  110

Further reading  119

References  123
   References  Research projects undertaken by IIS students  127
Acknowledgements

This handbook is based on almost 20 years of experience with interdisciplinary studies of the authors, editors and others involved in writing this book. The materials and practices of the University of Amsterdam’s (UvA) Institute for Interdisciplinary Studies (IIS) contributed significantly to the approach that we have adopted. We are also grateful to all the people who read drafts and provided useful feedback and critical commentary. In alphabetical order, they are:

• Prof. dr. F.A. Bais
  Institute for Theoretical Physics (ITFA), Faculty of Science, UvA
  External faculty member of the Santa Fe Institute
• Prof. dr. K. van Dam
  Emeritus Professor at the UvA and founder of the IIS
• Prof. dr. J.A.E.F. van Dongen
  ITFA and IIS, Faculty of Science, UvA
  Institute for History and Foundations of Science, Utrecht University
• Dr. R. van der Lecq
  Department of Philosophy and Religious Studies, Utrecht University
• Prof. dr. W.H. Newell
  Emeritus Professor of Interdisciplinary Studies, Miami University, USA
  Executive Director and Past President of the Association for Interdisciplinary Studies
• Dr. T.J. Schuitmaker
  Athena Institute, Faculty of Earth and Life Sciences, VU University Amsterdam
• Prof. dr. R. Szostak
  Full Professor, Economics Department, University of Alberta, Canada
  Past President of the Association for Interdisciplinary Studies
• Dr. J.C. Tromp
  IIS, Faculty of Science, UvA
• Ms L.U. Wenting, MSc
  Director IIS, Faculty of Science, UvA
We also greatly appreciate the support and feedback of the program directors, lecturers and students of various bachelor and master programs, in particular:

- Mr J. ter Schegget, MSc – Bachelor Bèta-gamma
- Prof. dr. W. Bouten – Bachelor Future Planet Studies
- Mr H.B. de Vries, MSc – Bachelor Interdisciplinary Social Sciences
- Ms R. van Wieringen, MSc – Bachelor Interdisciplinary Social Sciences
- Ms M.A. van Eenbergen, MSc – Bachelor Interdisciplinary Social Sciences
- Dr. F. Nack – Master Information Studies
- Ms S.M. van Beekum, MSc – Master Brain and Cognitive Sciences
- Mr J.J. Kling, BSc – student Future Planet Studies
- Mr B. Cornelissen – student Bèta-gamma
Preface

An Introduction to Interdisciplinary Research is a handbook on interdisciplinarity and its background, and a manual on conducting interdisciplinary research for undergraduates and beyond. Although several books have been written about interdisciplinary research, providing rich theoretical descriptions of and hands-on approaches to the topic, this handbook is a more condensed resource focusing on students in the social and natural sciences. The most relevant comparison can be drawn with Allen Repko’s seminal Interdisciplinary Research: Process and Theory, 2nd ed. (2012). 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. As a result, our book mainly focuses on European students, whereas Repko’s book seems to be primarily addressing undergraduate students from institutions in the US and Canada. This is why our book primarily contains examples of research carried out in Europe. Furthermore, we focus on students with majors in the social and natural sciences and less on those who major in the humanities or liberal arts and sciences. We have also included a thorough description of complexity, which we and others consider to be a main driving force behind interdisciplinarity. However, the most significant 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 – gives a brief overview of interdisciplinarity and provides fundamental information about the origins of interdisciplinary research, what it entails, when it can be applied, and why it should be applied. The second part of the book – The Manual – focuses on the step-by-step process and sets out instructions on how to undertake interdisciplinary research. The third part contains a model example of an interdisciplinary project and the career stories of some interdisciplinary scholars.

Many questions surround interdisciplinary research. How does it differ from disciplinary research? What does it demand from the interdisciplinary researcher? What potential 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, a merely disciplinary approach will not suffice. Such problems necessitate an interdisciplinary approach when scientifically and socially robust answers are sought.
The interdisciplinary research process is not an easy journey. In fact, it is a challenge for undergraduate 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 encounter 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.

It would have been impossible to write this book without the contributions of the experts, lecturers, students and other individuals affiliated with the IIS at the UvA. We hope that you enjoy it, that you will learn a lot while reading it, and that you put the insights obtained into practice. We also welcome your feedback, so if you come across mistakes, or have suggestions to improve it, please get in touch with us via L.degreef@uva.nl.

Chapter guides

The first part of the handbook begins with a short introduction to the main topic of the book (chapter 1). Next we give an explanation of what science actually is; in other words, we will dive into the philosophy of science (chapter 2), after which we define what an academic discipline is, and provide a description of the historical development of the current disciplinary structure of the academic system (chapter 3). We then describe how this division into disciplines evolved (also in chapter 3), and thereafter we move on to define multidisciplinarity, transdisciplinarity, and interdisciplinarity (chapter 4). This is followed by an overview of the most relevant drivers of interdisciplinary research, which, in our view, share one characteristic: complexity (chapter 5). Part 1 concludes with a feature that is unique to interdisciplinary research: the integration of disciplinary insights at different levels (chapter 6). This is where interdisciplinary research differs from multidisciplinary research.

After reading part 1, you should have acquired enough knowledge to start your own interdisciplinary research project. Part 2 will guide you through this process by means of a model for interdisciplinary research introduced in chapter 7. It points out where monodisciplinary and interdisciplinary research approaches differ, and gives a step-by-step explanation of the process from the problem definition (chapter 8), the formulation of the research question (chapter 9), and data collection and analysis (chapter 10) to the discussion and conclusions (chapter 11). Then, in part 3 (chapter 12), we start with an example of an interdisciplinary research project following the steps of our model, introduced in part 2. Furthermore, we share the stories about the careers of four interdisciplinary scholars in chapter 13.
Part 1
The Handbook
‘The What’
1 Introduction

Half a century ago, philosopher of science Karl Popper (1963) 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.” This statement has become increasingly relevant. Today, many of the phenomena and problems that we are trying to understand and solve indeed ‘cut across’ the traditional boundaries of academic disciplines. Modern technological developments and globalization add to the complexity of problems and, in response, we are becoming increasingly aware that an integrated approach is necessary. Healthcare, climate change, food security, energy, financial markets, and quality of life are but a few examples of subjects that drive scientists to ‘cross borders’ and engage with experts from multiple fields to find solutions. In short, complex questions and problems necessitate an interdisciplinary approach to research.

Most real-life problems are multifaceted, in that they have multiple types of causes and determining factors. These different types of causes and determining factors often have to be addressed in different ways with different disciplinary methods. We know from research, for example, that alcohol intake is involved in over half of the violent acts that take place in the public domain. However, the relationship between the intake of alcohol and aggressive behavior is much more complex, and different disciplines have different perspectives on this relationship, as you can see in figure 1. Each discipline’s focus is on another factor (in this case either nurture- or nature-related) at a different level of analysis, using different theoretical frameworks, and different methodologies.
Another example of a multifaceted problem is the financial crisis. Over the past five years, academics from different disciplines have tried to explain what caused the global economic recession. These disciplinary explanations, however, only shed light on part of the problem. When combined, they may offer a more comprehensive explanation, as you can see below in figure 2.

---

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

---

**Figure 2** Different perspectives on the causes of the financial crisis
The previous examples illustrate that knowledge is, to a large extent, generated within separate disciplines (see also box 1). Consequently, in interdisciplinary research we need these disciplines to provide insights into different aspects of our research problem. So, before we turn the focus to interdisciplinarity, it is essential to understand what an academic discipline is. For this, it is useful to understand the origins of academic disciplines, as well as their development. In the following chapter, we define the academic discipline before providing an overview of the discipline’s inception and expansion throughout the science system and beyond. This is followed by a definition of the concept of interdisciplinarity and important related concepts (chapter 4). Chapter 5 focuses on the importance of complexity as the driving force behind interdisciplinarity, and provides an overview of the different manifestations of complexity. Finally, chapter 6 provides a description of the integration of disciplinary knowledge to produce new, interdisciplinary insights (see the example below on an interdisciplinary theory on poverty), which is the key feature of interdisciplinary research.

Box 1

An interdisciplinary theory on poverty

Eldar Shafir and Sendhil Mullainathan, respectively Professor of Psychology at Princeton and Professor of Economics at Harvard, developed an interdisciplinary theory on poverty. Their theory, published in the book *Scarcity - Why Having Too Little Means So Much*, was praised both in and outside academia.

The starting point for their research was the finding that poor people generally make bad decisions. Compared to middle-class people, poor people eat less healthily (even when healthy food is made available to them), take out loans with high interest rates more often, and are generally bad at taking long-term effects into consideration. However, as Shafir said: “No one was studying why poor people are making these bad decisions” (E. Shafir, pers. comm., 12 December 2013). Shafir and Mullainathan started to connect findings from their disciplines. They found that the bad decisions poor people make are actually well researched in psychology. For example, poor people were discounting the future and showed loss aversion in their decisions, two effects known from research on decision-making. The question the researchers then investigated was: Why are poor people more prone to these effects than others?
In their experiments, they found that psychological traits like bad character or low intelligence could not explain why poor people made more bad decisions than people with more financial resources. Instead, Shafir and Mullainathan came up with another explanation: It is often a person’s context that dictates whether someone can make a good decision. Shafir again: “Slowly came the realization that many of the mistakes made by the poor are caused by poverty itself.”

In their book, the researchers explain that when someone experiences scarcity – whether it is a lack of money, friends or time – this shortage ‘captures’ that person’s mind. Her mind will intentionally and unintentionally deal with scarcity, and this leaves less cognitive capacity for other things, such as making a good decision.