Scientific Thought and Research Methodology

Concepts, Principles, Philosophy of Science, and Ontological Dimension

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Series in Philosophy of Science
Vernon Press

www.vernonpress.com

In the Americas:
Vernon Press
1000 N West Street, Suite 1200,
Wilmington, Delaware 19801
United States

In the rest of the world:
Vernon Press
C/Sancti Espiritu 17,
Malaga, 29006
Spain

Series in Philosophy of Science

Library of Congress Control Number: 2024944715

ISBN: 979-8-8819-0046-5

Cover design by Vernon Press. Image: Estancia del Sello (Escuela de Atenas).jpg, Raphael, Public domain, via Wikimedia Commons.

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PREFACE

About This Book

The scientific research process contains many uncertainties for young researchers. Moreover, the terms, concepts, theories, and techniques that researchers encounter can sometimes seem confusing to them. This confusion can be overcome by reaching a state of scientific thought. This book aims to introduce the basic concepts, principles, and research methodology of science to researchers and science enthusiasts pursuing their undergraduate and graduate education.

More specifically, my purpose in writing this book is to present topics that are not commonly covered under the assumption that they are generally known in research methodology books (which contain technical knowledge) that focus more on the use of analysis programs (such as SPSS, Minitab, SAS for analysis, etc.). This book aims to familiarize the reader with **scientific thought** through topics such as the *philosophy of science, logic,* and *methodological or other related concepts,* which constitute the background of and are necessary for the pursuit of social science.

In this book, I describe statistical concepts and related terminology within the context of methodology. In short, this is not a statistics book. Moreover, I do not cover statistical package programs. In this regard, please note that this is an entry-level research methodology book. Namely, the book can serve as a preliminary resource before learning about technical infrastructure (i.e., data collection tools or statistical package programs.).

Let us consider why researchers should pursue scientific thought and learn methodological concepts and the basic assumptions of some approaches of the philosophy of science to scientific research before a statistical package program: Knowledge of the scientific method not only involves ways to collect data and conduct analysis, but also helps one to correctly handle a research study, ask a proper question, define the research problem, and develop a research model. For this reason, before using analysis programs, researchers should develop *a state of scientific mind*; that is, they must understand the systematic nature of science-making which covers *principles, standards, methods,* and *theories.*

In this book, I discuss the basic philosophy of science necessary for researchers without delving excessively into philosophical discussion. I also offer examples from the social and natural sciences (without overwhelming the reader with theoretical details) to make it easier for the reader to understand some concepts related to scientific research. Furthermore, this book, even if it aims to bring readers to a state of scientific thought, has constraints, as mentioned above, concerning philosophical debates and the introduction of scientific concepts and notions. Sometimes, only providing a few sentences about scientific concepts also involves the risk of misunderstanding by readers. To avoid this risk, I strongly encourage readers, when they feel confused regarding any concept, to read further. Additionally, please keep in mind that this book is not a multi-purpose source for scientific methods.

This book is particularly aimed at young social scientists. The purpose of this book is to prepare them for scientific thought while they are in the process of learning scientific methods. Keep in mind that some scientific methods are field-specific! There is no single (multi-purpose) scientific method that fits all fields and subjects.

How to Read This Book

Consistent and appropriate use of concepts is very important in academic literature. Since this book is designed as a general source for the field of social sciences and there may be differences in the topics and methods examined by each field, it is not easy to achieve unity of language. However, I chose to use a group of terms to express the research topics in a comprehensive framework. In this book, I frequently repeat the trio of terms *facts*,[1] *objects*, and *events* to indicate the general subjects of research studies from all social scientific fields.

This book follows particular concepts related to scientific thought. Initially, I introduce the concept of science and scientific fields within a general framework. Furthermore, I present alternative perspectives on science according to its purpose or function in Chapter 1.

Chapter 2 elucidates fundamental subjects requisite for the preliminary phases of scientific inquiry. A short introduction to classical and modern approaches to the philosophy of science is given. For that purpose, I provide general information about the **philosophy of science** and **logic**. It is important to acknowledge that this book adopts a deliberate strategy of simplifying certain concepts and topics to accommodate the breadth of its coverage. However, this approach inevitably entails a degree of surface-level treatment in order to provide an accessible overview of numerous subjects. However, I advise young researchers to study these topics more broadly, especially the philosophy of

[1] *Fact* is a controversial term in philosophy. However, in this book, I use *fact* as an entity to refer to factual realities. *Facts* can entail causal truths such as "Caesar died because Brutus stabbed him," general truths such as death, or particular events such as when Hume dies (Mellor, 2005; Oliver, 2005).

science (and, indeed, philosophy as such). The given content on logic is of a basic level in this book. I remind readers of the basic fundamental principles of logic that most of them probably already acquired in their high school education. In this chapter I guide the reader on how to apply the logical principles in reasoning.

Chapter 2 also presents **epistemology**, which is the science of knowledge. Under the heading of epistemology, standards and verification of valid knowledge are discussed. **Scientific ethics** is also the subject that shares the ethical principles of conducting pursuing science whilst distinguishing field-specific ethical problems. I encourage readers to obtain more detailed information about ethical studies, as each field has its own ethical standards from field-specific sources.

I examine the **ontology** of the scientific research subject in Chapter 3. This strange word means we will be making ourselves aware that we study subjects and variables which exist. I believe that once ontological basics are understood, it becomes easy to handle the variables properly because we comprehend, distinguish, and interpret subjects and variables given the fundamentals of ontology. Ontological dimensions include the *properties* of studied facts, objects, or events, and the *relatedness* of studied subjects in terms of context and operations. In other words, the entity dimension, properties dimension of the subject, and relatedness dimension of the subject in Chapter 3 are the *entity*-related headings.

In Chapter 4, the **human dimension** is examined under two subheadings – those cognitive and technical dimensions. The cognitive dimension and technical dimensions have been considered in the scientific methodology-related section since the human mind (via reasoning) and technical tools (use of language, integrity of hypothesis and research model and providing objectivity of scientific research) should be used correctly in pursuing science. The cognitive concepts presented in Chapter 4 may seem controversial. The main intention of including the cognitive dimension is to illuminate readers about different ways of thinking because there are many ways of thinking in accordance with purpose or need. For that purpose, this chapter presents the cognitive operations of the human mind and introduces how those operations can be achieved effectively. It should be noted that the definitions cognitive-operations-related are compiled in dictionaries and there is no philosophical consensus on those definitions. The purpose of the presentation of cognitive operations is to provide an understanding of their distinctive features.

I have also employed the basic assumptions of *general system theory* as a guide for a better understanding of how to conceptualize scientific research subjects in Chapter 4.

The position of some headings, such as general system theory, may be seen as controversial by some scholars in the philosophy of science. Or readers might ask why I have not explored general system theory in Chapter 3 under the concept of ontology. The reason is that general system theory is a concept created according to the way of conceptualization of the human mind. Further, under the ontology heading, I also explore the concept of randomness, which forms the basis of General System Theory and Chaos Theory. These theories originate from natural sciences and are used in many social science fields because they help understand some social phenomena and events.

The **technical dimension**, in Chapter 4, contains titles such as *objectivity*, *semantics*, and the *use of language*. Semantics and use of language are language-related topics we will cover. I also believe it is essential to choose the right *terms* for concepts in science. This is a quality and technical standard. Sometimes we cannot be aware of the fact that the words we choose to use do not exactly correspond to the concept we want to convey in real life. Or sometimes, two words/groups of words represent the same meaning in our minds, and we cannot see the subtle details of the meaning. This section of the chapter aims to show readers the world of linguistic concepts and other standards related to the pursuit of science but does not enter philosophical discussions of semantics in terms of the philosophy of science.

The use of language is important because you must be able to express your findings well. Thus, rhetoric is crucial. Sometimes, you will be expected to portray the essence of your findings in a few sentences; sometimes, you will need to provide a powerful depiction like a literary writer. In both cases, you should harness rhetoric to use language effectively. Further, findings and conclusions must be put into words accurately and successfully. In doing so, explaining the vital aspects of the subject matter under study may require detailed explanations and evaluations based on different contexts. On the other hand, at a scientific congress and conferences, you will likely present your conclusions, written on dozens of pages, in a mere few minutes. Naturally, the subject matter of the research and the essence of your findings and inferences should be expressed in a limited number of sentences. Scientific writing is like going back and forth between a literary portrayal of the development of an event to the finest details and summarizing the day in one sentence.

In the section on technical dimension we will also look at *structure/integrity* and *objectivity/subjectivity*. Those topics are included on account of their relation to our human features. Research studies necessitate providing the integration of research models with studied theory and being objective in pursuing science.

I present some concepts related to scientific methodology in Chapter 5. The concepts presented in Chapter 5 are vital to comprehending basic notions regarding scientific research. Some concepts may seem close to each other at first glance (such as information and knowledge) and can be used interchangeably. However, there are differences between scientific research concepts, sometimes at a nuanced level, and if they are understood correctly, they can be used in the right context.

I discuss **types of**, and the **process of**, **scientific research** in Chapters 6 and 7, respectively. In Chapter 6, qualitative, quantitative, and mixed research methods are presented. In Chapter 7, the scientific research process is introduced from determining the research topic to the reporting phase. In Chapter 8, I cover special topics such as *science*, *ignorance*, the *art of deception*, and *pseudoscience* that some readers might find particularly interesting.

Finally, I have organized the glossary in the last part of the book a little differently from traditional science books; I include some concepts, terms, and even some scientific jargon that are considered important for scientific thought, even if they are not directly related to scientific methodology.

Researchers, especially young scientists who are interested in science and wish to pursue a career in this field, should be equipped with additional qualities. One of them is *versatility*, which is critical because diverse interests improve people's comprehension of facts and events.

Where Are We in the Knowledge Era?

We live in the knowledge era. However, this does not eliminate our need to produce new knowledge. We engage in science not only to satisfy our curiosity also to improve our ways of doing business, to enhance our working life, to make our methods of travel safer, to live more comfortably, to produce better medicines and more effective medical approaches to be healthier, to develop and accelerate our ways of communication, and even to decide how to dress before going out. But maybe more importantly, we come to know ourselves and our environment better through new knowledge. We always need to produce and use knowledge for a purpose, and this will continue. As to what makes scientific knowledge so critical is that sometimes we entrust our lives to it.

Let us not forget to mention the most crucial thing: We must understand the value of knowledge. Francis Bacon once said, "***knowledge is power.***" Such striking words may be effective in showing the importance of knowledge. While engaging with science, our aim is not always to produce extremely striking results (such as a revolutionary new teaching technique in education). Each small piece of knowledge produced may contribute to the accumulation of wisdom and progress in each field. Hence, every research finding need not make big statements. I only want to draw attention to understanding the significance of knowledge here. Of course, each piece of knowledge created by us is not for improvement or for a particular purpose. But social progress depends on generating knowledge. Bacon, in his famous aphorism, emphasized the improvement of human life. Using the right knowledge in the right way saves lives. A lack of required knowledge or knowledge used incorrectly makes people's lives miserable. It is that simple.

Returning to the previous paragraph, we must not see knowledge only as a source of power. That is right, in a sense. On the other hand, we must consider knowledge as a source of well-being for the life and happiness of humankind. Aphorisms such as "***knowledge is power***" sound more political nowadays, and I see, personally, knowledge as a source of progress in human well-being, not only as a source of political power.

We have shaped our modern life in every way via humanity's accumulation of knowledge. We are so accustomed to this situation that the knowledge behind every blessing from which we benefit is no longer visible to our eyes. However, in ancient times, knowledge was scarce and written sources were rare. We can better understand this when we realize that many lives have faded due to a lack of small pieces of knowledge (i.e., poisonous or medicinal plants) throughout the history of humanity; many people have survived due to having those pieces of knowledge and living in an ocean of information, which makes our lives easier today, with such great wealth and blessings for humanity.

Our ability to produce knowledge at a dizzying pace looks gorgeous. Its natural conclusion is the rapid aging of some information. From this angle, we can also say that we live in an information dump containing incorrect and nonfunctional information. This is because each piece of knowledge we obtain is not necessarily correct, functional (for human benefit), or up-to-date. The correct use of knowledge is also vital. Therefore, we also need both general and scientific ethics to guide us in how to use our knowledge.

In the knowledge era, we are, at the same time, living in an ocean of incorrect information. All information surrounding us is not correct. False information can be produced for manipulation, which is also discussed in this book. Besides, information pollution is one of the up-to-date problems of modern life. There are many websites that claim to offer scientific knowledge. Sometimes well-known news sources share deceptive information or include some pseudo-scientific findings without seeking expert opinion. Moreover, most of the knowledge produced today is temporary in nature (yes, information is getting old, but recording and archiving can be functional), and it can only be functional under particular conditions. Only a small part of the information we produce qualifies as permanent; this is generally the case in the natural sciences. Of course, natural sciences also produce temporary knowledge. For example, meteorology makes estimations of daily weather. Hence, the knowledge meteorology produces is temporary. Since much of the knowledge generated in the social sciences reflects the reality of certain periods and conditions, it is mostly temporary. Thus, knowledge produced in the social sciences has a bad habit of getting old fast. For example, consumer expectations are constantly changing under the influence of social media and fashion trends, labor market characteristics vary from generation to generation, and new social realities require new institutions. The education system is constantly changing everywhere. Today, the fact that we have a fabricated education system (the content may differ, but the systematic context is the same almost everywhere) left over from the industrial revolution is being questioned, and some educational scientists seek to change it.

In the present day, in addition to producing knowledge, it is critical to compile existing information (such as through time series analysis) or to reprocess it with different information (through synthesizing) to make it more useful. In short, we encounter processes such as synthesizing and re-processing information with different components and in different contexts. Further, concepts and applications such as big data[2], data mining, and Web browser analytics are entering our lives. The better organization and visualization of knowledge used in education is increasingly gaining importance, improving the quality of education in the process. As the use of infographics has become widespread, it has become easier to present and to gain knowledge.

Scientific knowledge is only one of the many types of knowledge that shape and guide our daily and professional lives—such as *everyday knowledge*, *philosophical knowledge*, *art knowledge*, and *technical knowledge*—but perhaps the most important one. All types of knowledge mentioned above appear to some extent as extensions of *scientific knowledge*.

Scientific knowledge production requires recognition of scientific methods. When we say *method*, the first thing that comes to mind is to use predefined (and also consistent) ways and techniques to be followed in order to answer a scientific question or solve a problem. Scientific methods provide consistency and an adherence to standards, which are important because the purpose of scientific methods is to produce accurate knowledge.

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[2] *Big data* refers to large digital datasets that arose from advances in technological capacity and analytical methods. These datasets cover “everything within a particular field (e.g. utility records) or platform” (e.g., Twitter or Facebook) so that “states and corporations are able to collect, store, and process more data than ever before”. The digital nature of these data creates “potentials for data mining and data linking, allowing connections to be made between diverse data” (D’ignazio, 2019: 2; Tinati et al., 2014: 664).

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Source of Figure 17. A vector illustration of tectonics: https://pixabay.com/vectors/dorsal-tectonics-plates-geology-6801801/

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