

1. Introduction

This policy report was prepared by a committee organized by the InterAcademy Council (IAC) and IAP – the global network of science academies. It sets forth values, principles, and guidelines for the responsible conduct of research that can serve as a common framework of good practices for the emerging global research enterprise. It makes broad recommendations specifying the responsibilities of various participants and stakeholders in that enterprise, and describes the institutional arrangements necessary to encourage and help ensure responsible conduct. The report also outlines ongoing changes in the research environment and the challenges to fostering research integrity. See Box 1-1 for the complete terms of reference.

Two key ideas and themes underlie the committee’s analysis and recommendations. First, responsible conduct is an essential component of excellent research. Responsible conduct allows the self-correcting nature of research to operate effectively and accelerates the advance of knowledge. Second, while procedures and institutions to effectively investigate allegations of irresponsible research conduct and act on the results are necessary, efforts aimed at *preventing* irresponsible conduct and ensuring good practices through mentoring and education are ultimately more important. The committee hopes that this report encourages participants and stakeholders in the global research enterprise—researchers, research institutions, public and private research funders, journals, academies, and interacademy organizations—to redouble efforts to promote responsible research in the context of individual labs, institutions, disciplines, countries, regions, and the global enterprise.

The Globalization of Research

During the twentieth century, governments, businesses, and philanthropic organizations around the world recognized that new knowledge and new technologies can pay rich economic and social dividends. As a result, many countries greatly increased their investments in research and

BOX 1-1

Terms of Reference: Project on Research Integrity and Scientific Responsibility

Projects that address issues of research integrity and scientific responsibility will be undertaken by the InterAcademy Council (IAC) and IAP – the global network of science academies.

1. The IAC and IAP will jointly develop a short policy report on principles and guidelines, for individual scientists, educators, and institutional managers, on research integrity, which will include addressing issues of research management, reward, principles, practices, and culture. The product will have use throughout the global science community. In addition to constituting a basic source for use by all the IAP and other academies, it will be provided to research-funding agencies around the world; university leaders; ministries of education, research, science and technology; scientific and professional societies and associations; relevant international scientific disciplinary unions; and other relevant international bodies. This project will be undertaken by a committee of experts, appointed by the Co-Chairs of IAP and IAC. The draft report will be subjected to the IAC peer-review process involving an additional set of experts from around the world. This project should be completed by mid-2012.
2. The InterAcademy Council will develop international educational materials for individual scientists, educators, and institutional managers, addressing principles and guidelines for scientific responsibility, including scientific ethics, integrity, and responsibility for avoidance of misuse of science. The products will have use throughout the global science community. The project will be undertaken by an expanded IAP-IAC committee of experts and should be completed during 2013.

development (R&D). These investments have had a dramatic influence on human life. Science and technology have raised living standards, improved health, and augmented the ability of people to access information and communicate with each other. The relationship between investments in basic research and economic success is complex. But examples worldwide of science and technology-based industries—from Silicon Valley to Oxford to Bangalore to Beijing—demonstrate that a connection exists.

Many countries are now investing substantial sums in scientific and engineering research and development. Most industrialized countries are devoting between 1.5 percent and 3.5 percent of their gross domestic products to R&D, and many have pledged to increase these investments. Knowledge generated by research is a global asset available to anyone prepared to access that knowledge. An increasing number of countries have realized that their ability to take advantage of existing knowledge and generate additional knowledge requires increased investments in R&D (NSB, 2012).

Some of the fastest increases in R&D spending have been in rapidly developing countries that see science and technology as the foundation of prosperity. Millions more scientists and engineers are now working in these countries than there were just two decades ago. This great expansion of R&D has altered the global distribution of science and engineering work. In 1999, 38 percent of the world's R&D was performed in the United States, 27 percent in Europe, and 24 percent in Asia. In 2009, Asia accounted for 32 percent of world research, the United States for 31 percent, and Europe for 23 percent (NSB, 2012).

Research has become such a critical part of modern societies that protection of its core values and norms is important for both the research community and the broader society. Many national and international organizations have issued statements that describe the basic responsibilities and obligations of researchers. *Responsible Conduct in the Global Research Enterprise* draws on information from other statements in providing a guide for researchers, research administrators, and policy makers throughout the world.

The Changing Face of Science

The environment for research has been rapidly changing, with important implications for research integrity. For example, even as fields of research have become more fragmented and specialized, interdisciplinary research has become increasingly important and has contributed to major advances

(NAS-NAE-IOM, 2005). Examples include the application of information technology to problems in biology and the development of models to foresee the nature and consequences of climate change. Research funders and research institutions have created procedures and centers for bringing together people from different disciplines, but such collaborations still can encounter difficulties. For example, disciplines may have very different conventions for determining the order of authors listed on a publication. If these differences are not acknowledged and dealt with upfront, disagreements may surface later.

The increasing data-intensity of research in many fields also has implications for the conduct of research. Disciplines that have long relied on “big data,” such as high-energy physics and astronomy, have established conventions for sharing and reusing data. Other fields, such as social and behavioral sciences research that uses online behavior data, may not have developed principles and guidelines for gathering, analyzing, storing, and sharing data.

A Growing Awareness of the Need to Maintain Research Integrity

Researchers and the research community traditionally have had the responsibility for defining and upholding ethical conduct in research (NAS-NAE-IOM, 1992). Researchers have used peer review and evaluation to judge the quality of research and to reward researchers. They have trusted that dishonest or substandard work would be uncovered through efforts to reproduce it. They have relied on the importance that researchers attach to maintaining their reputations as a strong disincentive to misbehavior.

The first formal laws and regulations to ensure responsible conduct in research addressed the protection of human research subjects and nonhuman laboratory animals.¹ Many countries have adopted such laws in reaction to widely publicized examples of wrongdoing, such as the human experiments undertaken by the Nazis, the Tuskegee syphilis study of the U.S. Public Health Service, and incidents of laboratory animal mistreatment (Adams and Larson, 2007; DHHS, 1993).

In recent decades, many universities and other research institutions, scientific societies, and national governments have developed rules, guidelines, institutions, and procedures to address actions that damage the

¹ The imperative to maintain ethical behavior in clinical medical practice has been recognized since ancient times, as illustrated by Hippocratic Oath (Greece), the work of Sun Simiao (China), and the Oath of the Hindu Physician Caraca in the first century AD (India), (Chinaculture.org, 2012; NLM, 2012; Valiathan, 2009b).

research enterprise. As this body of work has developed, significant differences have emerged among countries (RIA, 2010). For example, the U.S. federal government defines “research misconduct” as “fabrication, falsification, or plagiarism (FFP) in proposing, performing, or reviewing research, or in reporting research results” (OSTP, 2000). By contrast, Finland defines “fabrication, misrepresentation, plagiarism and misappropriation” as “fraud in science,” and includes behavior such as “understatement of other researchers’ contribution to a publication and negligence in referring to earlier findings” as “misconduct in science” (TENK, 2002). The *Australian Code for the Responsible Conduct of Research* (NHMRC-ARCUA, 2007) includes “failure to declare or manage a serious conflict of interest,” “avoidable failure to follow research proposals as approved by a research ethics committee,” and “willful concealment or facilitation of research misconduct by others” in its definition of research misconduct. Box 1-2 describes the terms used in this report.

Countries also differ in how allegations of irresponsible behavior in research are investigated and in the responses to findings. In most countries, the employer of a researcher accused of wrongdoing, such as a university or other research institution, holds the primary responsibility for investigation. In Japan, the Science Council of Japan developed a *Code of Conduct for Scientists*, and has asked research organizations to implement their own codes along with education programs for researchers (SCJ, 2006; RIKEN, 2006). In some countries, national funding agencies play an important role as an alternate mechanism for reporting allegations or as a mediator, such as the DFG Ombudsman established by Germany’s national research funding agency (DFG, 1998). Some national bodies go farther, acting as overseers of institutional investigations or as enforcers of sanctions against those found guilty. In other countries, national bodies play only an advisory role. A perhaps unique approach has been taken by India, where the Society for Scientific Values was founded as a purely private, voluntary body that investigates allegations of misconduct and reports the results, but without legal or administrative authority (SSV, 2012). Discussions are ongoing in several countries over whether the systems currently in place should be modified (CCA, 2010; RIA, 2010; Godlee and Wager, 2012).

Several prominent organizations and conferences have focused attention on the responsible conduct of research. The 1st and 2nd World Conferences on Research Integrity (WCRI) were held in 2007 and 2010, respectively. The 2nd WCRI resulted in the *Singapore Statement on Research*

Integrity, a one-page statement defining responsible conduct in research. The Organization for Economic Cooperation and Development has held meetings and produced several reports aimed at defining good practices in promoting responsible research practices and addressing allegations of irresponsible behavior in international collaborations (OECD 2007, 2009). The European Science Foundation and the All European Academies also have worked to define best practices and have produced a code of research conduct (*The European Code of Conduct for Research Integrity*, ESF, 2010; ESF-ALLEA, 2011).

Going beyond issues of irresponsible research practices, the Budapest World Science Forum (2011) has put forward a vision of expanded world scientific cooperation. IAP (2005), along with other scientific organizations, has urged scientists to take responsibility for preventing misuse of biological agents.

The Incidence of Irresponsible Research Behavior

National organizations in several countries that deal with irresponsible research practices report on the number of investigations opened and how they were resolved. For example, in its 2010 annual report, the U.S. Office of Research Integrity reported that it closed 31 cases, with 9 findings of research misconduct under the U.S. government's definition (ORI, 2011). Also, recent research has sought to better understand the attitudes of researchers toward irresponsible research practices and their actual behavior (Fanelli, 2009; Tavare, 2012). These surveys tend to indicate that the incidence of irresponsible actions is higher than official statistics indicate.

Recent investigations have found that the number and percentage of scientific papers that are retracted has increased (Van Noorden, 2011). The problem of data irreproducibility is also attracting increasing attention; a significant percentage of published results may not be reproducible (Mullard, 2011). Retractions and data irreproducibility can result from a range of causes, including bias and misuse of statistical techniques, as well as intentional falsification and fabrication (Ioannidis, 2005).

Other things being equal, the incidence of irresponsible research practices will rise with the amount of research being undertaken and with the number of researchers. The number of researchers working in the world rose from 4 million in 1995 to 6 million in 2008, and worldwide R&D expenditures rose from \$522 billion (current U.S. dollars) in 1996 to \$1.3 trillion in 2009 (NSB, 2012). The committee does not believe that it is currently possible to generate an authoritative estimate of the incidence of

BOX 1-2 Terminology and Definitions

In developing this guide, the committee made several choices aimed at simplifying the language of the report and making it more useful.

In this report, all unethical and undesirable behaviors by researchers are referred to as *irresponsible research practices* or *irresponsible conduct*. The report refers to ethical and desirable behavior as *responsible research practices* or *responsible conduct*.

In many countries and contexts, those unethical practices that damage the research record, such as fabrication or falsification of data and plagiarism (FFP), are regarded as being egregious and receive significant sanctions.

Other behaviors, such as inappropriately requesting or conferring authorship, failure to appropriately share data, failure to retain data, inappropriate use of statistical or analytic methods, mistreatment of students and subordinates, publishing substantially the same work in multiple journals when readers expect the work to be original, and misrepresentation of research results in the media may not be considered as serious or sanctioned as heavily as FFP. Nevertheless, they are also considered irresponsible research practices in this report.

Finally, inappropriate treatment of human subjects of research, mistreatment of non-human laboratory animals, misuse of biological agents, and other behaviors that in most countries would be addressed under separate regulatory frameworks from FFP are also included as irresponsible research practices.

BOX 1-3

Notable Cases of Irresponsible Research Conduct

Hwang Woo-Suk (Korea), formerly of Seoul National University, was found to have fabricated results of research on human stem cells that was reported in *Science* in 2004 and 2005 (Kennedy, 2006).

Gopal Kundu (India), a biologist, was debarred from academy activities for 3 years by a committee of the Indian Academy of Sciences in 2010 after a finding that he had reused images in a 2005 paper that had been published earlier (Jayan, 2010). The 2005 paper was retracted by the journal that published it (SSV, 2007).

Li Liansheng (China), formerly of Xi'an Jiaotong University, was stripped of a national award by the Ministry of Science and Technology in 2010 after it found that some of his work was plagiarized (Jia and Tang, 2011).

Scott Reuben (United States), formerly a professor of anesthesiology and pain medicine at Tufts University, whose research had a major influence on pain management treatments, admitted to fabricating his clinical trials. He was sentenced to prison for health care fraud in 2010 (Edwards, 2010).

Jan Hendrik Schön (Germany), a physicist at Bell Laboratories, was found in 2002 to have falsified data underlying significant findings in semiconductor research (Bell Laboratories, 2002).

Diederik Stapel (the Netherlands), a social psychologist, admitted in 2011 that he fabricated and falsified data underlying numerous publications (Tilburg University, 2011).

Jon Sudbø (Norway) formerly a biologist at Oslo's Norwegian Radium Hospital, fabricated patient data for multiple studies published through 2005 on pain killers and smoking risk (Couzin and Schirber, 2006).

Irresponsible research conduct also occurs in the humanities. Examples from historical research and writing include S. Walter Poulshock's 1965 book *The Two Parties and the Tariff in the 1880s*, which was found to have been based on fabricated evidence; improper use of other authors' writings in the works of popular historians Stephen Ambrose and Doris Kearns Goodwin in the 1990s; and the fabrication of the "Hitler Diaries" in the 1980s (Lewis, 2004; MacArthur, 2008; Sternstein, 2002).

irresponsible research practices. However, even without such an estimate, the committee believes that the task it has undertaken is essential. Growth in the research enterprise, along with the continued emergence of high-profile cases in countries around the world (see Box 1-3), reinforce the need to address irresponsible research practices.

About the Study Process

The terms of reference for the study were developed and the committee was appointed during the third quarter of 2011 (Box 1-1). The committee Co-Chairs first met with staff in October. The full committee held face-to-face meetings in December 2011, January 2012, February 2012, and March 2012. In addition to its discussions and review of published materials, the committee consulted with several experts on issues of particular interest, including Melissa Anderson of the University of Minnesota, Philip Campbell of *Nature*, K.L. Chopra of the Society for Scientific Values, Judith Curry of the Georgia Institute of Technology, and Ryoji Noyori of RIKEN.

The committee has had access to a wealth of recent reports and background materials regarding research integrity. These documents demonstrate that significant differences exist among countries in policy frameworks for dealing with irresponsible research practices. Yet the committee strongly believes that global standards of behavior reflecting the universal values of science are not only possible but necessary. This report makes several broad policy recommendations that can be implemented universally, while recognizing that specific institutions, procedures, definitions, and sanctions used to address improper research behavior will vary by discipline and by country.