Research Integrity: Perspectives from China and the United States

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Abstract

Both China and the USA recognize the critical role of research integrity in sustaining a productive research enterprise. Both countries have also experienced public backlash to reports of researcher misconduct, prompting a greater government response, with its mix of regulation and funding incentives and a commitment to changing the research culture through greater emphasis on education. China faces special challenges in remaking a research funding system marked by a climate of pervasive corruption and personal favoritism. As it breaks from its recent past, China must find ways to alter a culture of scholarship still influenced by its unique history and that affects vast numbers of students and faculty. China is increasing its investment in response to these challenges but in

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several respects is still playing catch-up with the West. In the USA, the challenges are also formidable. There is a research culture that puts undue pressure on scientists to produce breakthrough research, a need for government oversight that is not unduly intrusive but nevertheless consistent with public demands for accountability, and a need for rigor in designing effective educational approaches to help bring about the cultural change needed.

Introduction

Within the global science and technology arena, the USA and China are world leaders in economic investment in research and development (R&D). Such leadership in R&D gives both countries a highly visible platform from which to address issues related to the ethical conduct of research, a critical area for a well-functioning and productive scientific enterprise. Ethical issues related to scientific research and its applications must be considered globally because of the melding of multiple cultures, regulatory systems, and institutions, thereby creating the potential for tensions among the values, norms, and legal frameworks represented by international collaborators. As Leshner and Turekian (2009, p. 1459) have noted, "there is substantial variation in the norms and standards that govern the work of scientists in different countries. Effective collaboration requires harmonizing these standards of conduct so that scientists can work together with full trust and confidence."

Both China and the USA are committed to developing effective and trustworthy collaborations, between each other and with other countries. Both participate in the Global Research Council (GRC), which is "comprised of the heads of science and engineering funding agencies from around the world, dedicated to promoting the sharing of data and best practices for high-quality collaboration among funding agencies worldwide" (http://www.globalresearchcouncil.org). The GRC explicitly includes research integrity among its priorities, and the GRC principles for peer review are also the guiding principles for the National Natural Science Foundation of China (NSFC). Moreover, AAAS and the China Association for Science and Technology (CAST) began in 2007 a collaboration dedicated to examining ethics in science and are developing several case studies for use in both countries' research integrity education efforts. These shared experiences and commitments inform the overview presented in this chapter.

What Is Research Integrity?

"Research integrity," as used in the USA, refers to intellectual honesty in designing, conducting, evaluating, and reporting research guided by established professional norms and ethical principles for doing research. It involves taking personal responsibility for one's work and for taking affirmative steps to protect the integrity of the scientific record (This description is a synthesis by the authors of the discussion in the Institute of Medicine 2002, pp. 34–35). It includes expectations that researchers will not engage in “fabrication, falsification and plagiarism,” the official definition of research misconduct of the US Government (Office of Science and Technology Policy 2000), but extends beyond that to include the way scientists are expected to behave in their work and their interactions with other scientists.

In China, research integrity has a unique history that still influences contemporary thinking and practices. In ancient China, the conduct of a scholar was measured by “cheng” (诚). The composition of the left and right parts of this Chinese character implies “to speak the truth.” Morality is often regarded as the ideological summit of a scholar, as exemplified by the classical essay by Laozi (233 BC). The convention of ethics, on the other hand, was framed in the form of “Three Guidelines and Five Ethical Rules” (which defined the relations among people of different classes, genders, and generations). In the “Spring and Autumn” (770BC–476BC) period, the diversity of the scholarly community was characterized by constant debates among “100 schools” of academic factions, such as Taoism, Confucianism, Legalism, etc. Confucianism eventually dominated the mainstream of the scholarly community, and its emphasis on humaneness led to a rather tolerable approach to research integrity in China.

China has a tradition of unbalanced ethical and moral standards among experts in different fields. As stated by Confucius, “The mind of the scholar is conversant with righteousness; the mind of the laymen is conversant with gain.” (The Analects, 4.16). The social status of the scholars in philosophical exploration was high; they were the model for the moral standard and were portrayed as the masters with high integrity. Those exploring the material aspect (such as natural science and technology) of learning were regarded as materialistic and tricky and had low social status. Although honesty had traditionally been considered a general moral requirement for all people and their behaviors, concrete norms had not been set for research activities until the arrival of modern science in the twentieth century, when the long march to build research integrity started (Yang 2013). The modern standard of scientific ethics and integrity was introduced mainly by the scholars who were educated abroad. The rules of citation, the reproducibility of research data and findings, and the protection of intellectual property were unfamiliar to the general public and to many old-style scholars.

There are many meanings for the word “integrity,” and there is no equivalent word in Chinese to match exactly the English word. Similar words are used by Chinese institutions, such as scientific ethics, construction of a study ethos, research morality, when characterizing different groups of people. In *Opinions on Strengthening Research Integrity of Our Country* issued by 10 Chinese department agencies and academies in August 2009, research integrity is roughly defined as “. . .the following behaviors of scientific workers in their scientific and technological activities: inspiring the spirit of science, with pursuing truth, seeking truth from facts, innovation-oriented, open-minded and collaboration as its core, in compliance with applicable laws and regulations, adherence to ethical principles of scientific study, and following the code of conduct accepted by the scientific community." This is similar to the aspirational nature of research integrity in the USA, while also including reference to existing legal and professional requirements.

What Are the Perceived Problems in Research Integrity?

In contemporary China, the societal perception toward research integrity has experienced several pivotal changes. The first started about a century ago with the establishment of scientific method and procedure for rigorously presenting one's findings. The development of this scientific culture is attributed to those Chinese scholars returning from abroad, along with positive feedback from their students. The return of many overseas Chinese scholars under the "open-up" policy reinforced the situation.

Respect for intellectual property signifies the second change. Though Chinese journals in science and mathematics adopted an international style of citation in the first half of the twentieth century, other journals, especially those in social science, took the group citation style (namely, all citations were appended at the end, without explicit indications of where they were inserted in the text) until the 1980s. Journals in medicine, engineering, and agriculture are somewhere in between the two opposite styles of citation. Precise and comprehensive citation style was gradually recognized by academia in China in the past three decades, with the natural sciences leading the way and the social sciences last to join the other disciplines. These changes were prompted by the general reform and opening up of China and the specific programs of international academic exchange.

Respect for the cross-language intellectual properties marked the third change. Chinese-origin submissions of research papers to international journals boomed in the early 1990s. At the beginning, the bulk of those submissions had been intended for the English versions of various Chinese journals in science that had covered the same content but in different languages. Academics had the impression that dissemination of scientific knowledge could be enhanced by multiple languages, and overlooked the issue of "self-plagiarism" between different language versions. The copyright law of China at that time stated that the author was free to submit the work to another journal if he or she did not receive an acceptance note from a journal in 30 days. Authors were also allowed to submit their published works to journals of different languages since "the authors have the translation right." (Copyright Law of PR China, 2001 edition). In that period of time, many Chinese scholars had mixed feelings about their publications (including the reviews) in journals of different languages (Yang 2013). At the turn of this century, the situation started to change. Gradually, the different language versions of Chinese journals became independent in content. Several debates about dual Chinese/English submissions took place in forums organized by the China Association of Science and Technology (CAST) and other academic institutions. Some researchers (mostly in social science) reasoned that the copyright law was aimed to promote and to streamline the dissemination of knowledge to the vast media, while others argued that Chinese scientists should honor the copyright transfers they signed, which inevitably contained clauses on the transfers of translation rights.

The fourth pivotal change emerged from public awareness of the issue of research integrity. At the beginning of this century, members of the public were astonished that "respectable scientists" could steal someone else's "intellectual property" or could "fabricate" or "falsify" their research findings. The public is not satisfied with the self-investigation of research misconduct allegations, as many exposed cases were not properly investigated or remained unclosed after a long time. The regulations and effective policies and procedures for dealing with research misconduct need to be improved. Strong public reaction stimulated media intervention (Hao 2009). More and more journalists endeavored to expose the dark secrets of scientists. Government officials were the next in the line to understand the severity of the issue. They coordinated a concerted approach to combat research misconduct.

Regardless of the progresses mentioned above, there are many forms of research misconduct facing the scientific community in China. Yuan (2011) summarized 122 counts of research misconduct mentioned in 40 documents issued by 32 of the leading universities in China. Some forms of misconduct were not easily judged or sanctioned. It is necessary to develop strategies to prevent questionable research practices related to authorship, data management, etc.

There is no obvious answer as to why some scientists lack research integrity and engage in unacceptable research behaviors. For some observers in the US, it is often considered to be a problem of "bad apples," where a relatively few scientists commit misconduct for reasons associated with a psychological breakdown. However, this perspective has shifted to recognize a context in which "although researchers might be well intentioned, there is truth to what psychologists have observed: that everyone is capable of missing a moral issue (moral blindness); developing elaborate and internally persuasive arguments to justify questionable actions (defective reasoning); failing to prioritize a moral value over a personal one (lack of motivation or commitment); being ineffectual, devious, or careless (character or personality defects, often implied, when someone is referred to as 'a jerk')..." (Institute of Medicine 2002, p. 62).

While not dismissing the role of personal shortcomings, many now believe that the problem is more systemic to science than simply a reflection of a few bad apples (Iorns 2013). The problem of a research environment that works counter to research integrity will be discussed below, but suffice it to mention here that until recently, there has been very little commitment to gathering the data and insights necessary to better understand the relationship between researchers' behavior and the environment in which they work.

Finally, another perceived problem associated with the notion of research integrity is accountability. Misconduct is a failure of accountability when public funds are misused or wasted on research built on false or fabricated studies.

It can lead to bad policy and perhaps even harmful actions. As the US National Science Board declared in 2008, “Accountability must be an integral part of planning successful collaborations to assure supporters that research integrity is a priority…” (National Science Board 2008, p. 4). Whether you are a researcher seeking new truths, a funder making an investment in the future, or a citizen who counts on science to improve the human condition, you will want scientists to be held accountable for anything they do that diminishes the integrity of scientific research.

Accountability also comes into play when scientists claim they are aware of the problem and are taking steps to address it. In its 2002 report, the Institute of Medicine (IOM) stressed that “Fostering an environment that promotes integrity in the conduct of research is an important part of…accountability” (Institute of Medicine 2002, p. 1). There is an expectation that the research community will be able to show that its efforts to improve the integrity of research are having a positive impact. In this case, the community has so far fallen short. There is “no solid evidence” to show what is or is not effective at fostering a “research environment that is conducive to nurturing ethical research practices” (Frankel 2003).

Discussions about research integrity in the USA and China inevitably raise concerns about research misconduct. There is no definitive account of the amount of research misconduct in the USA and no reliable data on whether misconduct has been increasing or decreasing, although over the past several decades there appears to be an increase in the reporting of instances of misconduct in the professional and popular press. Nevertheless, the absence of firm numbers does not mean that the problem can be dismissed. Even if research misconduct is rare, it still has broadly significant ramifications whenever it occurs. The social relevance of science, the large expenditures of public monies on research, and continuing reports of high-profile incidents of misconduct in the press have fueled public concerns, prompted congressional hearings and federal regulations, and opened the eyes of many in the research community to a serious problem.

In China, research misconduct is defined more expansively than in the USA. It includes the following 13 categories: (1) Plagiarism; (2) Fabrication; (3) Falsification; (4) Multiple submissions, under the same or different languages; (5) Improper and exaggerated authorship; (6) Conflict of interests biasing reviews, evaluations, or grant assessments; (7) Lobbying officials for government grants and sending messages to influence review panels, promising to return favors; (8) Using academic prestige to dominate the field and suppress potential challengers; (9) Unfair or honorary authorships, and selling and buying research papers; (10) Deliberately neglecting to cite earlier or the most related works; (11) Fabricated citation of a bogus author or journal; (12) The creation of “trash” or “fake journals,” which collect submission fees from authors, conduct no formal review, and then only print enough copies to send to the authors; and (13) Inappropriate use of statistics.

Although it has been difficult to obtain a reasonable assessment of the amount of research misconduct in the USA, in China, where it is defined more broadly, research misconduct is considered extensive and severe. The *Journal of Zhejiang*

University Science (JZUS) is an international journal published by Zhejiang University. It is among the best of the university journals in China and receives submissions from all over the world. It was the earliest journal in China that implemented Crosscheck to screen for similarities. The result from a 5-year screening of over 5,100 submissions indicated that 31 % of the submissions contained above 30 % similarities with the existing literature (Zhang 2010). The revelation of these data sent shock waves through the scientific community in China.

When similar software was used to cross-check Ph.D. theses with the existing Chinese literature, a similar figure was reported. The severity of the issue persuaded various graduate schools in China to enforce similarity checks before the submission of theses. At a press conference in August 2014, the NSFC revealed six severe cases of misconduct discovered by data mining between submitted and funded proposals by similarity checks, along with 400 plus minor ones earmarked during reviewing, against a total submission of 151,000 proposals.

In ancient China, when "Kekao" (national examination offered by the emperor) was the only way to become an officer, some scholars risked their lives to bring in hidden notes. Today, the heavy burden of homework and the absence of integrity education in the primary and secondary schools induce young pupils to copy each other's homework. When those youngsters enter universities, they find the web a paradise for facilitating their homework. When a Stanford University faculty was recruited to Zhejiang University to teach scientific writing, he used his own software to check the course reports submitted by an elite class and found that a large percentage of them were done by "cut and paste" from the Internet. He swiftly gave all those students zero marks. The students felt offended about the harsh grades and discussed on the web about taking revenge. As reported in *Nature*, the alleged and convicted cases of research misconduct in Zhejiang University from 2009 to 2012 were 43 and 23, respectively (Cyranoski 2012). Since 1998, there has been active censoring by the NSFC of scientists who submit plagiarized grant proposals. This campaign has resulted in a decline of 70 % in alleged misconduct per applications over the past 14 years, but the total number of allegations remains at the same level.

What Factors are Likely Causes of These Problems?

If the focus is on the few bad apples, then one might conclude that failures of research integrity are due to personal moral shortcomings. If, however, the problems are considered more systemic to the scientific enterprise, then the focus must turn to the larger research environment, where collaborators, institutional resources and policies, professional journals and societies, government regulations, the media, and public perceptions and expectations all interact to influence researchers' behavior.

This complex system is not well understood, but it is viewed by virtually all relevant stakeholders as critical to the development of research integrity. Indeed, government regulations in the USA specify that research institutions "must [f]oster a research environment that promotes the responsible conduct of research, research training, and activities related to that research or research training," (42 CFR Part 93, Sect. 93.300(c) 2005.). The 2002 IOM report declares that:

> "It is. . .incumbent on all scientists and scientific institutions to create and nurture a research environment that promotes high ethical standards, contributes to ongoing professional development, and preserves public confidence in the scientific enterprise." (Institute of Medicine 2002, p. 33).

Despite its importance, and despite the fact that virtually every scientist acknowledges its centrality to good scientific behavior, the IOM acknowledged that in the end, "the means of promoting integrity in the individual researcher and developing an institutional climate that fosters integrity are not precisely known" (Institute of Medicine 2002, pp. 25–26). In its report, therefore, it recommended that more resources be made available

> "to fund studies that explore new approaches to monitoring and evaluating the integrity of the research environment. . .for research designed to assess the factors that promote integrity. . .[and] assess the relationship between various elements of the research environment and integrity in research" (Institute of Medicine 2002, p. 128).

There have been some efforts to address the issues associated with assessing the research environment and its impact on research integrity. In summer 2000, the US Office of Research Integrity launched a new funding program on "research on research integrity," which continues to this day. ORI's 2001 funding announcement noted that "no systematic effort has been made to evaluate the different approaches to transmitting high standards for integrity in research, making it difficult to know which ones, if any, are effective," (U.S. Office of Research Integrity 2001) and encouraged the submission of proposals to address that gap. A recent effort is the Survey of Organizational Research Climate (Crain et al. 2013), which generates data on "seven dimensions of local research climate to inform, motivate, and help to evaluate efforts to improve those climates and to promote responsible research." Much more remains to be done.

In China, also, the scientific community tends to attribute the failure of research integrity mainly to a deteriorating research climate instead of a few bad apples. Research misconduct has been fueled by several driving forces (Qiu 2010; Yang 2013). One is the budget incentive. In many major research universities or research institutes, competitive research grants constitute oversized fractions of budgets, providing an economic incentive that is a factor in ethical violations. For example, the competitive research grants constitute 35–45 % of the total budget of "C9" universities (the nine most renowned Chinese universities, analogous to the Ivy League in the USA). That is more than education funding, tuition, and donation combined. It makes the universities obligated to further enlarge the grant total, even at the risk of contributing to research misconduct.

A second driving force is a performance-based award system embedded in many universities and research institutes. The low government salary leads those universities to set additional "university credits" to increase their salary competitiveness. Those credits are substantial (may be as high as 50 % or even higher of the total income of professors) and are typically quantitative to facilitate measurement by administrators. Performance-based subsidiary income can act as a perverse incentive if it prompts researchers to produce questionable studies, with respect to both their need and their value, in order to line their pockets with additional income. Two side effects emerge from these salary incentives. The first is bean counting: administrative management always tends to evaluate researchers in a numeric way. Misconduct can be inadvertently encouraged by the use of quantitative rather than qualitative measures of merit. The second side effect is awards for publications and grants. Many universities or research institutes award researchers (salaries or research grants) for publications in high-impact journals, or for receiving big research grants. The government's performance-based policy of allocating budgets to national universities or research institutes should help to lessen the need for and impact of such perverse incentives.

The third driving force for the slippery slide is the talent hierarchy, namely, escalated "talent titles" with increasing honors and resources. There are tens of different titles associated with talent, resembling various steps in the administrative system. A talent hierarchy in academia may encourage scientists to hype their findings, expand their egoism, and claim credit for team performance as their own. Consequently, some young scientists may be tempted to step outside ethical boundaries in order to climb the academic ladder.

The fourth driving force comes from societal, especially governmental, impatience and high expectations for quick results. The society always asks questions like "why can't China win a Nobel prize this year?" and "why do you look like an under-achiever?" This constant pressure may lead researchers to look for a shortcut in their academic career, since "failure" is hardly tolerable in a Chinese society. Too much pressure for researchers and students imposed by assessment and evaluation mechanisms may drive misconduct. For example, many medical doctors or nurses are required to publish papers to get a professional title, resulting in the publication of low-quality papers, or even taking improper actions to have a paper published.

These four driving forces are further intertwined with two situational factors. Many researchers attribute the causes of research misconduct to five aspects: personal, research team, research code/norms, managerial mechanism, and research environment. Academic norms in some disciplines are not well developed, widely accepted, or broadly disseminated. Some people can make mistakes or even commit research misconduct due to ignorance of such norms. Many scholars are not familiar with the concept of self-plagiarism, and there is still controversy over the justification of dual publication of Chinese and English versions of the same article. Importantly, insufficient instruction and guidance from supervisors and questionable research practices of senior researchers may have a negative impact on young scientists' conduct of research.

How, If at All, is Training/Education Used to Mitigate Those Factors?

Both the USA and China have placed great emphasis in recent years on the importance of increased ethics training and education of scientists. In the USA, the 2002 IOM report made clear that education on the ethical conduct of research is the path "most likely to have the desired results with the least level of intrusion and the greatest direct impact on overall norms" (Institute of Medicine 2002, p. 59). More recently, the US National Science Foundation (2009) emphasized the critical nature of ethics education by declaring that "education in RCR is considered essential in the preparation of future scientists and engineers."

> "[T]he provision of instruction in the responsible conduct of research derives from a premise fundamental to doing science: the responsible conduct of research is not distinct from research, on the contrary, competency in research entails responsible conduct and the capacity for ethical decision making" (Institute of Medicine 2002, p. 84). Education and training received a big boost from the US government, beginning in 1989. That year, the National Institutes of Health (NIH) required all of its training programs to include instruction in scientific integrity (U.S. Department of Health and Human Services 1989). In 1994, NIH sent an expanded message to the research community, stating that "Plans that incorporate instruction in the responsible conduct of research for all graduate students and postdoctorates in a training program or department, regardless of the source of support, are particularly encouraged" (National Institutes of Health 1994).

Another major milestone occurred in 2009, when NIH noted that "there have been a number of developments related to instruction in responsible conduct of research. The scientific community has responded by developing innovative courses, workshops, research projects on instruction in responsible conduct of research, and instructional materials." As a consequence, it issued a Notice to update its policy on responsible conduct of research education. The new Notice (National Institutes of Health 2009) was more direct in what NIH would require as part of research ethics instruction. It addressed more specifically who should participate, how often instruction should occur, and the form that instruction should take and offered "guidance to applicants, peer reviewers and NIH staff in determining how well specific plans for instruction in responsible conduct of research compare with the best practices accumulated over the past two decades by the research training community."

The US National Science Foundation (NSF) also took steps in 2009 in response to the enactment of the America COMPETES Act (P.L. 110–69). That legislation announced (U.S. National Science Foundation 2009) that

> "Effective January 4, 2010, NSF will require that, at the time of proposal submission to NSF, a proposing institution. . .certify that the institution has a plan to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduates, graduate students, and postdoctoral researchers who will be supported by NSF to conduct research."

Collectively, these interventions by the government demonstrated how its power of the purse – its role in funding scientific research and education – can influence teaching in graduate and professional education. Policymakers were determined to do their part in holding the research community accountable for adhering to accepted research practices and ethical standards.

Since 2000, there have been increasing efforts to introduce ethics education and training for scientists via online mechanisms. Taking into account both USA-based and international resources, more than 30 sources of online research ethics instruction have been identified (http://www.miami.edu/index.php/ethics/projects/WHO/resources), and it is likely that hundreds of US universities have adopted some form of online ethics training for researchers.

Despite these efforts, NIH has stated that:

> "While on-line courses can be a valuable supplement to instruction in responsible conduct of research, online instruction is not considered adequate as the sole means of instruction. A plan that employs only online coursework for instruction in responsible conduct of research will not be considered acceptable, except in special instances of short-term training programs. . ., or unusual and well-justified circumstances" (National Institutes of Health 2009),

a position that casts doubt on the adequacy of online training as a sufficient approach for teaching research integrity in the USA.

Although starting somewhat later than the USA, training in research integrity is gathering momentum in China. In the turn of the new century, some leading universities and research institutes in China have recognized the importance of research integrity and assigned the function of the education of responsible conduct of research and the judgment of research misconduct to their academic committee. In 1997, CAST established a special committee for research integrity and conducted educational activities on scientific ethics. In 2006, the Ministry of Education (MoE) established a committee to promote academic ethics, and the Ministry of Science and Technology (MoST) issued an executive order [Order of MoST, No. 11, 2006] on the treatment of research misconduct. In early 2007, joint meetings for promoting research integrity were initiated by MoST, MoE, the Chinese Academy of Sciences (CAS), Chinese Academy of Engineering (CAE), NSFC, and CAST to coordinate actions in promoting responsible conduct of research by regulations and education. In 2007, CAS instructed its 100 institutes to develop educational programs on research ethics for their members (Hepeng 2007, p. 1207). In August 2009, several government agencies and key scientific organizations jointly issued a policy statement for promoting research integrity in which they stated that:

> "Universities and colleges should strengthen the development of courses and teaching materials on research integrity education in order to enrich the content of education and perfect teaching methods. They should take seriously their responsibility to strengthen the training of talented instructors and researchers of research integrity" (Joint Committee 2009).

Research-oriented universities are developing courses on ethics and research integrity, mostly for 1st-year (occasionally 2nd-year) graduate students. A handy reference for that endeavor is the textbook *Scientific Integrity – Text and Cases in Responsible Conduct of Research* (Macrina 2005). The book was translated into

Chinese in July 2011 by NSFC, and 120,000 copies of the translation were sold to university faculties and students. It has since served as a textbook for research integrity for college seniors and graduate students, on the recommendation of six government ministries and funding agencies. The city of Beijing printed 100,000 copies of *An Outline for Scientific Morality and Ethics*, edited by a task group on research integrity education established by CAST. The group also edited a collection of examples of scientists with high academic morality and integrity; 20 monographs and 18 reference books on research integrity were printed last year, totaling 40,000 copies. Several textbooks on research integrity have emerged, such as a graduate textbook published by Tianjin University Press in 2011. CAST is working on a joint set of cases with AAAS. The exchange of expert views from the two countries indicates that both the black and white situations revealed in actual misconduct cases in China and the hypothetical cases that focus on the gray areas of research conduct can be beneficial to young researchers in China.

CAST and the Ministry of Education (MoE) jointly conduct nationwide education programs on research integrity for new graduate students and new faculties. When the new graduate students start their curriculum, a concerted approach is taken to have research integrity training as the first class after their enrollment. The training effort can be exemplified by the grand lecture on scientific values and research integrity given at the Great Hall of the People for 5000 graduate students in the first month of their enrollment. Lectures are also given by experts in various provinces by the members of Ethics Committee of CAST. This and other education programs are believed to reach about a half of the new graduate students. Every year, each university provides compulsory lectures on ethics for new faculty to make sure their first steps in academic careers are sound. Statistics (collected by CAST and MoE) show that 18,000 lectures on research integrity were given in China in 2013, which reached 2.19 million graduate students, 3 million undergraduates, and 260,000 university teachers. In addition to the education effort, regulations for research integrity are put forward by MoE, MoST, CAS, and the Surveillance Committee of NSFC to define the ethical boundaries for research conduct.

In order to transfer such education from special lectures into daily learning and research activities, more efforts of "training the trainees" are being made by major universities in their faculty development centers in recent years. For instance, in Nankai University, RCR education has been included as an essential part in training new faculty and newly promoted faculty every year since 2011, and similar activities have been started by a number of universities in the recent years. Various new forms of integrity training have emerged. For example, the policy of text screening for plagiarism has raised the awareness of students about the wrongs of plagiarism, and also encouraged them to become knowledgeable about the details of research codes, norms, and the specific requirements for the conduct of research.

Clearly, for China, the numbers to reach are enormous and the need for materials remains high. In the USA, the challenge is less one of numbers and materials but more one of finding what works, a problem that the Chinese, as will be discussed later, are only now beginning to confront.

Is There Evidence that Training/Education Works?

Whether in the USA or China, “Education in the responsible conduct of research is critical, but if not done appropriately and in a creative way, education is likely to be of only modest help and may be ineffective” (Institute of Medicine 2002, p. 124). Yet, “little is currently known about the success of RCR education programs in achieving any specified outcomes” (Powell et al. 2007, p. 250).

The importance of assessing the quality and impact of research ethics education has not gone unnoticed by the scientific community.

> “Given the widespread application of instruction in ethics as a potential solution for misbehavior in the sciences, not to mention the substantial time and resources required for the development and implementation of instructional programs, a critical question arises: Are such programs effective?” (Antes 2009, p. 1). Antes and colleagues took a look at the literature and concluded that it “suggest[s] a great deal of interest in ethics instruction, but limited systematic, rigorous evaluation of ethics instruction” (Antes 2009, p. 9).

Looking at a few of the studies done over the past several years yields mixed results. Plemmons et al. (2006) found “the impact on knowledge was greater than that for changes in skills or attitudes” about RCR. Powell and colleagues observed that “The only statistically significant improvement associated with the course was an increase in knowledge, while there was a non-significant tendency toward improvements in ethical decision-making skills and attitudes about the importance of RCR training” (Powell et al. 2007, p. 249). Others have found that while some ethics education approaches

> “were effective in enhancing participants’. . .moral efficacy and moral courage,. . .Moral judgment and knowledge of responsible conduct of research practices were not influenced. . .” (May and Luth 2013, p.545). Finally, a more upbeat study by Mumford and colleagues found that “training not only led to sizable gains in ethical decision-making, but that these gains were maintained over time” (Mumford et al. 2008, p. 315).

The fact is that “although there appears to be a general consensus about the importance of ethics education for researchers and scientists, there is little agreement about the most effective approach to instruction, or even the most appropriate goals for these programs” (Antes 2009, p. 1). In their meta-analysis of efforts to “assess prior program evaluation efforts,” Antes and colleagues found that evaluation studies “reported mixed findings regarding the effectiveness of instruction. Some ethics courses have been shown to induce the desired effects, whereas others indicate little or no effects of ethics instruction on learning outcomes” (2009, pp. 1–2). Furthermore, as part of the bigger picture, one needs to find agreement on what changes will lead to desired effects and how much of a change will lead to results that make the effort worth the costs.

In China, a preliminary evaluation of the recent campaign in research integrity training is positive. Data from various graduate schools of major universities in China reveal that graduate students have a clearer awareness of what types of research conduct they should avoid. Similarity checks of submitted Ph.D. theses in many universities have indicated a decline in "cut-and-paste" sentences/paragraphs from the existing literature. The culture is changing from "why not cheat" to "it's not worth getting caught." Increasingly, students realize that research misconduct is a mistake they cannot afford to make, as written down in several confessions by young researchers who committed plagiarism. The program managers of NSFC give talks on research integrity around the country, which may also contribute to the awareness of questionable practices in grant applications. Nevertheless, evaluations of China's efforts are in their infancy, and their quality and effectiveness will be the next big issue for evaluation and improvement in the country.

Are There "Best Practices" or Highly Recommended Approaches to Training?

In 2009, NIH issued a Notice stating that the

> "guidance provided below is directed at formal instruction in responsible conduct of research. It reflects the accumulated experiences and the *best practices* of the scientific community over the past two decades. These practices have been incorporated into many of the best regarded programs of instruction in responsible conduct of research" (National Institutes of Health 2009). (Emphasis added; this characterization can be solely attributed to NIH based on its review, rather than on any consensus within the scientific community.)

Another effort at identifying best practices is the Project for Scholarly Integrity of the Council for Graduate Schools, the only USA-based national organization "dedicated solely to the advancement of graduate education and research" (http://www.cgsnet.org/about-cgs). In 2012, it published *Research and Scholarly Integrity in Graduate Education*: *A Comprehensive Approach*, which it described as a

> "best practice guide [that] documents the results of. . .a multiyear, multi-institutional CGS initiative to identify promising practices in embedding research and scholarly integrity into graduate education. The document discusses a wide range of innovative strategies including the use of assessment to enhance and build support for high quality, relevant research integrity programs. It also includes case studies, useful tools, and analysis of baseline survey results on activities, resources, and institutional climate for research integrity" (Council of Graduate Schools 2012).

It is not clear the extent to which this effort has influenced the adoption of any of the practices and recommendations it proposes beyond those institutions participating in the original study. Nevertheless, it is one of very few efforts of such magnitude that seeks to be evidence based in its approach.

Realistically, however, when one examines the evidence presented above about the dearth of rigorous assessments of research ethics training and, where assessments have been conducted, acknowledges their mixed results, it is premature to think in terms of best practices for research integrity education and training. There may be "common" practices, but referring to them as "best" practices would be misleading.

One of the more common practices in the USA relates to the content of instruction, where government agencies have indicated what topics should be considered essential to education and training in research integrity. ORI, for example, in 2000 identified nine core areas that could be included in research integrity instruction: (1) data acquisition, management, sharing, and ownership; (2) mentor/trainee responsibilities; (3) publication practices and responsible authorship; (4) peer review; (5) collaborative science; (6) human subjects; (7) research involving animals; (8) research misconduct; and (9) conflict of interest and commitment. These nine topics have dominated research integrity instruction since then, but several years later, ORI supported a project to recommend whether new core areas should be included. In July 2007, the project reported that six additional areas were identified by a group of 18 external experts, but ORI never officially adopted any of them (U.S. Office of Research Integrity 2007). Those topics included the following: (1) the financial and operational responsibilities of Principal Investigators; (2) social responsibilities of researchers; (3) historical background in responsible conduct of research; (4) current issues in responsible conduct of research; (5) lab safety and environmental health; and (6) philosophy of science, including roles of bias and worldviews in science. Although not widely adopted, there are instructors who have broadened the topical coverage in their educational offerings beyond the nine "core areas."

In 2009, NIH took a step in broadening the original ORI list by adding the following topics to the core nine: "the scientist as a responsible member of society, contemporary ethical issues in biomedical research, and the environmental and societal impacts of scientific research" (National Institutes of Health 2009). Both the ORI and NIH policy statements are guidelines, however, with institutions and instructors given flexibility on what is ultimately included. In fact, NSF has taken a different approach, informing researchers that "NSF believes that the research community, encompassing both individual researchers and institutions, is best placed to determine the content of RCR training without a need for NSF-specified standards" (U.S. National Science Foundation 2011).

Although those topics are pervasive in research ethics education and training, there is also recognition in the research community that the research environment changes over time. Such a dynamic environment means that the roles and responsibilities of researchers will also evolve, thereby altering the ethical challenges that researchers face. Hence, educational efforts must be flexible and responsive to those changes.

The Chinese approach to ethics education has been top down, namely, from ministries/funding agencies to universities/research institutions, then to researchers, which may be more likely to work there than in the USA. It is viewed as a valuable approach in China's initial stage of combating research misconduct. At the national level, it creates a research climate built upon the public awareness of various misconduct behaviors. At the university level, it leads to policies such as compulsory integrity courses, research integrity lectures to newly appointed supervisors, and adoption of their own codes of research conduct. At the student level, it enforces a disciplinary environment for the respect of intellectual property.

The extensive education campaign staged in China by CAST and MoE, as mentioned above, is rather unique. It combines the concepts of research integrity (as developed along with modern science) with the traditional moral values of scholars. The campaign focuses on the spirit of science, scientific morality, scientific ethics, and scientific norms. However, China's ambitious newly launched campaign has not yet been accompanied by systematic evaluation, so its effects on nourishing the research climate in China is still too early to assess.

What Improvements Might Be Made in Education/Training?

To answer this question requires insight into the strengths and weaknesses of current efforts, something that is far from settled knowledge. As Joseph Whittaker, a Dean at Morgan State University, has observed, "The lack of data on what works, what doesn't work, and what has had mixed results has impeded the development of programs that build on prior successes and avoid prior failures" (Hollander and Arenberg 2009, p. 16). Better tools and strategies for evaluating educational and training initiatives are sorely needed, as is greater clarity on the goals of research integrity education and training so that whatever approaches are employed can be measured against those goals. Otherwise, it will be difficult to persuade instructors, administrators, policymakers, and, most critically, trainees and students that education in research integrity can make a positive contribution to the country's investment in research and is deserving of support.

The report by the National Academy of Engineering of a workshop on "Ethics Education and Scientific and Engineering Research: What's Been Learned? What Should Be Done" noted that "skills and knowledge are not sufficient if the individual does not have the personal and social motivators that encourage praiseworthy behavior." The report continues by urging that "Environments must be structured to reward individuals who demonstrate ethical behavior" (Hollander and Arenberg 2009, p. 14). Good role models and mentoring would seem to be an essential component of such an environment. So, too, would be empowering students by giving them the confidence, insights, tools, and skills needed to fulfill their ethical responsibilities. In the long run, embracing empowerment of students as a core objective would be an improvement that could be expected to enhance all such initiatives.

While such empowerment is essential, the task is admittedly daunting. To cite Kalichman, it may be "wishful thinking to expect any form" of ethics education or training "to counter perceptions of the institutional culture or what is seen on a daily basis" by scientists and students (Kalichman 2013, p. 8). To counter those perceptions, researchers should do what good scientists are quite good at – studying a problem and testing different hypotheses about what works and why. Admittedly, "Self-assessment is never comfortable. But if the scientific community is to live up to its responsibilities to maintain the quality and integrity of science, then one has no choice but to do so, and to do it with the same rigor that scientists apply in the laboratory or in the field" (Frankel 2003).

The top-down education effort in China may be complemented by a bottom-up package for improved research integrity. Three tentative approaches are currently conducted by CAST and MoE. The first approach involves coordinating about ten universities to develop detailed course books on research integrity training, with cases collected in their own universities but of common education values. The second approach is the annually conducted training series on current issues of research misconduct. Namely, CAST and MoE organize annual national forums to train graduate school executives of 100 leading universities. The contents of the training are focused on several hot issues of research misconduct in that year. For example, ghostwriting was one of the issues selected in 2014. These graduate school executives will later conduct the research integrity trainings in their respective universities. The third approach is to encourage individual universities to develop different research integrity codes addressing the characteristics for various disciplinary fields within the university, while adhering to common guidelines of research integrity. That approach takes into account the evolution of research integrity cultures in different disciplines, while acknowledging that common guidelines apply across all disciplines. Progress in these diverse training approaches is expected to expand the horizon of research integrity training and reinforce its impact in the future.

Conclusion

In both China and the USA, the campaign against misconduct and for promoting research integrity has focused on both regulation and education. The initial approach was to establish regulations of research conduct. Various government agencies have been tasked with promulgating and enforcing regulations that deal primarily with misconduct in science. While the USA has settled on a narrow regulatory definition of misconduct, China has adopted a more expansive definition (Chong 2006; Lin 2009).

The scientific communities in both countries realize, however, that for real and lasting change to occur, it must be achieved through education that reinforces the notion that good science and ethical science go hand in hand. Yet, education must itself be supported by strong incentives to “do the right thing.” Unfortunately, in both China and the USA, the research environments affect the governance of science in ways that have actually created incentives to cut ethical corners. In China, a good academic climate is still to be built and reforms are required (Cao et al. 2013). To succeed, China will need to overcome strong currents with deep historical and cultural roots, where an “authoritarian ‘top-down’ power structure inside the scientific community will tend to discourage internal criticism and stop monitoring from being as effective as it could be” (Dickson and Hepeng 2006).

In the USA, the problem is neither an “authoritarian” system nor the absence of “internal criticism.” In fact, the research environment has been heavily criticized in recent years, even described by one Nobel laureate as being “disfigured by inappropriate incentives” (Schekman 2013). Others argue that existing “incentives create a subconscious bias toward making research decisions in favor of novel results that may not be true" (Nosek 2012). A critical issue for US researchers and their institutions is how to generate evidence that will offer guidance on creating an environment that will promote research integrity.

In the USA, government mandates have helped to spur and shape research integrity education and training. There is a great deal of activity in America's universities and elsewhere. These efforts span a diverse range of approaches, content, target audiences, and instructor backgrounds, reflecting a commitment to experimentation that captures the spirit of science. Yet, there is little evidence to demonstrate their effectiveness or to identify "best" practices, in part because so few studies have been undertaken and in part because agreement about the goals of such instruction, what changes would produce the desired effects, and how to weigh the effects of change against the costs involved are not clear. For China, the challenges are meeting the needs of large numbers of students and faculty with a relative shortage of educational materials. As mentioned above, there are major efforts underway to get good teaching materials into the hands of 1st-year graduate students and their instructors, but upper-level graduate students and postdocs need them as well. Moreover, as in the USA, the rush to meet this burgeoning need has not been combined with a sustained effort to assess the effectiveness of such materials.

Where one is likely to find common ground between the two countries is on the need to produce scientists who are open to questioning others, to speaking out when their colleagues engage in questionable behaviors, to taking affirmative steps to report misconduct by other researchers, to serving as role models and mentors to others, and to understanding the social complexity of the issues they will face. If successful, then China and the USA will produce a scientific workforce both capable and motivated to use its acquired knowledge, skills, and attitudes to bring about a transformative change in the research culture.

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