Comment

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A researcher stacks mouse containers at an animal-breeding facility near Guangzhou, China.

Five ways China must cultivate research integrity

Li Tang

A swift increase in scientific productivity has outstripped the country's ability to promote rigour and curb academic misconduct; it is time to seize solutions.

How researchers in China behave has an impact on the global scientific community. With more than four million researchers, China has more science and technology personnel than any other nation. In 2008, it overtook the United Kingdom in the number of articles indexed in the Web of Science, and now ranks second in the world. In 2018, China published 412,000 papers.

But China also produces a disproportionate number of faked peer reviews and plagiarized or fraudulent publications. Its share of retracted papers is around three times that expected from its scientific output (see 'Outsized retractions').

The past few years have witnessed high-profile cases of faked peer reviews, image manipulations and authorships for sale, some involving prominent Chinese scientists. In May last year, China asked two groups to foster research integrity and manage misconduct cases: its Ministry of Science and Technology (MOST) and the Chinese Academy of Social Sciences (CASS). In November 2018, 41 national government agencies endorsed a set of 43 penalties for major academic misconduct. These range from terminating grants to restricting academic promotion and revoking business licences. This year, the government issued a foundational document to promote the scientific enterprise and foster a culture of academic integrity[1].

China's strides towards reform have been well received domestically and abroad, but effecting lasting change is hard[2]. To better characterize the situation, my team has studied global retraction data alongside national grants and applications that were revoked. We also surveyed researchers online and interviewed major stakeholders in China[3,4]. These included experts on university ethics committees, programmes for research-integrity training and plagiarism detection, as well as funding-programme managers, journal editors and academics. Here, I outline major challenges in research integrity, and potential strategies and solutions to buttress it.

Five strategies

Align norms. What counts as misconduct rather than acceptable practice differs across cultural settings and disciplines. The lack of consensus over what misconduct means is a thorny challenge for an emerging scientific powerhouse. One of our interviewees noted that senior academics even disagreed over what constitutes an allegation.

Any discussion about misconduct and penalties is buffeted by conflicting norms: historical versus the present, national versus

international. For example, the reuse of text without proper citation is, to some degree, accepted in textbook publishing in China. Until 1999, duplicate submissions or even dual publication in Chinese and English were not considered particularly inappropriate. More than 20% of our survey respondents felt that duplicate submission and self-plagiarism were common in their domain. These are deemed misconduct in international scientific communities.

That presents Chinese scientific leaders with a dilemma: if wrongdoing is not punished, the scientific community could become more tolerant, and there might be more misconduct and recidivism. That would waste public money, erode trust in science and tarnish the country's reputation. Already, Chinese academics can find it difficult to maintain or expand international collaborations, and universities and funding agencies outside China have ethical concerns about forming partnerships.

But requiring strict compliance with international norms would target a broad spectrum of misbehaviours that are common practice. And high standards with unworkable rules could legitimize non-compliance[5]. Either scenario could stymie reform.

Optimize approaches. Research misbehaviour needs to be policed. Strategies can be classed as 'patrols' or 'fire alarms'[6]. Like other countries, China deploys both.

On the patrol side, China National Knowledge Infrastructure (CNKI), a Chinese version of the Web of Science database, provides a plagiarism-checking service to Chinese journals and universities. These have deployed CNKI software to detect plagiarized texts, including those saved as manipulated images. Since 2010, grant proposals have been checked for possible plagiarism at the National Natural Science Foundation of China (NSFC). Similarly, the National Social Science Fund of China (NSSFC) instigates systematic clean-ups for its funded projects, halting those that are left unfinished after the completion deadline (typically six years after receiving the grant). This put an end to 302 of 5,035 grants funded from 2002 to 2005. Terminated projects increased from 60 in 2002 to 99 in 2005, but have plummeted since checks were implemented and publicized in 2012 (ref. 3; see 'Checks changed behaviour').

Patrol deters certain types of misconduct, particularly before a grant or degree is awarded or a paper accepted. But patrols require dedicated software and infrastructure, so are costly to enforce. Every May (just before graduation), college students, university faculty members and support staff spend hours checking theses for plagiarism.

Perhaps that is why a fire-alarm tactic is dominant. China's science agencies and universities often wait to act until contacted by the media, wronged parties or whistle-blowers, and they focus most on cases that grab headlines. This can be effective in the short term: in 2017, after 107 articles by Chinese authors were retracted by the journal *Tumor Biology* for faked peer reviews, investigations were completed within 4 months. More than 100 people were penalized and some 40 NSFC grants revoked. But the fire-alarm tactic leads to selective investigations and uncertainty. It punishes past offences, but does little to deter future ones.

Empower enforcement. The burden of policing misconduct is too much for national agencies in any country, China included. That power is delegated to the universities and institutes where researchers work. But these organizations, concerned about soiling reputations and losing grant funds, are often unwilling to investigate alleged misconduct. They tend to respond only when whistles are blown. That depends on whistle-blowers who shoulder great professional and personal risk, especially in Chinese society, which values collectivism and interdependence over individualism and independence. In a 2017 survey of Chinese scholars, more than half of respondents who observed misconduct in the past three years said that they did nothing about it (unpublished results; see also Supplementary Information).

Assign responsibility. Perhaps the most difficult challenge in China, as elsewhere, is whether and to what extent to hold team members accountable for misconduct in joint work. Increasing specialization and globalization has made collaborations larger and more essential. That complicates how to allocate blame as well as credit. Should each listed author be held accountable for the full work, or just for their own? Should the corresponding author take most of the responsibility for fraud and errors others committed? Although more journals are requiring detailed descriptions of authors' contributions, discerning who should be responsible for a collaborative piece of work is difficult. This is particularly true when older articles are retracted as a result of proven fraud — often, author contributions have not been specified.

The supervisor–student relationship poses a particular dilemma. In China, when PhD students are found guilty of misconduct, their supervisors are also punished. In recent scandals, plagiarists were stripped of their doctoral degrees, and their supervisors were demoted and barred from taking on PhD candidates. Alternatively, junior scientists might be punished, while senior ones responsible for misconduct retain status and position. Some argue that holding members of a research team accountable by association will improve enforcement and prevent scapegoating; others say that this shift in responsibility is unfair and burdensome.

Cultivate integrity. China's rapid research development must be brought into sync with a culture of integrity. Like other countries, it has seen that tying publication requirements to degree requirements, promotion or monetary rewards can lure researchers into inappropriate behaviour[7].

Integrated tactics

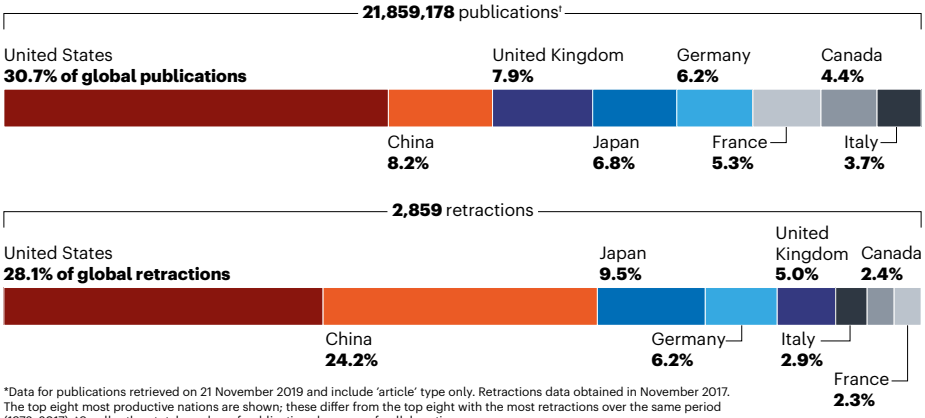
What is the best way to implement these strategies? I propose that working on several fronts will make each easier to accomplish.

Forgive, then be tough. China's scientific community first needs to agree on a common code of academic integrity that defines misconduct and undesirable research practices and sets out sanctions. China has a greater diversity of funders and a more mobile scientific workforce than ever before, so all stakeholders — including researchers, managers, journal editors and funding officers — must be in accord.

Penalties should focus on the most egregious acts, which are universally recognized: falsification, fabrication, plagiarism and fake reviews. Researchers should be admonished for past fraud but face harsher penalties for incidents that occur once the code is in place.

OUTSIZED RETRACTIONS

China has published 8% of the world's scientific articles, but by 2017 had garnered 24% of all retractions*.



*Data for publications retrieved on 21 November 2019 and include 'article' type only. Retractions data obtained in November 2017. The top eight most productive nations are shown; these differ from the top eight with the most retractions over the same period (1978–2017). †Smaller than total number of publications because of collaborations.

SOURCE: L. TANG/WEB OF SCIENCE

Less serious questionable practices that were historically accepted should be subject to a statute of limitations.

Institutionalize. Integrity must be built into scientific institutions, with MOST and CASS taking the lead. CASS should set up departments to oversee misconduct cases, as MOST has. Both agencies should facilitate communication between all stakeholders and coordinate input from research societies to formulate workable rules that are compatible with international norms.

Transparency will help. Funding agencies should, for example, publicize the claimed achievements and promised research outputs of award recipients in prestigious talent programmes. This accountability will deter fraud and false advertising. China's General Administration of Press and Publications can help by urging Chinese publishers and database providers to take a proactive stance. For instance, Chinese journals often simply remove retracted articles from their collections and the CNKI database. Instead, journals should explicitly mark articles as retracted, as many Western journals do[8]. They should also share their 'blacklists' of authors who have repeatedly been found guilty of duplicate submissions.

With the right support, universities and research institutes can be best placed to initiate misconduct investigations. MOST and CASS should help them set up procedures. These should include appointing an independent ombudsperson to protect whistle-blowers and those accused of misconduct, for example by developing strategies to prevent cyberbullying and smear campaigns. In addition, each university should employ a professional chief integrity officer — not a faculty 'volunteer' — who reports directly to a vice-president.

Incentivize. Administrative agencies must explicitly link support for a university to whether it vigorously investigates misconduct allegations and promotes integrity education, including putting dedicated professionals in place. Agencies can also set up open, regular communication about reform with junior and senior researchers — for real-world input and to allow institutions to learn from each other.

Educate. A healthy academic atmosphere cannot be built on penalties for misbehaviour alone. Universities could set up research-integrity help desks and hotlines, making contact information and investigation procedures accessible. The Chinese university code of academic integrity should be linked from every course syllabus. Teachers should have access to plagiarism-checking software and to training so they can understand its shortcomings.

More broadly, universities must work out how to provide effective integrity education. Training upstream is always better than disciplining transgressors after the fact (see also go.nature.com/2rpdhkv).

Many Chinese universities now require graduate students to take responsible-conduct courses. Around three-quarters of our survey respondents said they had received training in research ethics and integrity. Those enrolling for a PhD at Fudan University in Shanghai, for example, must attend mandatory ethics modules. Only those who pass the ethics quiz can register for further coursework.

Such training needs to be universal across Chinese institutions, and at all levels: for faculty members, technicians and non-scientific staff. Principal investigators who coordinate collaborations, as well as young researchers who collect, check and validate data, must know and accept their responsibilities[4]. 'Trust and verify' should be bywords for all. For example, at least two team members should collect and code raw data and record source links and detailed procedures. Pre-registration of analysis plans could also prevent tampering[9].

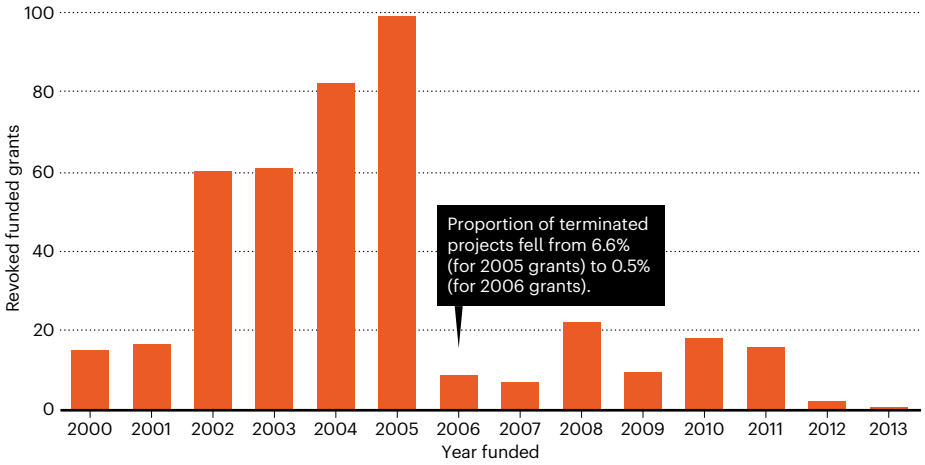
Study. Also needed is rigorous research on what kind of institutional structures and programmes foster integrity, which types of training effect the most lasting change, and how to apply best practice. Comparative studies could provide lessons from other countries that have experience in combating academic misconduct and cultivating integrity. For example, in 2014, Denmark adopted a new code of conduct for research integrity as a result of orchestrated efforts by researchers, funding agencies and other stakeholders. The Netherlands followed suit in 2018. Indian efforts against predatory publishing could be adapted for China, as could the long-established US emphasis on quality rather than quantity in research evaluation.

To gather this knowledge, oversight agencies should have an open-door policy for stakeholders to express constructive and diverse opinions. Proceedings of misconduct investigations should be made public, not be shrouded in secrecy[10]. Funding agencies need to earmark money for research-integrity studies to attract bright minds to the field. This year, the NSFC issued an open call for proposals on research integrity and ethics; it is unclear whether such funds will be available in future.

China must curb misconduct and foster integrity if it is to realize the central government's ambition of "world-class universities, world-class disciplines". It is still too early to anticipate all the changes reforms will bring, but the government has signalled its determination to act. We might see more investigations of misconduct because of closer scrutiny in the next couple of years. Improving the research practices of Chinese scholars will boost innovation and development everywhere.

CHECKS CHANGED BEHAVIOUR

After the National Social Science Fund of China began terminating grants for incomplete overdue projects in 2012, researchers quickly complied with the funding agency's deadlines for finishing work (typically six years).



SOURCE: NSSFC

The author

Li Tang is a professor of public policy at the School of International Relations and Public Affairs, Fudan University, Shanghai, China; and a member of the board of directors of the Chinese Association for Science of Science and S&T Policy (CASSSP).
e-mail: litang@fudan.edu.cn

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Supplementary Information accompanies this article: see go.nature.com/2qahhbu

Correction

This article (*Nature* **575**, 589–591; 2019) misstated which agency revoked 40 grants for fake peer review. It was the NSFC.