A private researcher's struggles against research fraud. II. Suggestions for reducing the fraud problem

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This is the second of two papers relating to research fraud. In the first paper, the author described a twelve year battle to expose research fraud from a novel perspective: that of a self-funded private researcher working with university colleagues. In this paper he makes some draft proposals for combating fraud based on his experiences and observations as an "outsider". These suggestions are intended to be thought-provoking rather than prescriptive.

Key index words and phrases: blockchains, cloud, quality control, research ethics, research fraud, research integrity, women in science

During his first career as a college physics teacher the author had the satisfaction of teaching physics to many young people who went on to develop their own careers in science. His proud boast to the students was that science was the most trusted form of human endeavour, because it included a comprehensive set of quality control instruments. Eventually fraud would always be discovered and the truth revealed.

During his second career as a private researcher working with several universities, he discovered that market forces are undermining his idealized quality control model.

His twelve year struggle to expose research fraud is described in Part I of this series of papers [1]. To his surprise, his zeal for exposing the truth was neither welcomed nor rewarded. Instead, he was ostracized by his university colleagues and his efforts resulted in protracted mental and physical health problems. His experiences suggest that new research quality control instruments are required that eliminate risks for whistleblowers without simultaneously crushing academic freedom by creating a stifling surveillance atmosphere in the laboratory. These joint requirements lie at the heart of the following proposals.

1. Reinforcing our commitment to research ethics

1.1 Initiating undergraduates into good research behaviour

Research ethics should be studied in the early weeks of first degree courses within the wider context of professional ethics. Here are suggestions for how to do it:

- Students must learn that research fraud is not a victimless crime; it has serious consequences for society.
- Guest speakers from industry should emphasize the commercial cost of research fraud.
- The research ethics syllabus should cover whistleblower ethics in order to discourage spurious complaints from becoming acceptable.
- The voluntary swearing of a Hippocratic-style oath to carry out honest research should be debated. The dangers of such an oath need to be discussed as well as its merits.
- An improved vocabulary to describe failure to meet the rigorous standards of scientific research[1Q] needs to be developed and taught. This should distinguish between innocent failures due to misunderstandings and wilful failures due to cheating.
- The sceptical philosophical approach to science developed by Karl Popper [2] needs to be assimilated so that tomorrow's researchers avoid overemphatic statements such as, "Our research *proves* that ...".
- At the end of their induction course the students' knowledge of research ethics should be tested at all universities on the same day. This would promote a sense of "rite of passage" into a higher education world where cheating is unacceptable.
- The burdens of teaching the courses and marking the exam papers should be shared by all active researchers (e.g., on a three year rota). This will provide researchers with regular reminders of the importance of research ethics throughout their careers.
- Research ethics must be debated by all involved in research: arts, humanities and the natural sciences.

In the long term a cohort of students with a strong commitment to research ethics will deliver a multiplier effect by their example. Many will become parents of the next generation of students, some will go into research management and others will go into teaching science at school level.

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1.2 Failing with dignity—we need a kinder science

One of the most productive aspects of being human is our ability to learn from our mistakes. But the (male) aggressive culture that contaminates modern science stifles this trait. Worse still, it increases the temptation to act fraudulently to hide failure, to prevent humiliation within the peer group.

Here are some suggestions for changing this culture. They should be considered as possible syllabus topics for the undergraduate course on research ethics.

- **Quality is more important than quantity.** The scientific community should recognize the dangers inherent in overproductivity in the publication of research papers and reduce its status as a mark of scientific ability. Each author of a journal paper should be obliged to state what he or she contributed to the paper. All of the answers should be published on the journal's web site.[1]
- **Admitting to human failings.** Researchers should be encouraged to include a "Lessons learned during the research journey" section in their papers, where they explain how they learned from their mistakes.
- The corrosive effect of peer aggression and pressure to publish should be recognized in stories about the history of science. An example is the "crucifixion" of Fleischmann and Pons [3], whose careers where destroyed when they hastily and mistakenly announced that they had discovered a method for inducing cold fusion.
- Universities that encourage or tolerate alluring public announcements before peer reviewed research has been accepted for publication should be marked down in world research rankings. In the long run, fewer public announcements more strongly backed by evidence will add to the status of universities.
- Famous cases of admitting, and learning from, failure should be given greater exposure. For example, the "Rayleigh–Jeans catastrophe" [4] should be told as it was: a ground-breaking failure of classical physics to explain black body radiation. Rayleigh and Jeans were highly respected scientists so their failure allowed their peers to think the previously unthinkable. The result was our modern, quantum-based physics that has, *inter alia* delivered the electronic age.
- The new vocabulary of failure suggested above should identify three grades of retraction.
  Class A for retractions due to blatant fraud;
  Class B for retractions where fraud is likely, but where there may be mitigating circumstances (e.g., pressure from a research supervisor);
  Class C for instances where an innocent mistake has been made, but the paper needs to be retracted because it is leading other researchers astray.
- As a final act, before a paper goes to press, all authors should be contacted and asked if they wish to make a discreet Class C retraction in the light of any developments since their paper was originally submitted. No questions about the reason for the retraction would be asked, and there would be no permanent record of it. To separate the serious fraudsters from the impulsive risk-takers, a ten day period for reflexion would be allowed before the window of opportunity for discreet retraction ended.
- Papers describing negative results such as failed drug trials and medical procedures should be valued by researchers as contributions to our body of knowledge. A practical method for achieving this will be proposed in section 2.1.

1.3 Women in science

1.3.1 Professor Dame Sally Davies, Chief Medical Officer of the UK, is quoted as saying, "I think I suffer from imposter syndrome. I worry whether I'm good enough and if I can do the things that are being asked of me—which is typical of women" [5].

Imposter syndrome needs to be valued but not encouraged. People who feel that they are overperforming are less likely to risk cheating than arrogant scientists who are so confident that they are right that adding a little bit of false evidence can only "improve" the truth.

1.3.2 The coöperative skills of female researchers should be encouraged, rather than women being expected to adapt themselves to the prevailing male-oriented competitive culture.

1.4 Institutions

Universities and other academic institutions find themselves in an invidious position when they are called upon to investigate internal fraud. The more rigorous and honest they are, the more damage they can cause to their own reputations.

This disincentive could be avoided by setting up an Independent Research Complaints Commission (provisional title!) and making it compulsory for all written complaints, no matter how trivial, to be logged with the Commission. To motivate prompt logging, complainants should have the option of sending a blind carbon copy direct to the Commission.[2] A two stage approach would keep bureaucracy to a minimum:

[1] Some journals already print this information at the end of the published paper.
[2] Ideally, the Commission would include nonacademics whose first loyalty was to justice, not academia.

(i) An internal investigation into the plausibility of a complaint would be carried out by the university. Minor issues would be resolved internally, but the Commission would be informed of be outcome.

(ii) If necessary, a deeper investigation would be made. This would be chaired by a member of the Commission, with all other members of the investigation panel coming from outside the institution raising the alarm.

The Complaints Commission will need funds, which could be raised by adding a small "Integrity Tax" to the costing of all publicly funded research. The tax will pay for itself if it leads to improved research quality and greater public trust in science.

Complaints submitted to the Commission could become a valuable data source. After removing individual and institutional names from the written complaints all the logged data could be published on the Commission's website, making it a learning resource for the undergraduate research ethics courses. It would also provide the raw data that could be processed by researchers to identify weaknesses in the research quality control system and predict new trends in research fraud.

1.5 Learning from others

Universities should adopt the zero tolerance aspirations of the James Cook University in Australia. It openly declares zero tolerance to fraud and corruption and actively discourages such activity [6]. In the author's experience, a clearly stated zero tolerance policy would be a useful resource for holding institutions to account, preventing them from using weak excuses to avoid unwanted investigations.

1.6 Competitive research integrity

Competition between universities is healthy and the various league tables comparing teaching and research performance have a rôle to play. In order to boost public confidence in the rankings, each institution score should be weighted to take into account its policies, honesty and transparency with respect to tackling research fraud and other integrity-related issues. Policies should include zero fraud tolerance and having a whistleblower system that is effective, but protects against malicious complaints. Transparency includes being honest about the misdemeanours of staff and students. The ranking system should not penalize institutions for being the innocent victims of research fraud, proved that they have diligently tried to avoid it.

1.7 Improved monitoring of funding for academic research

The author of this paper is a private researcher who has worked with universities and engineering companies. His experience is that academic research funding bodies are relaxed about how taxpayers' money is spent. However, the use of funds for industrial research is carefully scrutinized. For example:

(i) As the lead partner for the PedSALi project [7], the present author alerted the UK Engineering and Physical Sciences Research Council (EPSRC) on several occasions that the university work was going badly wrong, but nobody responded to his warnings. [A.][2Q]

(ii) In the four years that the project ran until it collapsed in failure, the named EPSRC representative never contacted the author nor visited the university to see what was going wrong.

(iii) The author's warnings were not passed on to the EPSRC referees who assessed the project for grading and payment. Their grading was made on the basis of self-assessment by the university and later the university was paid in full [1].

(iv) The project assessment referees rubber-stamped the university self-assessment that the work was "tending to internationally leading". (See §3 of [8]).

European pedestrians who have been injured in motor vehicle accidents since 2005 would probably disagree with this assessment.

In contrast, the author's recent research project relating to low carbon footprint power generators was part-funded by Innovate UK and involved partners from the private sector only [9]. Quite rightly, it was rigorously monitored by a visiting Innovate UK officer every quarter. The moderator examined the research progress and quarterly expenditure. This rigour was a cost-effective use of taxpayers' funds, because it forced the participants to periodically assess our progress towards achieving the project goals.

Here are three proposals for making funding bodies more assertive when dealing with academia:

(i) **Trust nobody should be the guiding principle.** Academics are just as likely as industrialists to go astray when handling public funds. "Academic freedom" is a right to investigate uncomfortable truths, not a right to ignore them.

(ii) **The funding bodies themselves need monitoring.** A guardian of public funds should regularly stress-test the funding bodies' procedures to ensure that their financial monitoring systems are not becoming sloppy and that they remain capable of detecting and combating the latest types of research fraud.

(iii) The guardian body should offer *a last resort hotline* for whistleblowers (such as the present author [1] to submit their evidence to. Hotline contact details should be prominently displayed on all funding contracts. This will help to concentrate minds on the importance of tackling fraud.

1.8 Pre-university science

1.8.1 Removing cheating skills from the school curriculum

The way in which we teach young people to do science can inadvertently train them in the arts of cheating. This is especially true in physics lessons, where practical work places great emphasis on measurement and the student often has a good idea of the numerical value of the result they are expecting to obtain. Hence, there is a strong temptation to please the teacher and obtain high marks by adjusting experimental data to obtain the "right answer" for the quantity being measured.

We need to re-examine the practical science experience in order to shift the emphasis away from accuracy towards honesty, and from determination to understanding. Here is an example of how we could do this based on a physics experiment to determine the acceleration due to gravity, g, using a pendulum. The standard experimental procedure can be summarized as follows:

- Use the formula periodic time $T = 2\pi\sqrt{(l/g)}$ to determine g using five different values of l, the length of the pendulum.
- Plot your results in the form of a suitable straight-line graph.

The student is likely to know the accepted value of g and there will a temptation to ignore any readings that are "too far" from the expected trend line.

Using the same apparatus, a more fruitful scientific experience will be gained if we change the aim of the experiment as follows:

- Use the formula periodic time $T = 2\pi\sqrt{(l/g)}$ to predict the measured values of T for five different lengths of pendulum l.
- Then plot a suitable straight-line graph to compare your predicted and experimentally determined results.

The student would be posed a series of questions that required written answers. The aim of the questions would be to steer the students towards improving their experimental skills and understanding movement under gravity, rather than "discovering" the value of g. Instead of being rewarded for deleting "poor" results that look out of place, the student would be rewarded for explaining them.

1.8.2 Accepting responsibility by doing original research

School pupils should be encouraged to do real research that is of value to their community. For example, monitoring air quality, carrying out ash dieback surveys or monitoring the states of other species. This will emphasize the importance to society of the honest recording of experimental results.

Where opportunities are available, PhD students and other academics should employ school pupils as research assistants to help them collect data. This work could be done in the field, in the laboratory or online. The academics should give feedback talks to the pupils to maintain their interest.

The story of the *Mpemba effect* should be told, and collaborating academics encouraged to treat suggestions from pupils with respect.[3]

2. Rebuilding trust in the quality of scientific information

By common consent, the peer review system remains the gold standard for quality control of research papers intended for publication. But the system is not perfect because referees are busy people who cannot check all of the claims made in a paper. As a result, some bad papers slip through the peer review system.

2.1 Quality control of data

It is proposed that national or regional data storage centres should be set up for use as cloud-based *read only* research diaries. Researchers would submit their ongoing results, photographs, sketches, jottings and any other type of information they wished, preferably on a daily basis.[4] Undergraduates and school pupils would also be encouraged to use the system for storing their laboratory work results, so that they get into the habit of archiving their work. A short period of grace, say seven days, before the data was converted to read only status, would allow genuine inputting errors to be corrected. Albeit adding to the burden of tasks,

- this resource would discourage researchers from exaggerating their sample sizes, with claims such as "the test was repeated ten times" or "3,000 patient records were examined" becoming verifiable;
- when submitting a paper for referee scrutiny, the authors would add hyperlinks to their "research diaries" so that their claimed results could be cross-checked. Each researcher's archive would also include digital copies of any research papers that they cite, with the relevant sections highlighted;

[3] Mpemba was a 13-year-old Tangyanikan schoolboy who accurately reported his scientific observations on the rate at which warm water freezes, even though they sounded illogical. His science teacher dismissed them. But Mpemba earned lasting fame because his observations were correct and they changed our understanding of how water freezes [10].

[4] Industry has required something similar for some time; that is, notebooks to show thought processes and early results; and they are regularly inspected.

- it would still not be realistic for referees to rigorously check the entire content of all papers. But the possibility of their doing so would discourage aspiring fraudsters;
- open access to the raw data following publication of papers would encourage informal post-publication peer review. Openness needs to be rewarded to encourage this relatively laborious data archiving practice. For example, all papers that offer open access to the raw data should be entitled to carry a "bragging rights" indicator such as <O. A. Data> (meaning we offer open access to our data.). This should improve the citation ratings of papers that are open to scrutiny;
- funding applicants should be allowed to claim for the additional costs incurred by filing open-access data;
- the electronic tamper-proof research diary system would offer researchers protection against their work being plagiarized or misquoted;
- a type of fraud that is hard to dated involves the methodology being retrospectively changed to fit the research data. In order to avoid this, details of the methodology, such as the hypotheses to be tested, statistical instruments to be used etc., should be recorded in the cloud diary at an early stage in the research project;
- occasionally a retrospective review may indicate that data is seriously flawed and need to be retracted. It should be possible to remove this data, but only with the approval of an external adjudicator;
- the cloud would also allow researchers to use other workers data for meta-analysis studies and computer simulations, with a blockchain system being used to prevent plagiarism;[5]
- the publication of valid negative results would initially generate "bitcoins"[4] of equal worth to those generated from positive results, encouraging their publication. Advanced algorithms could be used to assign an approximate value to the novel information;
- artificial intelligence (AI) agents [12] could be used to check the cloud data and provide a supplementary form of peer review. Some of these agent reviews would be bizarre, but they would provide an original perspective, which would help to keep human reviewers on their toes by presenting criticisms that needed to be addressed. "AI peer review" would be a cost efficient method of correlating raw data stored in the cloud with published data. As intelligent agents evolve, their ability to spot mistakes in the basic science, such as those discussed in §12.2 of Part I of this paper [1] should improve;
- ingenious new methods for hacking into the peer review system have been described by Haug[13]. This evolving problem could be reduced if all aspiring peer reviewers had to submit their e-mail addresses, brief biographical details and peer reviewing record to a global directory that was accessible by journal editors;
- research journals prefer to publish positive research results. But the increasing use of meta-analysis as a research tool, combined with creating "bitcoin" type value for negative results, would give added impetus to the publication of honest, but less than encouraging, research outcomes;
- publishers should consider adopting, a industry-wide, a policy of including a certain percentage of negative results papers in their journals;
- undergraduate coursework cheating is a different animal to research fraud, but lives in the same stable. Bespoke essay-writing services would find it far more difficult to operate profitably if students were obliged to store their date-certified draft essays and research notes in the cloud, where they would be accessible by tutors or AI agents.

2.2 Anonymity of peer reviewers

Peer reviewing is vitally important but time-consuming work. Occasionally reviewers will undertake the work to puff up their CVs rather than contribute to research quality control, which can result in sloppy reviewing, an example of which has been discussed in §12.2 of Part I of this paper [1]. Anonymity favours sloppy reviewers at the expense of the good ones, suggesting that anonymity for reviewers should be abandoned. But there are also strong arguments in favour of anonymity. We need to test the matter scientifically by allowing consenting reviewers to have their names published and evaluating the consequences over time.

2.3 Reducing peer review bias

Peers bring a huge amount of specialist expertise to the peer review process. Generally speaking this is useful, both for reviewing research papers and assessing new research proposals, but it also brings bias because nobody likes to approve publication of a paper or support a research proposal that undermines their own career interests. For example, a flawed paper that supports the reviewer's career interests is more likely to be waved through than a moderately good paper that threatens them. Review systems need to include skilled outsiders to reduce

[5] Blockchains [11] would allow research data to change hands in the manner of bitcoins. Generating the original data or adding value by processing it would be the equivalent of minting bitcoins. This approach would increase the value of meta-analysis, which is one of the key tools for highlighting anomalous research results.

this bias. They could include full time science teachers who want to be part of the advancement of science, but have no career interest in any particular line of research.

2.4 Accreditation of research journals

The spoof medical research paper entitled "Cuckoo for Cocoa Puffs?" that was produced by a random text generator, yet still accepted for publication by 17 medical journals, caused great amusement in the popular science press in January 2015 [14]. Some researchers talked down the threat thus posed, explaining that the paper was submitted to open-access research journals (although, as discussed in §12.2 of Part I of this paper [1], even highly respected journals are quite capable of publishing nonsense). The "trust nobody" principle must be applied to journals too. This is an area where the author confesses ignorance. Stakeholders in the research journal system must pool their ideas for establishing a way of journal accreditation and quality monitoring.

2.5 Research papers for the wider public

The general public should be recognized as stakeholders in defending research integrity. For this to become reality, they must be at ease with the research process.

A distinguished scientific body, for example, the Royal Institution in the UK, could be given funding to set up a panel of academics and other experts to write well balanced review papers on science, technology and medical issues of public interest. The papers would be written and referenced to best practice journal standards, encouraging the public to become citizen scientists. The academic rigour and scholarly format would set them apart from articles in popular science magazines.

Suggested features of these papers would include:

- The publication of hard copy papers to satisfy the collecting instinct and electronic versions for ease of internet hyper-linking.
- A comprehensive list of key words, allowing readers to carry out their own online research.
- All papers would be refereed by *named* experts.
- All journal references cited would be hyperlinked to their abstracts, with additional links to (say) The British Library, allowing full copies of most papers to be purchased.
- A readers' forum, where lay people and professionals could contribute to the scientific debate, would be added as supplements.

2.6 Tweaking the science prize system

High profile prizes for science, mathematics and technology add glamour and human interest to science. But, as suggested in Part I of this paper [1], envy of academic success can provide a motivation for sabotaging research. Jealousy can be minimized if supportive roles are given due credit. Here are three suggestions:

(i) The award ceremony citations for research prizes should include a list of the top three individuals or groups that made the prize-winning breakthroughs possible. They or their surviving families would receive a certificate recognizing their contribution. The list could be drawn up by the winners in the interval between being notified and receiving their awards. This would provide each prize with a second round of media attention and emphasize the importance of supporting rôles in science. Hopefully, inspiring school science teachers would be named in the acknowledgments, adding status to their profession.

(ii) We should create additional high-status prizes that reward outstanding team efforts. The prizes would not be awarded for the breakthrough, but for the way the teamwork allowed the breakthrough to be made. Team and individual prizes could complement each other. For example, the awarding of the Nobel Prize for physics to Peter Higgs for predicting the existence of the Higgs boson could have been complemented by the award of an equally high-profile prize to the large team at CERN who actually found the particle.

(iii) Technicians who build the scientific equipment and others who assist in the data collection processes should be acknowledged in published papers.

3. Reducing the misbehaviour pressures on trainee and junior researchers

- In the case study discussed in Part I of this paper [1], the wilfully misleading research was done by doctoral students who were working towards their degrees under the supervision of the principal perpetrator. In order to ensure that their PhD studies were "successful", they had little choice but to carry out bad research as instructed. This experience suggests that trainee and junior researchers need professional protection against overbearing supervisors. A cloud-based system that allows junior researchers to "lock up" their research results before they come under pressure to change or ignore them would be helpful.
- During the early days of their student projects, unlucky students may make a wrong planning decision that fails to take their chosen research area forward. Nevertheless, they can still gain important research skills. Mentors need to emphasize the value of "failing with dignity" [cf. §1.2 above] to discourage trainees from cheating to ensure their graduation success. Research theses could include an open letter from the mentor to the external moderator explaining how any

scientifically disappointing research results were still consistent with the student having acquired good research skills.

- Laboratory technicians and other support staff should be required to attend research integrity training courses so that trainee researchers become immersed in a strong research integrity-focused work environment. This training should include gaining familiarity with the cloud-based and other resources used to reduce research fraud. Technicians could contribute to the teaching of the induction research ethics courses. This would reinforce their identity with upholding research ethics.
- Kornfeld and Titus [15] recommend that trainee researchers should complete a terminal anonymous questionnaire on the quality of their supervision. This type of evaluation could be overseen by the Independent Research Complaints Commission discussed in §1.4 above.

4. Conclusions

Research misbehaviour exists in many forms that are constantly evolving. Cumbersome regulations or laws that try to curb misbehaviour are unlikely to keep pace with this evolving problem. Instead, the author advocates the scientific community moving towards a proactive mindset that naturally reduces the appeal of research fraud. These proposals are intended to be thought-provoking rather than prescriptive and the practical difficulties of implementing some of them are fully recognized. Hopefully, they will be improved upon by others with a broader understanding of the university research culture.

There is a steady output of discussion papers addressing research integrity issues. Recent contributors range from Euro Scientist [16] to the UK Parliamentary Office of Science and Technology [17]. Compared with these professional bodies, the contribution made by the present author can be criticized as coming from a very narrow band of experience. But what he lacks in breadth is made up for by his novel experience as a victim of research fraud. For example, the Parliamentary Office of Science and Technology draws the UK Research Integrity Office (UKRIO) into the discussion as a resource for defending research integrity [18]. But the author's twelve year battle to expose research fraud provides evidence that UKRIO is more concerned with defending the reputation of British science, rather than exposing British research fraud.[6,7]

The types of quality control suggested in this paper would inevitably impose a considerable burden of bureaucracy on the research enterprise. It might even be stifled. Nevertheless, it could be argued that no research is better than fraudulent or otherwise bad research. Both bode ill for the future of humanity. Hence, inculcating integrity at a young age (§1.8) is likely to be the most effective of the suggested measures.

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