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View Point

Science and the Sufi Spirit

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In 1993, while visiting southern India for the first time, I made a trip to Sringeri. I had been an admirer of Shankara and his exposition of Advaita philosophy since my student days and I was, therefore, quite excited to be finally visiting Sringeri. However, once I got there, I felt very disappointed, almost cheated. There was far too much about the rituals and the atmosphere that appeared to be antithetical to the pristine and austere majesty of Shankara's absolute monism. There were idols being prayed to and made offerings to, and there were pontiffs being sycophantically venerated. It was far removed from the concept of seeking salvation through being lost in contemplation of the Absolute. I was not just disappointed but disgusted as well. Suddenly, I remembered a phrase that a friend of mine in college, Vibhay Jha, once used to describe such feelings of deep revulsion: 'spiritual nausea'. More recently, I am again getting reminded of that phrase; unfortunately, this time by much of what I see in the manner in which science is conceived of, practised and taught. Websites of many scientists today are reminiscent of company websites trying to flog a product. The peer-review process has become so perverted that one feels it might be better to do away with it. Specialist discipline-specific journals have begun to turn down "unfashionable" papers as being of insufficient general interest. Young scientists, writing to inquire about possible jobs, tell you how much foreign money and collaboration they will bring in: "hire me, and get all this free!" The list goes on, and gets progressively more depressing.

More importantly, beyond the fact that there is much about the way science is now done that some of us find depressing, the problem is that the way we do, and assess, science has consequences for the quality of science. In my own field of experimental evolution, one lesson learned from over 30 years of selection experiments is: "you get EXACTLY what you select for". Outside the domain of evolutionary biology, in the domain of human endeavour, we select for behaviours by incentivizing them. If we incentivize good products, we get good products; if we incentivize rapid profits, we get rapid profits, not necessarily good products. If the only concern about the way we are doing science was that some people did not like it, then the response would be simple. The displeasure of a few, uncomfortable with change, should not be allowed to halt progress. However, what I believe we need to think about seriously as a community is whether over the years we have, perhaps inadvertently, ended up incentivizing some aspects or outcomes of scientific activity that are now resulting in selection for things other than good science.

My purpose in writing this article is to put forward a few points that I think we, as members of the scientific community in India, need to think about in the context of what we are selecting for in our scientists. In the following sections, I will discuss some of the aspects of science, and how it is done

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and evaluated, where I feel that we are ultimately selecting for things often antithetical to good science. There is some support for this view from recent discussions in the literature about the effects in China of incentivizing publications in journals of perceived high importance. After discussing some of the aspects where I think some course-correction might be needed, I will conclude by discussing possible implications of this viewpoint for science education, presentation and evaluation.

Science Should Not be Thought of as a Career

For at least the past two decades, science has been sought to be made more attractive as a career in India. The changes involved have certainly made academics a considerably more paying profession compared to what it was when I was a child and academic parents often struggled to meet family responsibilities. However, I can also increasingly see a downside to repeatedly referring to science in terms of a career. A dictionary definition of a career is: an occupation undertaken for a significant period of a person's life, and with opportunities for progress. The problem is that 'progress' in this context is typically assessed in careerist terms: sales targets achieved, loans disbursed, promotions, bonuses etc.

In science, however, progress should ideally be measured in terms of the advancement of knowledge resulting from one's efforts. In this sense, I do not think science should be conceived of as a 'career' any more than classical music is, even though one can make a living doing both. I stress that the problem here is not the actual issue of enhanced monetary compensation for doing science in an attempt to ensure that those taking up science as their profession can also be assured of a reasonably comfortable life for themselves and their families. The problem is a perceptual one, resulting from the repeated close juxtaposition of the words 'science' and 'career'. Words have an insidious way of affecting the way we think, quite implicitly and subconsciously. Once we start thinking of science as a career, rather than a passion, we are on a slippery slope, where the logic of careerism slowly takes over the ordering of our priorities. A stunning example of what typically happens when a passion gets mutated into a career is provided by the Urdu poet Sahir Ludhianvi who, towards the end of his career as a film lyricist, was writing such forgettable songs as "*Gapuchi gapuchi gum gum, kishiki kishiki kum kum, aa sanam hum dono pyar karenge janam janam*". This from the same poet whose book '*Talkhiyaan*' (Bitternesses) started with the couplet "*duniya ne tajurbaat-o-havaadis ki shaql mein, jo kuch mujhe diya hai vo lauta raha hoon main*" (I am returning to the world whatever it has given me in the form of experiences and accidents).

Science, like classical music or poetry, is best done in what one might call an "amateur" spirit, even though one might be earning a living doing it. The repeated emphasis on career and professionalism, unfortunately, seems to have led to a replacement of the scholar with the entrepreneur-technocrat as the role-model for young scientists. The increasing emphasis on patents in many areas of science also appears to have played a role in this transition. Today, summer research students coming to a lab often inquire whether they might expect to be authors on high-impact papers. Prospective PhD students ask what the job prospects will be after they finish their degree. Young faculty applicants inquire about startup funds, square feet of lab space and pensions. Younger scientists seek pragmatic tips on how to win awards. Very few younger people seem to be primarily excited about the possibility of working on interesting questions in their field.

Another big casualty of the science-as-a-career model is mentorship. In career mode, one subconsciously begins to conceive of one's primary responsibility as being to further one's career rather than furthering the growth of knowledge and revelling in the awesome privilege of being part of the continuing chain of knowledge that links us to past and future thinkers. That is why, for example, the significance of mentoring as a major part of a scientist's life seems to be fast disappearing. From a careerist point of view, mentoring is a distraction because it does not enhance the metrics by which career progression is increasingly judged.

Another point that I think is worth pondering upon is that we are going to attract the wrong kinds of young people to science by stressing its monetary rewards. Publically-funded science cannot possibly compete with the private sector in terms of remuneration. Therefore, the notion of attracting really intelligent young people who do not come to science because of poorer prospects of making money than in other sectors, is bound to be counterproductive in practice. Intelligent people who enjoy being part of the chain of knowledge have always been coming to science, even when it was relatively less paying as a profession than it is now. Intelligent people who prioritize monetary benefit over a passion for knowledge will not get attracted to science because of better salaries, as there will always be other professions where they can earn much more. The people we will end up attracting will be of somewhat second-rate intelligence, who may end up preferring science to a third or fourth tier job in the corporate world. I am not sure that science and the growth of knowledge will benefit if more such people become scientists.

The balance that I think needs to be restored here is that, while telling young prospective scientists that they can expect to have a comfortable life as a working scientist, we should avoid pitching science as a profession or career. Rather, we should be talking about the fact that, as a scientist, one has the luxury of being paid a salary for doing something that is both exciting and enjoyable. In more mundane (in the sense of not involving much creative aspect) careers, the work is not interesting *per se*; the material rewards are what make the drudgery acceptable. In science, the work itself is the reward; the material rewards are, in a sense, a bonus: this is the sentiment we need to be conveying through our deeds, not just words, to students, postdocs and younger colleagues.

Science Should not Recognize Hierarchies

Nowadays, science as a collective endeavour involving large numbers of people also needs to be organized and administered. For smooth organization and administration, hierarchical structures are important and necessary. To that extent, we do need to have hierarchical structures in the scientific establishment to organize and guide the logistic efforts required for the scientific activities nationwide. However, I think we should be clear in our minds that the need for hierarchy is purely in the administrative domain, not in the actual domain of science itself. We should not conflate hierarchies of science administrators, who are typically scientists themselves, with hierarchies in scientific work *per se*. Also, the administrative hierarchy necessarily involves professional administrators who are not scientists, and we must be careful not to confuse them with scientist-administrators. Unfortunately, these kinds of conflations and confusions are common in India. Typically, scientists, once they have acquired some recognition for their work, start thinking of themselves as 'experts' rather than 'students' of a field. The main corollary to thinking of oneself as an expert is that one dislikes being questioned or argued with on scientific matters, especially by students and younger or contemporaneous colleagues. Thus, we tend to conflate administrative/salary/age-related hierarchies that exist in most professions with an intellectual hierarchy. This is fundamentally antithetical to the very basic nature of scientific inquiry, based as it is on the twin pillars of skepticism and rationality. On a more pragmatic side, this is also a source of great discouragement to bright young people entering science. Over the past seventeen years as a faculty member, I have come to the depressing conclusion that the majority of PIs in India would not know what to do with a really brilliant student if they got one. Many in the field openly say that it is better to have sincere and obedient students rather than brilliant ones. This recognition of hierarchy in the practice of science leads to a smothering of proper scientific discourse because scientific disagreements are typically taken as personal insults. This problem is not new: Haldane wrote about this in the 1950s, as did Prof. P Balaram in a *Current Science* editorial some decades later.

I remember that when I was a PhD student in the USA, I was most impressed and inspired by the fact that my advisor and other professors treated me not as a subordinate but as an intellectual equal: younger by a decade or more and inexperienced no

doubt, but an equal in some fundamental sense. Once again, the words we use shape and echo the way we think: in India we "work under a boss for a PhD", whereas in the USA one "worked with an advisor towards a PhD". In India, on numerous occasions, I have heard irate colleagues responding to scientific arguments by a student with expressions like "you are arguing with ME, man?". This attitude should have no place in science, or indeed in academia. In my opinion, far more than any perceived difference in infrastructure and research funding, the stifling of free-wheeling scientific argument in India is what leads to the observed difference in terms of the quality of science between us and many western countries, on an average. It is our attitudes, not our facilities or funding, that are typically inferior and not conducive to creative, cutting-edge science.

Science should not Bother About Being Fashionable or Seeking Quick Results

Nowadays, largely due to the premium placed for purposes of career advancement on the number of publications in high-impact journals, we have a pernicious feed-forward loop at work in science that restricts work on fundamental questions. The scientific community today is giving importance not just to publications but also to immediacy, which is a function of how rapidly a published paper accumulates citations. This automatically incentivizes working on topical questions that many other people are working and publishing on. The result is that in each discipline some research topics become 'fashionable' and then there is a mad rush by others in that discipline to try and work on these fashionable topics. The incentivizing of research on fashionable topics of high immediacy, together with the pressure from funding agencies and promotion timeframes for quick publications, essentially means that we are actively encouraging young scientists to focus their attention on topical and relatively small problems such that the results from their research can be rapidly published before the winds of fashion in their discipline change. This is almost unimaginably counterproductive for science, given the well known association of creativity with youth. The younger scientists are the ones most likely to do really interesting and path-breaking work precisely because they are young, energetic and not burdened by the shackles of long-term familiarity with certain established modes of thought in that discipline. Yet, instead of encouraging them to frame longer-term scientific problems of a fundamental nature, we are actually ensuring that they should work on relatively trivial, though perhaps transiently topical, issues. Path-breaking research, almost by definition, takes time and has an immediacy index close to zero. By incentivizing immediacy and rapid publication, we are probably ending up selecting merely for a lot of "copy-cat science" rather than really interesting research.

Quality Cannot be 'Objectively' Judged by Quantitative Indices

Perhaps the single most pernicious philosophical choice we have made as a scientific community in the last couple of decades is that we seem to believe that quality can be judged 'objectively' through the computation of various quantitative indices. This underlying assumption actually generates many of the counterproductive patterns of incentivization discussed above. When we get together in committees for screening applicants or nominees for a job, fellowship or award, it is common to see an unnecessary importance being given to lists of publications (and where they appeared) rather than the content of those papers. Other quantitative measures, like *h*-indices have also become very popular, despite widespread discussion in the literature about their severe limitations as measures of quality. It is not uncommon in biology circles in India to hear a scientist's perceived worth being summarized by phrases like "he/she has two *Cells* and one *Neuron*" which, in a few cases, almost strikes one as a description rather than an achievement.

I have had arguments with many colleagues in the scientific community about why we try so hard to reduce our evaluation of a scientist to some numerical index. The most common answer I get is that it promotes 'objectivity' in assessment. In my opinion, this is an absolute fallacy – quality cannot be judged through quantitative indices. Moreover, if

the purpose of a selection committee is to decide who among the candidates has the highest *h*- (or any other) index, then we should not need to have scientists on such committees at all. Sorting applications in descending order of some index could be done through a software or, in the interests of employment, by a clerk. On a similar note, why is it that when we seek to hire a postdoc or a young faculty member, we ask for recommendation letters from their peers or mentors? Is it not precisely because we seek a 'subjective' assessment of the candidate's quality from those who have worked with him or her?

Other than the philosophical problem of quality not being amenable to quantitative assessment, there are also many other practical problems with this form of assessment of a scientist's worth through the impact factor of the journals where the papers were published, how many citations they received, and so on. The bottom line is that the only way to judge a paper's worth is to read it critically. A lot of bad papers do get published in very well thought of journals, and *vice versa*. This problem of a lack of correlation between the paper's quality and the perceived importance of the journal is only exacerbated by the increasing tendency for journals, including specialist subject-journals, to publish only topical papers as they are expected to lead to better citations and, hence, an increase in the impact factor of the journal. Interesting and important papers on non-fashionable research topics are typically neither published in high impact journals nor gather quick citations. A minor modification to a commonly used and fashionable technique, on the other hand, might garner citations really fast. Moreover, the impact factor of a journal pertains to the average number of citations of papers published therein, within some specified time period. It has no relationship to how many citations an individual paper received: indeed, the distribution of citations of papers in high impact journals is typically highly skewed. And if that were not enough, the number of citations a paper can receive is a function of how many people work in that particular area. One consequence of this is that a third-rate journal in more densely populated research fields will have a higher impact factor than a first-rate journal in a less densely populated area of research. Thus, all else being equal, in some fields of work people will have far more citations, and publish in higher impact journals, than in others, rendering the use of citation-based statistics misleading at best and grossly unfair at worst.

Ultimately, we need to accept that there is no substitute for a 'subjective' assessment of the quality of a scientist by others in that line of work. Ranking people by some quantitative performance index might perhaps make it more convenient to respond to "right to information" (RTI) inquiries but it is detrimental to science because it is incentivizing the wrong things. We should be focusing on nurturing young scientists with promise, those that show an independence of thought and some long-term vision in their choice of research problems. If we focus too much on youngsters delivering hit songs early in their career, we will end up selecting for Bappi Lahiris not Bhimsen Joshis!

Problems with the Corporate Ethos in Science

One noticeable aspect of how the manner in which science is done has been changing over the decades is the increasing presence of what one might loosely call the "corporate ethos" in science. This problem, of course, is not unique to science – society at large seems to be enamoured of the style of functioning typically associated with corporate honchos, and the effects of this are also clearly seen in education, journalism and medicine, all traditionally professions with a social-service self image that is now being eroded under a business ethos. Slowly but surely, society has moved to a state where successful businessmen are held up as generic role models, rather than role models for aspiring entrepreneurs alone. Nowadays, young scientists are encouraged to think of themselves as CEOs of labs rather than PIs. We talk about how we want to "package" and "market" our results, as though we were selling appliances rather than disseminating knowledge. We emphasize the importance of networking: I recently read on a website offering advice to young scientists that it is important for them in terms of career advancement to set aside 10% of their time for networking instead of solely concentrating on research or, God forbid,

teaching and mentoring. The problem here is that when we begin to conceptualize scientific activity, and measure scientific success, in terms of an implicit or explicit business model, we are actually applying the model to a system it does not work for because the system does not meet the assumptions of the model. In business, the purposes are two-fold: supply a service or a product, and make money out of that act. Success in business, therefore, can be measured by how much of a product was made and how well it sold. Slick advertising and fancy marketing can increase this sort of success. Science (at least basic science) is a search for understanding and knowledge: its sole purpose is to advance understanding. To measure success in science in terms of how many papers were published and how often they were cited does not make sense because these were not the purposes in the first place. We need to assess success in science solely by the degree to which the work has enhanced our understanding of the universe we are trying to explain. Unfortunately, we are mis-applying the business model to science, as a result of which we are encouraging our students and scientists to be good at marketing and advertising rather than actually doing good science. The results can clearly be seen in terms of under-referencing in published work to make the results appear more novel than they are, over-stating the implications of the results, often through the setting up of imaginary straw-men, the increasing ability of people to deliver fluent talks that seem convincing until the first critical question is asked, the websites of many scientists highlighting their publications in high-impact journals rather than the actual work, and so on.

Of Vultures and Falcons, and the Importance of the Sufi Spirit in Science

My motivation for writing this piece has been two-fold. First, I have been increasingly realizing, somewhat to my horror, that if I were 30 years old today, I would probably decide not to get into science because of the overall scientific culture and the way science is being done. Ever since I was about 15 years old, I wanted to be in academics. I have enjoyed working in science, whether at research or teaching and mentoring, and I feel privileged to be a small link in the unending chain of knowledge. Yet, there is something so distasteful about what I described above as the corporate ethos in science that I do not think I would have wanted to continue in science if this had been the situation when I completed my PhD. If I feel this way, I am confident that many others will too and, consequently, we may be alienating many people who would otherwise make good scientists and contribute to the growth of knowledge. A second, and related motivation, is the realization that many of us are inadvertently giving maladaptive advice to our students when we encourage them to take a more 'scholarly' approach to science, rather than the 'corporate' one. This is also unfortunate as it may end up making these students very disillusioned when they take up independent positions as scientists and realize that their approach does not seem to be valued by many of their peers and seniors. Thus, my hope is that this article will prompt some debate amongst us in the scientific community about what we are incentivizing and whether we should make some conscious changes in the way we are presenting science to our students and young scientists.

Essentially, the crux of the matter is that we seem to have lost sight of the primary purpose of science: the advancement of our understanding of how the universe works. Part of our focus has, understandably, shifted to the benefits to be gained from the application of science. Some of the focus has become competitive in that we wish to attract people into science from other career paths. We want recognition of our progress in science relative to countries with a comparable recent history over the past few centuries. Yet, somehow, amongst all these goals and the adoption of the corporate ethos, the basic purpose of science has been completely obscured, if not lost. A striking parallel to this state of affairs is seen in the historical development of most organized religions. After an essentially spiritual phase of pondering upon the Absolute, organized religion begins to crystallize as an administrative establishment with an increasing immersion in ritual rather than contemplation. The focus shifts to maintaining *status quo*, competing for disciples with other organized religions and talking about the (often

other-worldly) benefits to be gained from the practice of that particular religion. Thus, in a purely sociological sense, science shows some parallels with organized religion, right down to a 'priesthood' that can talk fluently in a language that lay-persons find hard to understand, seminaries to mass-produce new priests, and an increasing drift away from the original focus. I emphasize that I am not saying that science and religion show parallels in the theological sense: in that domain, science clearly differs from religion in its insistence that all 'scripture' be open to empirical testing.

If we examine the historical development of all major organized religions, we find that eventually they underwent some degree of alienation from the people and their roots, an alienation that was partly reversed by the simultaneous activities of a mystic fringe associated with that religious tradition. Every major religion has had its mystic, ascetic branch (Sufis or Sadhus) that typically remained truer to the original purpose of contemplation of the Absolute. The same, in the sense of this loose parallel, is true of science. I would like to suggest that it is this Sufi spirit that we need to nurture and conserve in science, lest it go extinct, to the detriment of the growth of knowledge and understanding. Some areas of science, especially those dealing with applied problems or those that are heavily technology-dependent, may require extensive patronage by the state, and a much more organized hierarchical structure for their development and functioning. At the same time, we need the 'non-corporate' science as well, especially in the domain of basic science. One lesson from history is that organized religion and mystic religion have typically had a somewhat adversarial relationship, even within the same religious tradition. The tension between the Ulema and the Sufis resonates throughout Urdu and Persian poetry. We should be careful that something similar does not happen in science, as the corporate ethos increasingly dominates the majoritarian mode of doing science.

An important aspect of the Sufi approach to religion was that it treated religion less as an organized activity focused on ritual and more as a way of life. The original focus was not lost; indeed, the idea was to structure one's life in a way that the focus remained on the Absolute. Social conventions of the age were often ignored, and standard measures of success were disdained. Large establishments to train subsequent generations in the rituals of the orthodoxy were not required. Introspection was greatly encouraged. Sufi elders (*Pirs*) typically mentored a few disciples (*Murids*) in what can only be described as a gurukul-like system. Many of these aspects have great relevance to the pursuit of basic science as an unending search for understanding. A corporate ethos may be the natural outcome of the evolution of the scientific establishment in the USA, a country with a limited intellectual tradition and a strong philosophical commitment to consumerism and capitalism. It is not clear why we should follow that evolutionary trajectory, given our much longer intellectual history and the very different philosophical underpinnings of our culture and worldview. The tools and techniques of science may be common worldwide, but the way in which we approach science can be our own – it need not be copied from corporate cultures. In medieval times, a common saying in Persian stated that to attain religious merit, business profits, and wisdom, respectively, one should go to Arabia, Turkey, and India. We could easily make the way in which we do science one of our scientific strengths, and shift our focus and incentivization pattern in a way that would promote basic research on fundamental issues.

The call for a sufi approach to science is essentially an appeal for returning the focus of science back to knowledge and understanding, with an emphasis on depth of comprehension rather than flashy but superficial work. It is an appeal for recognizing the importance of not only thinking about scientific problems but also spending some time thinking about how science is done and why. It is an appeal for focusing on the quality of research, not just some quantitative measure of output. It is an appeal to remember that science is primarily about ideas and not facts, concepts and not technologies. It is an appeal to rediscover the importance of mentoring and to not just treat students as a technical labour force to feed into the system. These appeals, again, are not new, though their urgency has perhaps grown.

Decades ago, Peter Medawar wrote: "Science and poetry in its widest sense are cognate, as Shelley so rightly said. So conceived, science can flourish only in an atmosphere of complete freedom, protected from the nagging importunities of need and use, because the scientist must travel where his imagination leads him. Even if a man should spend five years getting nowhere, that might represent an honourable and perhaps even a noble endeavour. The patrons of science – today the Research Councils and the great Foundations - should support men not projects, and individual men rather than teams, for the history of science is for the most part a history of men of genius". If this was true then, it is even truer now.

If we believe that the sufi spirit in science needs to be nurtured, then a few corollaries follow. We need to convey better to the lay population the fundamental nature of science as search, rather than always emphasizing the utilitarian and technological aspects of science. We also need to emphasize teaching science as a way of rational inquiry, rooted in skepticism, rather than as a collection of facts with explanations that are routinely taught almost as a matter of faith. We need to shift the focus of what we incentivize back from quick publications and citations to trying to address fundamental issues in various disciplines. We need to convince our students and younger scientists, through deeds not words, that what matters and, therefore, will be rewarded in science is a scholarly approach, contributing to the advancement of knowledge, and good mentoring. We need to go back to subjectively and holistically assessing the worth of scientific work in a qualitative rather than quantitative manner.

One other question that I think we should ask ourselves and discuss is what exactly we want our university education system to deliver. To my mind, we seem to expect our university education to accomplish two somewhat contradictory goals. On the one hand, we want our education system to help prepare large numbers of our youth to become productive members of the 21st century workforce. On the other hand, we also expect our education system to help nurture the next generation of scientists or, more broadly, academicians. To my mind, the kinds of focus and approach required in the academic system to optimize these two goals are mutually exclusive. Perhaps it is time to start a debate in India as to whether we might want to consider separating institutions expected to train technologically competent employees for the 21st century workplace from those institutions expected to nurture the next generation of scientists. In our present system, we are trying to achieve two incompatible goals and as a result are achieving neither to any satisfactory degree: our graduates and post-graduates are neither employable nor scholarly, clearly not a desirable state of affairs.

Finally, I would like to conclude by adapting to the present discussion a metaphor often used by my favourite Urdu poet, Allama Iqbal: that of the contrast between a vulture and a falcon. I quote below two couplets from Iqbal on this theme:

"*parwaaz hai dono ki isi ek fiza mein*

kargus ka jahaan aur hai, shaheen ka jahaan aur"

(Though both soar in the same sky, the worlds of the vulture and the falcon are different)

"*vo fareb-khurda shaheen jo pala ho karguson mein*

usey kya khabar ki kya hai rah-o-rasm-e-shahbaazi"

(How can the falcon raised by vultures possibly appreciate the nature of falconhood?)

Falcons soar in the sky in search of prey that also fly: they are predators of birds. Such hunting requires great focused effort and tremendous expenditure of energy. Yet, often the hunt will not yield a meal, despite all the effort. Vultures also soar in the sky, but in search of a carcass of an animal already dead through other agencies. The scientific parallel is striking. On the one hand is the option of searching for solutions to one's chosen fundamental scientific problems, realizing that sometimes the effort will not immediately yield quick returns. On the other hand is the simpler option of eking out a few quick publications by pecking at a problem

already essentially solved by others. What I wanted to say in this article can be summed up in one simple question: as a scientific community, do we wish to train the next generations of our scientists to be falcons or vultures?

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Suggested Supplementary Reading

(**Note:** The following are a sample of relatively recent articles that illustrate some of the present problems in science publishing and science assessment.)

Anonymous (2013) Looks good on paper: a flawed system for judging research is leading to academic fraud. *The Economist* (http://www.economist.com/news/china/21586845-flawed-system-judging-research-leading-academic-fraud-looks-good-paper)

Balaram P (2013) Science in school and college: teach less learn more. *Current Science* **104** 7-8

Balaram P (2013) Should we produce more PhDs? *Current Science* **104** 807-808

Balaram P (2013) Research assessment: declaring war on the Impact Factor. *Current Science* **104** 1267-1268

Bauerlein M, Gad-el-Hak M, Grody W, McKelvey B, Trimble SW (2010) We must stop the avalanche of low-quality research. *The Chronicle of Higher Education* (http://chronicle.com/article/We-Must-Stop-the-Avalanche-of/65890/)

Ching N (2013) Fame is fortune in Sino-science. *Nautilus* (http://nautil.us/issue/5/fame/fame-is-fortune-in-sino_science)

Clutton-Brock T and Seldon BC (2010) The seven ages of Pan *Science* **327** 1207-1208

Davis P (2013) The Rise and Fall of PLOS ONE's Impact Factor (2012 = 3.730). *The Scholarly Kitchen* (http://scholarlykitchen.sspnet.org/2013/06/20/the-rise-and-fall-of-plos-ones-impact-factor-2012-3-730/)

Hvistendahl M (2013) China's publication bazaar *Science* **342** 1035-1039

Leimu R and Koricheva J (2005) What determines the citation frequency of ecological papers? *Trends in Ecology and Evolution* **20** 28-32

Lortie CJ, Aarssen LW, Budden AE, Koricheva JK, Leimu R and Tregenza T (2007) Publication bias and merit in ecology *Oikos* **116** 1247-1253

Lozano GA, Lariviere V and Gingras Y (2012) The weakening relationship between the Impact Factor and papers' citations in the digital age. *arXiv*:1205.4328

Wardle DA (2012) On plummeting manuscript acceptance rates by the main ecological journals and the progress of ecology. *Ideas in Ecology and Evolution* **5** 13-15.