

SCIENCE AND SCIENTIST ACROSS THE BORDER

Sankar Iyer
(Overseas Editor, Science India)

Science is universal and knows no boundaries, be it political or geographic or religious. Scientists all over the world speak the same language and are engaged in unraveling the mysteries of Mother Nature. Thus I have the greatest pleasure in introducing a well-known Physicist from across our border (Pakistan). Dr. Pervez Hoodbhoy is a Professor of High Energy Physics at the Quaid-e-Azam University in Islamabad, Pakistan. He received his bachelor's degrees in electrical engineering and mathematics, masters in solid state physics, and PhD in nuclear physics, all from the Massachusetts Institute of Technology. He has been a faculty member at the Department of Physics, Quaid-e-Azam University, Islamabad since 1973. In 1984 he received the Abdus Salam Prize for mathematics and, earlier, the Baker Award for Electronics.

Dr. Hoodbhoy has written and spoken extensively on topics ranging from science in Islam to education issues in Pakistan and nuclear disarmament. He produced a 13-part documentary series in Urdu for Pakistan Television on critical issues in education, and two series aimed at popularizing science. He is author of 'Islam and Science: Religious Orthodoxy and the Battle for Rationality', now in 5 languages. In 2003, Dr. Hoodbhoy was awarded UNESCO's Kalinga Prize for popularizing science in Pakistan with TV serials and his film 'The Bell Tolls for Planet Earth' won honorable mention at the Paris Film Festival. As a part of the Kalinga Prize in 2005 Dr. Hoodbhoy undertook a 4-week lecture tour India that took him around to Delhi, Pune, Mumbai, Bangalore, Chennai, Hyderabad, Bhubhaneswar, Cuttack, Calcutta. His impression of India and Indian Science has been published in an article entitled "India Through Pakistani Eyes" (<http://www.zmag.org/sustainers/content/2005-02/20hoodbhoy.cfm>).

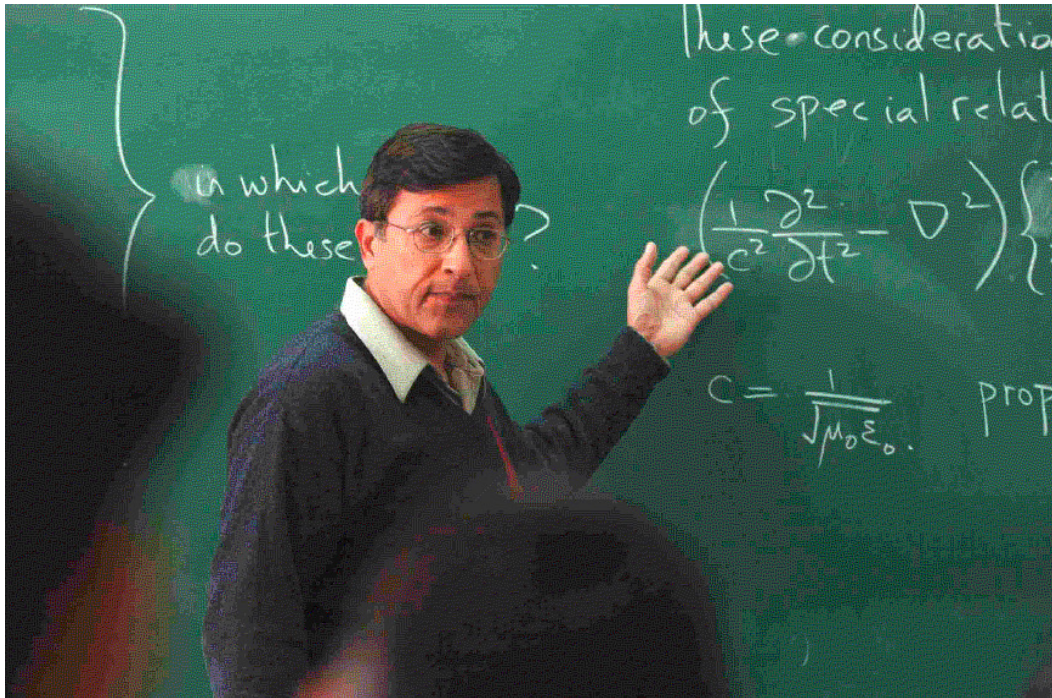
I contacted Dr, Hoodbhoy and requested him to contribute an article for our magazine. He readily consented to my request and has given permission to reproduce an article on Pakistani Science published in "Dawn", the leading newspaper of Pakistan. Dr. Hoodbhoy has also sent a special message for the readers of Science India, which is reproduced below. If you any questions for Dr. Hoodbhoy please send them to the Editor of Science India (scienceindia@rediffmail.com). We will try and get the replies from Dr. Hoodbhoy.

Cheers
Sankar Uncle

A MESSAGE TO THE READERS OF SCIENCE INDIA

Dr. Pervez Hoodbhoy

Professor of High Energy Physics, Quaid-e-Azam University, Islamabad 45320, Pakistan



Dr. Pervez Hoodbhoy at his best (teaching Physics)

As the world becomes more complex and doing science becomes harder, most scientists think of little beyond navigating the science jungle. But let's not lose sight of the forest for the trees. Science has the ultimate aim of creating greater consciousness and awareness about the world we live in. But are we succeeding? Far from it. Irrationality, pseudoscience and superstition attract more and more people the world over. It is not just the poor who are stupid and irrational; the middle classes of Pakistan, India, and Bangladesh are almost as badly infected. Nor is it just a country here or there. Science and the scientific method is under attack everywhere - including the US, a country that owes its pre-eminence in the world entirely to science. Orthodox Muslims, Christians, Hindus, and Jews are attacking the notion of reason with a ferocity not seen since the Dark Ages of Europe. Yes, you and I can keep quiet, but at the peril of letting the fanatical forces of unreason destroy the precious gains made by humanity over the centuries. Scientists of the world unite and confront the crazed fundamentalists!

Regards

PERVEZ HOODBHOY

March 23, 2006

Islamabad, Pakistan

ASSESSING PAKISTANI SCIENCE

by
Pervez Hoodbhoy

Constitution Avenue in Islamabad, the 8-lane arterial road that goes into the heart of Pakistan's political establishment and the Presidency, is lined with impressive buildings bearing the names of many scientific institutions. These include the Pakistan Academy of Sciences, Pakistan Science Foundation, Islamic Academy of Sciences, Pakistan Council for Science and Technology, Committee on S&T of Organization of Islamic Countries (COMSTECH), Commission on S&T for Sustainable Development in the South (COMSATS), and others. A short distance from the Presidency is the head office of the Pakistan Atomic Energy Commission, the largest single science-based institution in the country. Other institutions are spread across Islamabad. Their large numbers, astronomically high real estate value, and obvious wealth, shows that Pakistan's ruling establishment wants to be seen as taking science seriously. The question is: does it, and how far down the road has Pakistan's science actually come since 1947?

The answer depends considerably upon how one chooses to define scientific accomplishment. In defense technology, which is applied science, it has done relatively well. Pakistan manufactures nuclear weapons and intermediate range missiles that, once upon a time, were considered as cutting-edge technology. There is now also a burgeoning, increasingly export-oriented, Pakistani arms industry that turns out a large range of weapons from grenades to tanks, night vision devices to laser guided weapons, and small submarines to training aircraft. Dozens of industrial sized units in and around Wah, with many subsidiaries, are producing armaments worth hundreds of millions of dollars with export earnings of roughly 100 million dollars yearly. Much of the production is under license from foreign countries, some from CKD kits, and most machinery for the arms factories is imported from the West or China. Chinese assistance in every nuclear area, peaceful and otherwise, has been crucial. Nonetheless, even though Pakistan's defense production is mostly a triumph of reverse engineering rather than original research and development, its leaders have demonstrated the capability to exercise technical judgment and sufficient understanding of principles at some level.

There is less evidence of success in the civilian technology sector. High technology exports, as a percentage of total exports, amounted to only one

percent in 2004. Much of this comes from software exports officially evaluated at \$40 million but unofficially estimated at around 150 million dollars. This figure should be compared against India's 12.5 billion dollars in 2004. The difference of 80 times or more is wholly out of the proportion with the difference in populations, about 6.5 to 1. Although the economy is currently growing well, Pakistan has an economy deeply dependent upon remittances from overseas workers, most of whom constitute unskilled labour in Middle Eastern countries. Instead, low-tech textile exports are the mainstay of Pakistan's industrial production. According to the Pakistan Council for Science and Technology (PCST), in 43 years Pakistani scientists and technologists have managed to get just eight patents registered internationally.

DISAGGREGATING THE SCIENCES

Pakistan is at its weakest in the area of original scientific research, and the causes of weakness here appear poorly understood. The lack of understanding here has led to fundamentally flawed policies and delusions of achieving a quick turn around.

To engage in a sensible discourse on this important matter requires that, at the outset, we separate pure science from applied science. Pure science seeks to uncover new principles and fathom the inner workings of nature. Its discoveries, such as in cosmology or elementary particle physics, often have little or no relation to any kind of technology or economic need. The famous English pure mathematician and number theorist, G.H. Hardy, took much pride in the lack of application of his discoveries to anything in the real world. Nonetheless, without such foundational works in pure science and mathematics there would be no applied science, and no technology. Maxwell's equations led to wireless and television, abstract quantum mechanics to the transistor and integrated circuit, and Einstein's relativity to nuclear power and the bomb.

Pure science and applied science are judged by two different sets of criteria. Good pure science must be current, introduce or employ new concepts or uncover hidden relationships, be intellectually interesting to practitioners of the field, and stimulate further research into the discovering the nature of physical reality. Good applied science, on the other hand, is that which uses known scientific facts in non-obvious ways with the goal of creating technology in the form of processes, devices, pharmaceutical drugs, machines, computing systems, etc.

These elementary distinctions are important to understand now that tens of billions of rupees are suddenly being poured into funding scientific research in Pakistan, and enormous incentives are being given to Pakistani scientists to buy research equipment and publish research papers. This so-called

“renaissance” of science in Pakistan owes principally to the chairman of Pakistan’s Higher Education Commission, and a well-known chemist, Dr. Atta-ur-Rahman.

Writing in the prestigious journal “Nature”, Dr. Atta bemoans the state of scientific research in Islamic countries and offers his recipe for improving it. He thinks that the answer lies in increasing the number of scientific publications, and the number of science PhDs. He then proceeds to declare Pakistan as a success story. In his words:

“During the period 2001 to 2003, the sharpest increase has come from Pakistan, with a 40% increase from 636 to 890. This is a result of a system introduced in 2002 that provides researchers with an opportunity to more than quadruple their earnings if they increase the numbers of their papers published in peer-reviewed journals.”

Other claimed successes include a huge increase in the number of PhD students enrolled in Pakistani universities, and a doubling of the number of universities in the public sector over a period of five years or so.

A DISPUTABLE CRITERION

Does success lie in increasing numbers? Is it a good idea to use the number of published papers as a means to “quadruple their earnings” of scientists, and to go in for whole-sale production of PhDs? On the face of it, this seems eminently sensible. But experience in other countries points in the other direction. Two of Iran’s most distinguished chemists, Dr. Mohamed Yalpani and Dr. Akbar Heydari of Tarbiat Modarres University, argue that such a path is likely to do more harm than good.

Yalpani and Heydari , in a 2005 paper published in the journal “Scientometrics”, argue that this approach has failed in Iran. Intrigued by the fact that publications by Iranian scientists had exploded from a total of 1040 in 1998 to 3277 in 2003 – with over 30% of these in chemistry – these two scientists set about uncovering a number of facts that many had suspected but none had adequately documented.

Working systematically, paper-by-paper, Yalpani and Heydari discovered that:

1. Many scientific papers by Iranian chemists that were claimed as “original” by their authors, and which had been published in internationally peer-reviewed journals, had actually been published twice, and sometimes thrice, by the same authors with identical or nearly identical contents. Trivial changes had been made in the titles, with the contents, graphs, and references being 90% or more similar. These were clear cut-and-paste papers. Others were plagiarized papers that could have been easily detected by any reasonably careful referee.
2. Many Iranian researchers have chosen to repeat the same basic chemical reactions – of dubious practical or scientific value – over and over again. While this generates a lot of data and graphs, it is unlikely to be of much use for anything other than increasing the number of their publications.
3. Interestingly, in some of the papers published by Iranian groups, the exchange of N for O had been represented as acid catalyzed and in some as oxidative! Clearly, the international journal referees were sleeping.
4. Many important details, which ought to be provided by journal authors (such as sample preparation procedures, curing temperatures, etc), were missing. This leads to a suspicion that the experiments were carried out under circumstances that make the results unreliable.
5. While certain international journals are careful and demanding, others are fairly sloppy. Prospective authors, whose work is shoddy, obviously prefer journals which do not require a high degree of proof. Under pressure to publish, or attracted by the incentives offered by the Iranian system, authors often chose to follow the path of least resistance paved for them by the increasingly commercialized policies of many scientific journals. Prospective authors well know that editors are under pressure to produce a journal of a certain thickness every month.
6. Referring to the incentives proposed by Dr. Atta-ur-Rahman in his self-congratulatory Nature article, Yalpani and Heydari show their strong disapproval and note that “significantly, there is no mention of quality in his entire article”. They censure his approach for rewarding the “cut-and-paste” method which his incentives encourage. In their opinion this damages the scientific enterprise because it focuses the attention of the Third World scientist primarily on momentary personal material gain.

When reporting a finding in a Western scientific journal, the essence is lost because individuals often attempt only a minimal mimic of the formalism that lies behind true science.

The two authors note the general decline of the scientific quality of papers published by Iranian chemists although chemical concepts, reagents, instrumentation, and other tools had progressively become more sophisticated. Simply put: there is an explosion of junk scientific papers, perhaps cleverly packaged and capable of getting past referees, but of little use.

No comparable scientometric research, to my knowledge, has ever been done for Pakistani scientists. But these two Iranian chemists, who obviously are not writing for a Pakistani audience, have nevertheless put their fingers on a sensitive spot. They have given enough evidence for everyone to be worried, particularly those concerned with science in Pakistan.

ALTERNATIVE CRITERIA

How then is one to judge the state of science, and the individual merit of scientists if not by the number of published papers? To say that published scientific works carry no value is foolish. There is absolutely no doubt that the genuine scientific publication is extremely important to science, both theoretical and experimental. But it has value only if it is strictly preserved as a medium that succinctly and accurately conveys the essence of true scientific discoveries. If this medium is corrupted, either totally or partially, one must search for better achievement indicators. A better, though still imperfect, estimation of scientific quality is to see how many times a scientist's work is cited by others working in the same field. Citations – excluding self-citations or those made by members of the same group – is a relatively better criterion for assessment of achievement in the pure sciences.

For assessing research in the applied sciences, the task is much simpler. The value to industry of such research must be clear and apparent. This suggests that one must judge the plethora of scientific institutions in Pakistan – which are predominantly applied science institutions – principally by the technology, products, and processes that their work has given birth to. For agricultural research – which is relatively simple science but of immense economic importance – there are some good results to show in terms of cotton and wheat varieties produced, rice and tea strains, etc.

But in non-agricultural fields there is much confusion. It is time to demand clarity. Surely PCSIR, with an annual budget of over 80 million rupees is obliged to tell the nation what that money has produced (beyond a process for making mineral water). *The websites of almost all Pakistani S&T institutions are national embarrassments – that of the Centre for Applied and Molecular Biology has pictures of political personalities, starting with General Pervez Musharraf, but links leading to its activities (particularly research) lead nowhere.*

One must judge the “miracle” of the HEJ Institute – said to be Pakistan’s premier research institution – by criteria different from the present ones. Papers published on applied chemistry, the large number of PhDs produced, or the impressive international conferences it has organized, are indeed positive achievements. But the real criteria should be: what has it produced in the way of pharmaceutical products, patents, and services to industry. Unfortunately its otherwise elaborate website does not, at least as yet, provide information on this aspect. It is the responsibility of HEJ to provide proof of its success because it consumes the lion’s share of research funding. Dr. Abdullah Riaz, an opposition parliamentarian, has recently pointed out that the HEC had made grants amounting to a massive 1.36 billion rupees over 5 years to HEJ, and that both institutions are headed by the same individual.

As in India, in Pakistan all publicly funded national research institutions in the non-defence sector, as well as universities, should be required by law to put their achievements on the internet so that some level of monitoring is possible. Without transparency, unlimited amounts of money can easily disappear without increasing real scientific productivity.

FUTURE PROSPECTS

The future of science in Pakistan will depend fundamentally upon the kind and quality of education that students receive in their schools and colleges. Fancy equipment for scientific research, or increased access to the internet and various glitzy technologies, are add-ons that acquire meaning and importance only after there is an adequate understanding of fundamental concepts.

Unfortunately, by and large, our school education continues to be based upon rote learning. As such it actively seeks to destroy the questioning mind from early childhood by rewarding obedience and punishing originality. One does not see many positive trends here. A moribund examination system that rewards rote learning continues to resist all reform attempts. The recent decision by the ministry of education to downgrade the

importance of science practicals at the matriculation level from 25% of total marks to 15% is an alarming development.

So far, in the absence of a real understanding of the problem, the only prescription for boosting science remains the present one – throw unlimited amounts of money at the problem in the hope that things will turn around some day. The science budget for universities and institutes has shot up 12-15 times over the last 3-4 years.

But money and resources are fake issues. The most powerful engines of science, meaning mathematics and theoretical physics, are exceedingly parsimonious and undemanding of resources. A mathematician or theoretical physicist needs no equipment. Yet, with modest exceptions, high talent has nearly disappeared from Pakistan. Today one cannot count even 10 Pakistani physicists and mathematicians, living in Pakistan, who are good enough to get a job in a reasonable US university. But 30-35 years ago there were probably more than 3 times this number. India has many hundreds in this category, if not a thousand or two.

The dismal situation in Pakistani science is unlikely to change much until there is an understanding that science brings with it a world-view – a weltenschaung within which creativity, freedom, intellectual rigour, and scientific honesty are given the kind of value they receive in the West. The leaders of Pakistan's scientific establishment, who head a plethora of institutes and academies, never cease to demand more resources. But they never speak of the need for exercising the scientific method, critical thinking, skepticism, or viewing the world rationally. They stood by as if struck deaf and dumb after the October 8 earthquake. Comfortably situated in plush offices and driven around in fancy new cars, not a single one from among them moved to challenge the ridiculous and counter-scientific beliefs, freely propagated over the mass media, that this earthquake was God's punishment for our sinful behavior.

Let us face the fact squarely: pre-modern societies, or those which dispute the very basis of science, simply cannot produce meaningful science. Scientific progress requires social progress and a battle against superstition and fatalism. The task of bringing science in Pakistan will therefore have to go side-by-side with a much wider struggle to bring modern thought, the arts, philosophy and pluralism. Science cannot prosper under authoritarianism. And authoritarianism runs deep everywhere. It is underlies the conventional family structure that demands absolute obedience, and a tyrannical educational system where the teacher crushes independent thought. But without intellectual and personal freedoms, Pakistan shall continue to suffocate. Today's orgiastic money-dumping – one which has dazzled the world – will fizzle whenever the country's political administration changes. Suddenly the party will be over. By that time, the distance from India, and the developed world, will have increased many-fold.