Research Methodology
Prof. Soumitro Banerjee
Department of Physical Sciences
Indian Institute of Science Education and Research, Kolkata

Lecture - 72
Ethical Conduct in Science: Cases of Scientific Misconduct Part 02

The next case I will cite comes from the AT&T Bell Labs, where a young scientist published a series of papers in which he made some claims. You see, transistors that are at the base of all electronics, they have an on-off property: under certain condition they turn on, under certain condition they turn off, and that is at the base of all digital electronics.

This person claimed that certain crystalline organic molecules, behave in the same way. And then he showed that even single molecules have that on-off property. Then it was a huge news. Everybody was talking about computers becoming so small as to fit into the eye of a needle and things like that, because you can have single molecule computation elements.

But then when other scientists looked at the papers, they read the papers published by this scientist, by then famous, they noticed something odd. You see, every practical data obtained from an experiment does get contaminated with some noise. Noise is always present in the data.

We have learnt in this course how to account for the noise, how to present the data in spite of the noise, by error bars and all that. What was noticed by other scientists was that, the noise, its character is the same irrespective of the temperature at which the readings were taken.

If a reading was taken at 30 degrees, the character of the noise, the amplitude of the noise and other things were the same as the readings that were taken at 60 degrees. But that is unlikely, because at higher temperatures you do expect a higher amount of thermal noise.

So, they had a suspicion about foul play in this, because the noise is not behaving the way it should. So, they raised a flag, first to the journal, and then the journal wrote to the company, the AT&T Bell labs, and then there was an enquiry. Then it was found that

practically the whole of the data were fabricated. He did not get this data, these were completely fabricated results.

The next case comes from biology. One of the problems in biology is that, sometimes you might need to implant one organ from an animal to another animal. If they are unrelated animals, normally there is rejection. The body rejects that organ, and that becomes a problem. Even in human operations where there is a organ replacement, sometimes organs are rejected.

But when people do these experiments, they do it on mice and therefore, people have been trying to develop procedures, so that one organ from one mouse can be transplanted into another mouse. In 1974, a scientist from the Sloane Kettering Institute of Cancer Research reported that he has succeeded in doing that by a very simple procedure, where the donor organ was kept in a culture for a period, say, a couple of months. Then that would become such that the receiver's body would not reject that organ. It was a simple procedure. Cultures are done almost everywhere in biology. So, people thought that if this is really true, then it would be a revolution in biology, because transplants would become very simple.

But then, as I said, the way science works is that, after you publish a paper, other people would try to replicate the work, following exactly the same procedure as has been reported in that paper. That is what happened. Other people tried to replicate the work and then they failed. Still the organs were rejected by the recipient mouse. Then again the suspicion led to complaint, and the complaint led to an enquiry.

Before the enquiry actually took place, one lab assistant noticed something peculiar. What actually had been demonstrated by the scientist was: there was a white mouse, there was a black mouse, and he wanted to show that a part of the skin from the black mouse can be grafted onto the white mouse and that stayed in place, the body did not reject that. That is what he showed to everybody, as a demonstration of the procedure that he apparently invented.

This laboratory assistant notice that, when this mouse that has received the black patch on the skin was washed with a bit of alcohol, the black color was coming off. And then he reported to the university authorities. They came and found that, simply a part of the

white skin of the recipient mouse was colored black with a felt-tipped pen! So, it was a clear case of scientific malpractice.

The next case I will talk about happened in the University of Vermont College of Medicine, where a famous professor who commanded enormous resources, was investigating the relationship between obesity and aging. He was, in particular, investigating how the lipid content in human blood changes as a person ages.

One of his students was actually conducting the experiment and the professor had a hypothesis in mind and the data were obtained in order to test the hypothesis. The student noticed that the data that were obtained were not supporting the hypothesis when subjected to appropriate statistical tests. So, he reported that to the professor. The professor said, ok, leave the data on my table. I will take it home and take a look at it.

He took the data home, electronic data, and then the next day he brought it back and said that, now do the statistical test once again, I have made some small corrections. And when the student did the statistical test again, it supported the hypothesis. Well, that raised a flag in the student: what happened? This is not supposed to happen, because some data that has been obtained from the experiment has been changed.

So, he reported that to some other lab-mates. They also said that similar things happened in their case also. They also sometimes obtained data that apparently contradicted the professor's hypothesis. And the same thing happened: he took the data home and the next day returned the data and when subjected to statistical analysis, that supported his hypothesis.

So, the students then reported to the university authorities. Again an enquiry was started and it was revealed that many of the papers from that very famous professor were actually fabricated. In this case, since this professor was very famous and commanded enormous amount of money given by the government, all that being done with a fraudulent practice: that was not taken very lightly. The professor had to face a jail sentence.

The next case I will cite was a paper that was published in 2001, in the Journal of Reproductive Medicine. It was a famous journal and the paper was from the prestigious Columbia University Medical Center in New York.

It was on infertility and in-vitro fertilization. Many women suffer from the problem of infertility and normally the measure taken is in-vitro fertilization. This paper claimed that the success of in-vitro fertilization is influenced by some people praying for that woman. So, if other people at other places pray for the success of that procedure, then the procedure becomes doubly successful.

Now, this is a very important procedure, in-vitro fertilization, and therefore, even an increase of the probability success to the extent of 6 percent or 7 percent would be treated as a major breakthrough. But in this case the claim was about 200 percent, and so, people were suspicious. Quite naturally.

Again an investigation followed and the guilty was found. One of the investigators, he was practically a scientific con man, he believed in the paranormal and he wanted to validate his beliefs in the paranormal by some apparent scientific activity. This was one case, where he tried to show by some apparent scientific test that paranormal phenomena do occur. Obviously, in this case the collection of the sample, the statistical testing, the testing of the individuals, distribution into the control group and experiment group -- all that was faulty. There was nothing that can be called scientific in the whole procedure. But still, through that process this man succeeded in getting a lot of grant money.

The next case comes from the heady days when quantum mechanics was developed over a period from 1925 to 27. That was, more or less, a time when quantum mechanics was being developed.

At that time one German scientist Emil Rupp, claimed to have done a lot of experiments on the behavior of the interaction between matter and radiation. Much of these experiments were done using what were known as ‘canal rays’, cathode rays basically. There was a glass tube, at one end there was an anode and the cathode was at the middle, and the cathode had a hole in it. So, most of the electrons passing would be caught by the cathode; but there would be some which passed through the hole and these would reach the other end. While the electrons went, they would be emitting light or some kind of electromagnetic radiation, and Rupp would study the character of that electromagnetic radiation. He claimed that, he has found electromagnetic radiation of long wavelength, like 15 centimeters long wavelength, and things like that.

The reports were published and at that time people were trying to develop theories based on the experiments that were done. So his experiments were also used in theoretical development. Even Einstein noticed his results, and on that basis he proposed an experiment by which one can test whether the electromagnetic radiation comes instantaneously or over a period of time.

So, his experimental results were considered to be in the body of knowledge that was developing at that time. Nobody suspected at that time that these results could be fraudulent. But he slowly became bolder and bolder and in 1935 he crossed all limits. He claimed in a paper that he has succeeded in accelerating a positron beam in a way that nobody has succeeded to do before.

Now, suspicions were raised and other people asked, ‘how did you do that?’ Then, upon enquiry, it was found that he did not even have the apparatus to produce positrons. The whole thing was fabricated and it was then revealed that his earlier work were also fabricated. These are not true.

Finally, I will talk about the case of cold fusion. I suppose it was 1989 when a group from University of Utah in USA and University of Southampton in England, they worked together, and published a paper in which they showed that they have succeeded in producing what is known as cold fusion.

Fusion is something that happens at the center of the sun, where hydrogen fuse to produce helium and produce a lot of energy. If that can be replicated, if that can be done at an earthly temperature, then that would practically be the end of the energy crisis.

So, everybody was extremely excited. It was a huge news. In all the newspapers, the front page headline was that, at room temperature fusion has been achieved. This group, before sending it to the journal Nature, they actually held a press conference and announced it in the press conference. After that it was sent to Nature. It was published in Nature. But as it happens, the moment a discovery of such enormous importance happens, everybody would like to do that. So, researchers around the globe tried to replicate that experiment and most people failed.

Within 3 months, there was a international conference held, in which all these results were put together, in which most of the people reported that they had failed; but some people reported they had succeeded in producing some excess heat.

The process was electrochemistry, in which, in a container there would be heavy water and that was electrolyzed using palladium electrodes. This group claimed that at some point of time, there was overheating of the container and the source of that heat was unknown. The amount of energy that is going into the system by electrical energy that is known. But the amount of energy that is being produced is more than the amount of energy that is going in and so, there must be some other process going on. Such a process cannot be explained using electrochemistry, or chemistry as such, and therefore, it should be a nuclear process. That is what they claimed.

Well, there were some groups who also claimed that they have seen such overheating; but on closer scrutiny in that conference, it was revealed that these were possibly experimental errors or outliers being treated as more important than the regular data. Data have outliers and if you ignore the data and give more emphasis on the outlier, then such problems happen.

Those groups, since they were overzealous about the discovery, they wanted to have the same result, and so they also did the same mistake. The conference concluded that this was the case of ‘pathological science’, where scientists believe something and that influences the way they even do a measurement. They even take outlier data points as more important than the data itself and it was a pathological case like that.

Now it is understood that cold fusion does not happen. The whole thing is actually a case of wrong science.

I presented these cases. These are definitely not exhaustive. If you search the net, you will find many more cases. Believe it or not, cases of unethical practice in science is more prevalent than you might think.

Such cases are there in almost every institution in India. I have not reported those cases. Therefore, it is a problem. It is a major problem.

Why does it happen? It happens because many scientists take science just as a career and they would do anything that is needed in order to further that career. This is what happens in these cases also.

When such a scientist, who has not come to science for the love of science, just as a career, when such a scientist fails to achieve what he wanted: name, fame, prizes, promotions, when he or she fails to get that through normal science, following the correct procedures, formulating hypotheses, testing the hypotheses, all that painstaking process, when they fail to do that, then they take recourse to this kind of malpractice. Why? Because for them science is just a career.

What do we learn from that? We learn that science should not be taken just as a career. One should do science for the love of it. We do science, because we want to know the mysteries of nature. We are naturally inquisitive. The driving force for our science is our inquisitiveness. If you do science with that inquisitiveness as the driving force, you will do good science.

But if you do science with your career motive as your driving force, then this will happen. Therefore, my suggestion to the younger generation would be to avoid taking science just as a career.

Now, a few final words before we close this course.

Nobody is born with an ability to do scientific research. Like any other human pursuit, it has to be learnt. The way music has to be learned, sports has to be learnt, science also has to be learnt.

Just by spending your time in a laboratory and doing certain procedures, you do not learn science. Science is actually a way of thinking, a thinking process that is different from the usual thinking process that we learn from the society. It has to be learnt, cultivated, internalized, practiced and then only you can become a good scientist.

This way of thinking, that whenever I have a question, I try to find out what are the initial clues, initial information that I can gather about that event, form certain guesses, scientific guesses, the hypotheses, then do things to eliminate the wrong ones, ultimately make a decision on that basis.

This is the scientific process and one has to practise that. Not only in the laboratory, but in day-to-day life. In the day-to-day life also, we face questions, face problems, and it is the same scientific process that has to be followed. If one practices one process of thinking in the laboratory and another process of thinking in the day-to-day life, then one cannot become a good scientist, because one will influence the other.

The propensity to believe and not to question, the propensity to believe without evidence, will ultimately influence your scientific pursuit and you cannot be a good scientist that way. So, a scientist is scientist everywhere, a scientist is not a scientist only within the laboratory. A scientist is a scientist in the day-to-day life. In the society he or she stands out as a person who thinks scientifically, who is a rational individual, who can think and who can take decisions on rational basis.

In science, we have to cultivate logical thinking. As I have shown, the whole methodology of science is based on some logical premises. Therefore, one has to understand the method in which science teaches us to think. The thinking method: one has to internalize that and one has to make that a natural thought habit.

Faced any question, I think this way and only this way. We do not accept anything without evidence. These are elements of scientific behavior; what is known as ‘scientific temper’. In the Indian constitution, there is a clause, called article 51A, that demands all Indian citizens to develop scientific temper. It is more so for the scientific community. So, the scientific community is expected to develop a scientific temper and to propagate to the rest of the society.

It is a responsibility of the scientific community to propagate scientific temper, a scientific bent of mind, a scientific way of thinking, a rational way of thinking, among the rest of the society. If we remain cocooned within our laboratories, do not mix or send the message of science to the rest of the society, then we are not playing an ethical role as scientist. So, that is the last message that I would like to give to the students who are attending this course. With that I conclude this course.

Thank you.