

Nobel-Winning Chemist Sir Harold Kroto On Science Education And Creativity

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AsianScientist (Jul. 2, 2012) - Sir Harold Kroto is a modern Renaissance man. Besides discovering the Buckminsterfullerene (Buckyball) with U.S. colleagues and winning the Nobel Prize for Chemistry in 1996, he is also an accomplished graphic artist and long-term advocate for science education.

Prof. Kroto started the [Vega Science Trust](#) nearly twenty years ago, and recently started [GEOSET](#), a web-based science education initiative which is being picked up by numerous educational institutions around the world.

On a recent trip to Singapore, Prof. Kroto gave a public lecture entitled "Creativity Without Borders" that was organized by the Nanyang Technological University (NTU) Institute of Advanced Studies in association with the British High Commission of Singapore.

Asian Scientist Magazine had the opportunity to hear from Prof. Kroto his insights on science and education, and why creativity is so important in a child's learning years.

Prof. Kroto, what is your general philosophy on science education?

Well, there are several. The first thing is that for small children, I think they do have to trust their teachers and their parents. The most important thing for an educator or a parent, is to teach the children how they can decide what they are being told is actually true. And that is science because science deals with fundamental truths.

Most other human inventions gloss over the fact that they are not based on fundamental truth and are in general impervious to rigorous evidence-based assessment. They deal with human constructs and wishful thinking, various things that people find interesting or people created which may not necessarily have any truthful basis.

We should be teaching children not to accept any information without assessing the evidence very carefully. I want children to ask questions, to be curious, to ask "Why?"

As far as teachers are concerned, they should catalyze creative potential in every child. That is difficult because every child is different and all children find different people interesting.

To sum up teachers have a lot to do: a) Catalyze the creative potential for every child; b) Foster the ability to decide what they are being told is true; c) Encourage curiosity about everything; d) Make sure children do not accept unquestioningly what people tell them; and e) Encourage children to work things out for themselves. In fact it is vital that they accept no one's word without question on major issues including

their parents, their teachers, and most importantly themselves.

Given the abundance of information available, how should children or teachers go about validating all of this information?

If some minor things in textbooks are not right, that is not necessarily very important because people make the odd mistake. It is however important in a scientific text that one does not gloss over important issues and simplify key issues which might be somewhat complex. This is the challenge of teaching.

The philosophical approach is very important in the sense that for things that are very important to me in science, I look at them very carefully, and I read the papers very critically and look at the evidence as carefully as I can.

I think it is important when I look at a paper with interesting observations. I look at it and decide whether it is interesting enough for me to follow it up and check it out.

One should have a doubt-based attitude in science - or should I say the discipline of natural philosophy requires this. I consider natural philosophy the only construct we have devised to determine truth with any degree of reliability.

Now we call it science, it used to be called natural philosophy. I call it natural philosophy because it disconnects it from "science" in an important way because society in general does not know or appreciate the intellectual basis of "science."

A scientist is not someone who has done science at university or school or happens to like science and studied it, but someone whose profession is day in day out the discovery new knowledge ie is a researcher. That is a scientist is someone who looks deeply into the way things work and squeezes blood out of the stone of knowledge and gradually reveals the way the universe works. That is a "scientist" and science is hard work.

You recently initiated a web-based program called GEOSET, or Global Educational Outreach for Science Engineering and Technology. Could you share with us more about it?

Basically it is a project in which I get in teachers to record short presentations on particular concepts, not (necessarily) whole lectures, although we do have a lot of complete lectures streaming.

A lecture consists of a whole load of concepts and we want to capture these as separate entities. A teacher might have a concept that he/she likes to present and a clever idea on how to explain complex ideas and discoveries. The best teachers will have quite a few of these and I want to capture by recording them for posterity, so that teachers' ideas can be used by other teachers and furthermore they get a bit of immortality as well.

Excitingly, what we have discovered is that students are very good at presenting their own passions and original ideas. They have great imagination and they talk about things that really interest them deeply.

My view is that in general you can only teach things in which you have a strong interest, a conviction, and a passion. What we are doing is capturing these teaching gems for other teachers to use. We are getting students and teachers in universities and other educational institutions around the world to record the things about which they are passionate. We are activating a large number of people to participate and in time we shall cover all the bases.

I want to record the subjective aspects to conflate with what Wikipedia is doing. Wikipedia is fantastic; I really think it is the second great educational contribution of all time, after the printing press.

How would you say this fits in with your philosophy of science education?

I want the subjectivity. I want to see the teachers. I think teachers are almost invariably the people who encourage the enthusiasm in young people to become creative.

Some students can do it by themselves but by and large most people who have been creatively successful have had a teacher who recognized their ability and encouraged it. Basically they saw that this or that young person had ability and nurtured it in order to make positive contributions to society.

Are there any other endeavors that you have been involved in?

My main interest is in art and graphics. It is the main thing I love most. I do science as my job, and of course I like science, but it is not the most important thing in my life. I have always wanted to focus more on art and graphics, which I do quite a lot anyway on the side.

In my research I was never motivated by thoughts about the Nobel Prize or indeed any other prizes. I was very satisfied with what I had done as a scientist before we made this very surprising discovery in 1985. The discovery diverted me from the graphics which I really wanted to do and indeed, still want to do.

Over the years I have had a reasonable amount semi-professional/ professional success in graphic design. Some of my designs have won awards.

My first "important" award was not for my science but for graphic design and was highlighted in an international professional annual for graphic design.

I have an inside track that professional people in graphic design don't generally have in that I understand science; so I can usually create a graphic design highlighting an accurate intrinsic aspect of the associated science.

What advice do you have for young people?

I do think that most young people have some creative talent. They should never do a project half-heartedly. If they find that they are satisfied with second-rate effort, than they should look for something else to do where only their best effort will satisfy them personally – not just the teacher.

The individual must be prepared to stay up to 3 or 4 a.m. in the morning to do the best they can. Then they know there is something that they are sufficiently interested in to do it for themselves and to do it to the best of their abilities. If they do follow this advice, they will probably do it better than anybody else, probably better than people who could do it better naturally but do not because they have not their enthusiasm.

I don't believe in competition or have any interest in it. I was very satisfied with my work before we did the work that led to the Nobel Prize. That I have won the Nobel Prize is a surprise to me. You should do something that you cannot stop working on, or stop drawing, or is so absorbing that you have completely forgotten to go for lunch.

A big danger in young scientists especially in Asia is that they tend to ask me how to get the Nobel Prize. I never even thought about it. Don't do science because you want to win prizes or do something just because you think it is important; do it because it is something that you are curious about or fascinates you personally, independently of what other might think.

The basic experiment that I suggested to the Rice Group was a rather mundane one that did not seem very important before we did it. When we actually did it it turned out to have an amazing surprise up its sleeve. It was on the face of it a very mundane experiment. I knew what the result would be yet we did it.

The result was exactly what I had expected PLUS an amazing extra bonus this discovery of a hitherto unknown form of carbon.

Sir Harold Kroto was awarded the Nobel Prize for Chemistry in 1996 together with Robert Curl and Richard Smalley for their discovery of a new form of carbon, the Buckminsterfullerene (C60). He was knighted in the 1996 New Year's Honors list for his contributions to Chemistry.

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