Knowledge Societies, Science and Education

Knowledge Societies, Science and Education by Professor Gajaraj Dhanarajan, President and Chief Executive Officer, The Commonwealth of Learning

Delivered at the 55th Annual Session of the Sri Lanka Association for the Advancement of Science, Colombo, Sri Lanka, 29 November 1999

Transcript

1. At the recently concluded World Conference on Science, Mr. Federico Mayor, Director-General of UNESCO, made two points which I thought were most appropriate to mention at this conference of the Sri Lanka Association for the Advancement of Science (SLAAS). They are:

- Science possesses a huge force for change (and it is), a potential that must be used to the full.
- A new departure for scientific research cannot be envisaged without a new departure for science education.

2. Both statements are not new, the first have been taken by the scientific community as an axiom and the second is a call that gets made periodically by commentators of educational practice and political leaders of every shade whenever an opportunity presents itself. I moved away from being a practicing scientist and science teacher some 15 years ago and in that period have found, as part of my current vocation, moments to reflect on both science as a force for change and the nature of science education. I thank the SLAAS for the opportunity to share that reflection with you this morning. But before doing that, let me first congratulate and compliment you on this meeting and the theme seminar that follows. It is not very often that scientists give their precious time to discussing education. That you are doing so is a great tribute to this association and, more importantly from my standpoint, your theme seminar will focus on aspects of a new way of delivering education, is particularly welcome. The practice of distance education or technology-mediated education can contribute much to the debate on that new departure for science education that Mayor referred to in his message at the World Conference of Science.

3. As we prepare to welcome the last year of this millennium, the community of science workers has much to be proud about. You are leaving a millennium that witnessed, through your efforts and that of your colleagues throughout the world, miraculous ways of saving lives, feeding millions of people, moving people from continent to continent (and perhaps in the not too distant future) from planet to

planet, providing better and more shelter, transmitting knowledge, communicating with distant friends, relatives and colleagues, enhancing art, helping to preserve culture and educating. Even more importantly, explorer scientists of the 20th century have led the way in finding new resources to feed, new materials to build, new fuels to generate energy. Apart from the wonderful inventions and discoveries that have made all of our lives a little safer, more comfortable and enriching; theoreticians amongst us have split the atom, configured the relationship between time, space and gravity, described the cell, postulated the evolution of organisms among others. Science has indeed done much to make our lives what they are.

4. Yet there is a distrust of science, but not without reason. Either through misguided policy directions or driven by greed or power, our generation has also witnessed the destructive side of science and technology. The bombs; missiles; biological weapons; the pollutants that have poisoned our air, water and soils; the warming of the earth; the damage to the ozone; the awful destruction of our forests are but some examples of this destructive power.

5. Science itself is value neutral. For it to be beneficial to all of humankind we would need wise policies. Policies are not created in a vacuum. The men and women we choose (in most instances) as our leaders or those we appoint as our managers have designed them. Humanity's record in either the exercise of its choice of leaders or appointment of its managers is not a terribly enviable one. As we begin to look at the coming millennium, the knowledge of our people to exercise their choice will become even more critical for what the future holds for individual human beings; nations and the world depend largely on the wisdom with which humans use their science and technology. And that in turn depends on the character, distribution and effectiveness of the (science) education that people receive.

6. For a little while now, however, there has been serious concern about the state of science knowledge and education even among the educated citizenry globally, and not just developing economies. Some of you may know of a study in the early eighties on science learning when education researchers asked a group of young Harvard graduates - still in their caps - to explain the change in seasons. Most responded confidently that the warm weather of summer occurs because the earth is closer to the sun during those months and that it moves away from the sun during the winter months. In the same study, researchers also quizzed bright high school students about the phases of the moon. Most attributed these changes to shadows or clouds blocking the moonlight.

7. On an even more shocking note, some studies seem to indicate that less then half the population of even fairly well-informed societies do not know, for example, that the earth orbits the sun or how scientists figured out that it does; there is little knowledge on how the climate systems work and how meteorologists predict weather or the relationships between food production systems and soil fertility and the ways in which agricultural scientists measure this correlation. Very few lay people can actually distinguish between evidence-based explanations of how the physical world works and an opinion-based one.

8. Findings like these shocked the Americans into launching a series of investigations into the state of science knowledge, which resulted in a 1982 report appropriately entitled: A Nation At Risk: The Imperative for Education Reform. The fear clearly recognised the danger to the nation's economic well

being, particularly in areas dependent on scientific know how. The science education reform that got started as a result is still going on. It is becoming even more critical today than ever before, as societies become more knowledge based.

9. The new millennium is expected to bring far greater challenges to our lives than we had ever experienced before. What this future will be is difficult to predict. One thing, however, seems to be certain. Almost everything that human beings do today will be done through the application of knowledge resources. To function in these knowledge based societies, individuals will require among other things a basic knowledge of science, how it works, its limitations and its vulnerabilities. Individuals will also need a deeper understanding of the impact science has on society and the environment. Our technologies have given us unprecedented access to information and knowledge; but we need to ensure that our people, both young and old, have the capacity to turn that information into knowledge and apply it whether for purposes of a functioning civil society or for personal economic production. We need to improve the science literacy of all our people.

10. A culture that will increasingly be pervaded by science, mathematics and technology, science knowledge requires understandings and habits of mind that will enable citizens to grasp what those enterprises are up to, to make sense of how the natural and designed world works, to think critically and independently, to recognise and weigh alternative explanations of events and design trade-offs, and to deal sensibly with problems that involve evidence, numbers, patterns, logical arguments and uncertainties. These things will be essential to the education of today's children for tomorrow's world. These things will be essential for today's adults to create tomorrow's world.

11. As I said before, there is concern globally about the state of science, technology and mathematics education. The concern revolves around a number of issues. These relate to what is being taught and when it is taught. It concerns how science is taught to the various groups of learners. How could we improve the teaching of science, technology and mathematics? And, what should be the basis of judging the validity of science education? Ancillary to these, are questions that concern themselves with the funding of science education, the training of science teachers and the creation of science awareness in all parts of our community. Many people would argue that in most developing economies, science education might have failed their societies not only in the generation of knowledge and advice, but more importantly in the appropriate application of science for development. While I am not one of those critiques, I do have a concern about the quality of science education, especially its relevance, reach and effectiveness in many of our countries. How else can we account for the big gaps that we encounter in our daily life between presumed knowledge and actual practice, whether it is personal hygiene or habitat conservation. My concern is closely related to my even bigger anxiety that unless we improve the quality of our science and technology education, we will put in jeopardy the continuance of democratic governments. Citizens of the coming millennium have to be better informed about scientific and technological concepts in order to be effective participants in that democratic process.

12. How then do we extend and improve science education? I am sure I am not the first to raise this question and I certainly hope that I will not be the last. While I do not have a solution for the question, there seems to be some lessons that we could learn from world experience. One such experience comes

from an introspective inquiry that the National Academy of Sciences of the USA initiated some ten years ago, the findings of which are still being debated and in many instances followed. This enquiry called for the establishment of National Benchmarks for Science Literacy. These benchmarks called for students and other learners to:

- Be familiar with the natural world.
- Develop an understanding of the key concepts and principles of science, mathematics and technology.
- Develop a capacity for a scientific way of thinking.
- Be aware of some of the important ways in which mathematics, technology and science depend on one another.
- Know that science, mathematics and technology are human enterprises and therefore have their strengths and limitations.
- Be able to use scientific knowledge and ways of thinking for personal and social purposes.

13. These benchmarks prescribed the treatment of each one of the above themes in a curriculum from K to 12, as well as the first year of college with expectations of achieving respectable levels of science and mathematics literacy by all persons including those who exit formal schooling very early in life. It seems to me that an opportunity exists for Commonwealth associations for the advancement of sciences to do something similar. The shared traditions of education across the 54 countries of the Commonwealth allow for a collective strategy to be crafted. The Commonwealth of Learning will be happy to participate in such an event and further assist in developing a curriculum to respond to the strategy.

14. Achieving the objectives of the benchmarks will require science educators to reconsider the ways science is taught in schools and colleges. As you ponder the question of teaching science yourselves, you might find that your ideas have resonance elsewhere to:

- Replace memorisation with exploration and invention - there is a view that prescribes a new way of teaching science. This view recommends a different order to the sequencing of science instruction.
- Bring greater focus to the curriculum - concentrating on fewer key concepts and acquiring knowledge of a core set of ideas and facts; the curriculum of most of our schools across the Commonwealth are a mile wide and an inch deep. There is a strong belief that concentrating instruction of a few key concepts can substantially improve science literacy. This may allow for more exploratory ways of gaining knowledge and understanding of science through projects.
- Design assessment to measure performance and not regurgitation; many of our systems of measuring outcomes depend on the capacity of learners to memorise and regurgitate facts with little attention to testing comprehension of science principles or the ways in which science works. Evidence, at least in North America, seems to suggest that examinations by themselves do

nothing to help students understand science better; some may even turn students off science. If only our assessment systems could be designed to evaluate students by how they perform tasks that match curriculum goals.

- Build lessons on preconceptions about science rather than mere abstractions; most of us, even as children, come to a classroom with some ideas about our world and the way it works. Would it not be easier to use these ideas as starting blocks and prove, through experimentation, whether they are right or wrong?
  Select learning resources for the right reasons, especially in mathematics.

15. Ladies and Gentlemen, as you welcome the next millennium, you, like me, will realise that our future as individuals or nations is largely going to be shaped by science and technology and the wisdom with which we humans apply the knowledge, discoveries and products. This in turn will depend on the character, distribution and effectiveness of the education that people will receive. The debate you are embarking on over the next few days is but a beginning. Whatever the outcomes of the debate, a literacy in science, mathematics and technology is not an option for citizens of the Commonwealth in the next century.

I wish your Congress every success.