The Challenges for Science. Education for the Twenty-First Century
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SCIENCE EDUCATION AND INFORMATION TECHNOLOGY

MAMBILLIKALATHIL G.K. MENON

The very first aspect of the purpose of this conference it is to consider how science and technology permeate the educational system. We have an educational system and we want to see how science and technology percolate into it, and of course we are only going to look at the school primary and secondary education system. But there is an aspect that has repeatedly come up for discussion. Prof. Osborne raised it in particular when he discussed scientific literacy and it was also referred to earlier when science education and its relationship to the scientific information for the public was discussed. One is referring here to the whole area of science communication, or science for all rather than for specialists, and I believe this is an equally important area that we should consider because it is part of what emerges from the primary and secondary levels.

I would like to start by saying that the main area I would like to deal with is the scale factor in primary and secondary education, and this is because I come from India, which is a developing country. Professor C.N.R. Rao discussed certain categories of countries in his report about scientifically advanced, proficient, lagging and so on countries. There are many areas of development in India where India might be regarded as an advanced country, but let me say that if one looks at the overall picture, India is certainly a developing country as far as the area of primary and secondary education is concerned and as far as science education is concerned. Professor Rao made a very forceful and impassioned speech about the problems of development and the developing countries, so I will not repeat a large part of what he had to say, but if we are going to discuss the future, if we are going to discuss primary and secondary education and science education, and as I said the principal purpose of my pre-

sentation is to deal with the question of scale, I want to say that there are a very large number of issues across the spectrum, and these are seen essentially in the developing countries.

First of all, I know that in my country there was a promise made to achieve universal elementary education; there was a promise made in the Constitution of India in 1950. We still, in 2001, have not fulfilled this promise. There is the question of literacy. I am not talking about scientific literacy; I am not even talking about the ability to understand the meaning of things. I am talking about literacy *per se*, and when talking about scale we have 400 million illiterates in India. There is the question of equity, and I think that this a very important term that we ought to consider; and I have seen it across the whole spectrum, whether in the rural areas or the urban areas. And Professor Pinto DeMelo showed that in the case of Brazil the difference between the urban and rural is sectors very evident.

There is also a high degree of gender inequality; there is inequality between the young and the old. In fact Professor Cabibbo referred right at the outset to Professor Alberts and the fact that he had talked about those about the age of sixty. But I would like to say that if we just take the age group between fifteen and thirty-five, where the bulk of the working population comes from today in India, we have 110 million illiterates. There is also the problem of what are called 'drop-outs'. A 'drop-out' is essentially a child who joins school and does not proceed through school. He drops out at various stages in class two, in class three, and so on. And the figures for India are that for every 100 children who join class one, only twenty-five get to class 8. Seventy-five drop out. This is a very major problem.

And there is of course the state of schools, I think Professor Rao gave some indication of what the schools are like: roughly 40% of schools do not have blackboards; only 30% have libraries or laboratory facilities; and 73% have no proper buildings. Now, we heard a great deal about teachers, and I think Professor Mössbauer hit the nail on the head when he said that the most basic question is the teachers and the training of the teachers. But Professor Rao also told us about single-teacher schools. One teacher looks after the whole school, all the classes, all the subjects, and I can tell you that I have been to practically every part of India, because I have dealt with this field for eight years, with the planning of the education sector, and in a large number of these schools there is no teacher; there may be a single-teacher school but there is no teacher. Teachers who are appointed live in the better towns. They do not come to the rural areas. And you have schools in places where the children have to walk as far as twenty kilometres to go to

school and come back, often across difficult territory, including mountains. With all this, quite clearly, there are going to be drop-outs.

There was also a discussion on the question of teachers not joining this profession for a variety of reasons. First, in most developing countries today you find that they do not have any real position in society, or respect for scholarship. We have discussed the question of the importance of money and the other professions available. Reference was made to how a good mathematics student goes on to do other things, maybe in financial areas, rather than becoming a mathematics teacher, and I know that a very large number of those who are actually teachers instead of teaching in their classes give take private tuition outside – that is where they make their money. They go for coaching classes, as they are called, to enable students to pass examinations.

What I really want to point out is that we are really dealing with a different animal, dealing with a different problem in terms of the types of issues that come up in terms of the scale involved, and therefore I really asked myself when this workshop was planned: how can science and technology percolate into the educational system? I want to see in what way we can use our current scientific and technical capabilities to overcome this problem of scale, of distance, of access, of timing, because very often the problem that arises in developing countries is that schools are far away, they operate on fixed timings, and these are not the timings when students can go to school. Therefore they do not go to school or when they have other things to do they drop out. Can we therefore overcome the barriers of distance, the barriers of fixed locations and school buildings and the resources required? Can we overcome the barriers of time? And this is why I want to talk about science education and information technology.

Many here are probably familiar with the fact that one of the successful programmes conducted in India is what is referred to as the 'green revolution', the increase in food production. At that time television was just coming on the scene, and perhaps the first programme ever conducted in India on television was what is referred to as 'creshi dashan'. 'Creshi' is agriculture, and dashan is a view; and this was essentially to put across on television what was important to farmers in terms of seed varieties, what to sow, pest control techniques, and so on and so forth. This was a process of real education which was of value to them in terms of what they were actually doing.

This still continues. Later on, and this was really conceived by the person who envisioned the Indian space programme, Vikram Sarabhai, we

had an experiment which is referred to as the satellite instructional television experiment. This programme essentially borrowed a US satellite, a dual stationary satellite, the ATS 6, moved it overhead from America to overhead India, and used it for education. Televisions were put in remote villages and there were programmes of relevance to these communities, not necessarily teaching them at a primary or a secondary school, but aspects which were related to the totality of what was relevant to them, relating to water, relating to health, relating to education, relating to general knowledge and so on and so forth, so as to open their horizons. This was a very successful experiment.

But since then has television has grown tremendously in the country, and today television is no longer regarded in information technology as being a separate entity. One has what one calls convergence, which means the totality of all aspects of information storage, dissemination, communication, computing and so on. Today computers, broadcasting systems and telecommunication systems converge. There is an IT convergence, and the question that I would like to really raise here is the manner in which one can use this. Dr. DeMelo referred briefly to the use of Internet. But I would like to say that we are not only dealing with the computer, but also with television, with all types of systems for storage and for the dissemination of information. There are now a variety of things happening which would enable this to take place. Let me give you just one small example of how slum children make use of computers. In Delhi one of the companies involved with computers installed a computer in a slum area with just a hole in the wall, so that the children could have access to it, and it was switched on. They came and looked at this new object or toy, played around with it, they were pressing buttons and so on and so forth, and they saw all sorts of things happening on the screen. They were illiterate street children, but they all learnt and they knew far more about computers than adults who had followed the manuals in which you go step by step.

Television today is essentially used within a consumerist framework. It is used by the news media for a whole range of things. How much information has been transferred to society on a real time basis, whether the September 11 WTC event or what is happening in Afghanistan, what happened when man landed on the moon or what was happening in Yugoslavia or anywhere else for that matter, or when a goal is scored in a world cup! All of it in real time is available to huge numbers of people, and they absorb it. This is the power of the television. And yet, because of the fact that it has been completely handed over, in a certain sense, to what are called market

forces, education and health are rather neglected. Certainly we make the maximum use of business, of industry, of whatever they can do in the matter, but the primary responsibility in this sector will be that of government and of society, and therefore whatever means is available must be made use of by the public sector, and by that I mean government and society.

I would like to mention another area of information technology very quickly, and that is the area of languages. Reference is made to a whole range of issues relating to languages and Dr. DeMelo talked about various developments in Brazil. But if I ask myself in what way could I use them, the answer is: zero, except for kits, because they would all be in Portuguese. Elsewhere it would be in Spanish, and so on and so forth.

We have to realize that there are three thousand languages spoken in the world. Thirty-eight of these are spoken by more than ten million people. There are twelve which are spoken by more than a hundred million people. Language is a matter of great importance as we move into the future, if we want to have anything that is international, and not only international but also national. When we talk of India, we have eighteen constitutional languages in India, ten scripts, and about fifty dialects. Children, when we talk of primary education, grow up in their language groups with a mother tongue.

If you look at the way the human brain reacts to this, all information is essentially a process learnt in that idiom, that form of idiom. And in fact all records are kept in that fashion too. I mean, if you look at any farming records you will find that many records are kept in the local language, in that script. As we move into the future we have got to accept that language diversity is a basic trait of cultural pluralism.

There are different cultural identities, and hence a diversity, and on this rest the various forms of expressing feeling and thinking. Now, certainly it is true, and reference was made to the fact earlier on, that we have Internet. A very large part of it is in developed countries. I am not going into the detailed numbers on that. A significant part of it is in English, but if you take this very continent in which we are, Europe today, and take the number of languages in Europe, would one want to go over to an Internet based entirely on English? Or should we do what Professor C.N.R. Rao said and allow the gap to widen? He referred to standing on the bank of a river, a widening flooding river. Or are we going to have some mechanism whereby we can move over from one language to another with ease?

And I would like to just spend five minutes in telling you that this is possible, not just in a machine translation from language A to language B, but

in moving across from any language to any other language, and that is something with which I have been connected, and it is called 'universal network in language'. This was something which was developed by a team of two individuals who originally worked on machine translation at Fujitsu and who then were at the Institute for Advanced Studies in Tokyo, the UNU. I will not go into the history of the whole development but what does it amount to? It amounts to the fact that you can express yourself in the language you know, English, or French, or German, or Hindi, or Gujarati or Chinese, or Russian or Arabic, and in the script that you know. It is then put on a computer in the way you normally put it on, it goes into the server, and then what you have is an electronic language which picks up the totality of it, the words, the syntax. It has an enormous dictionary for the purpose and resides in the server, in machine language, in computer language. This is the process of UN conversion. You can pick it up in any other language anywhere else. If I today send a message from here in Italian, it can be picked up in Beijing, in Chinese, or in Moscow in Russian, in those scripts and in those languages.

Here is an opportunity to go across all the languages and to break the barriers that exist today. Now, I could go into greater details on this but I do not want to because of a shortage of time. But what I wanted to point out is: first one has the power of the television, and a television set, particularly with cable television, and now there are powerful new techniques which are coming in including overcoming the last mile problem through wireless and local loop, a variety of things which exist, which display in a form which is absolutely explicit and clear. I am not now arguing that this can substitute the teacher, I do not say that at all. What I am saying, however, is that it is a powerful adjunct. In addition to that, you are not then dependent only on doing everything within that language framework. You can cross over from one language to another.

This can be done for all purposes that we are concerned with at this level, which is primary and secondary education. I am not talking of technical education in great detail, there will be special domain areas: if you are going into neurosurgery, if you are going into high physics, if you are going into molecular biology, then of course you require a whole range of new dictionaries and words and so on and so forth. But, on the other hand, if one is talking of two aspects, and that is what I would like to focus on, which is in the original definition of the purpose of the Conference, namely how science and technology percolate into the educational system, and how one can move over experiences across the world, and how one can relate this as

science communication, namely the whole question of science and public understanding, then I think this too can be used in a very powerful way.

I can make a few clear suggestions about what should be done in this area. There has to be an immediate technological effort and an effort relating to lower costs. Efforts being made particularly in Brazil, in India, for instance, are bringing us down to the level of a hundred dollar PC, and I will make the prediction that soon we will have instead of the actual complex boards things printed on paper. You do not require all the elaboration required for the type of usage at this level. One would require systems that operate mechanically with battery systems, not only electrical systems. You have already seen Dr. DeMelo's projection on the availability of electricity; the situation in Africa is much worse; in the remote areas of India it is also very bad. My second suggestion relates to the increase in the number of languages connected to the universal network in language, because the universal network in language is the computer electronic language. But the language groups are working today on all the languages, all the standard languages of the UN system, plus a very large number of traditional languages, Hindi, Thai, Japanese, etc. which are not part of the UN system.

There has to be a commitment to the public sector and government funding of education, and particularly science education. There is I think the opportunity, and this is what Professor C.N.R. Rao in some sense hinted at, that there could be a declaration from here, particularly with the backing of His Holiness, on the importance of education for development, for values. I have not gone into this whole area which is a completely different area in its own right, but education is not purely technical, education includes value systems, and this of course finally brings us to a knowledge-based society which can use that knowledge effectively.

And of course I hope that we will also have the possibility of international programmes whereby very low cost science experimentation can be transferred, so that it can be used in much broader areas than presently. Indian experiments do not have to be confined to India, Brazilian experiments do not have to be confined to Brazil, Mexican experiments do not have to be confined to Mexico. One should be able to spread them around and make much larger use of them, and an international programme to make this possible is certainly called for. But I do believe that the very first part of the purpose of this workshop, namely how science and technology can percolate into primary and secondary education, is very important. It can be done, and I am not pessimistic about it, but it must attack the most single key factor in it: if you are going to deal with the world, scale is important.