HUMAN RESOURCE DEVELOPMENT AND SCIENCE EDUCATION IN THE PACIFIC: WHERE ARE WE HEADING?

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The theme of the Education Session at this Inter-Congress is *Human Resource Development: Pacific Teachers.* Having worked in the area of science education in the region for a number of years, I thought it would be appropriate for me to address the theme from the perspective of science education, especially because of the recognition that the quality of science education provided in our schools has a key role to play in human resource development, and in establishing a culture of science and technology in our societies. First, I will briefly outline some of the key issues and concerns that have shaped, and continue to influence school science globally. I will then look at some of the developments in our region in relation to curriculum reform in science education, science teacher education and professional development.

The rapid advance of scientific knowledge and the development of new technologies in this century have undoubtedly influenced a number of innovations in science education worldwide. But what is significant is that the past forty years provide examples of planned change on a scale rarely seen previously (Layton, 1986, p.9). In developed countries, the reasons for this included a concern for specialised scientific and technological man power to meet the demands of the industrial and military complex. During the same period, many nations across the world were becoming independent, and their moves towards modernisation involved the implementation of relevant science curricula to replace the ones imported from the West. Seen from this background, science and technology education were seen as important contributors to national development (Unesco, 1983, pp. 36-49).

Beginning in the mid-1950s , and continuing on to the next decade, many innovative science curricula were produced for the most able pupils. The National Science Foundation in the United States of

America, and the Nuffield Foundation and Schools Council in Britain, funded major curriculum projects in physics, chemistry, biology and integrated science. Despite these impressive curricula and the comprehensive resource materials accompanying them, the people who developed them did not see the anticipated qualitative improvements in teaching and learning in science. One major reason for this disappointment was that those who developed these curricula had overestimated the teachers' capacity and willingness to adopt the innovations without adequate preparation. After all, teachers are the critical agents in curriculum change. The phrase 'innovation without change' was coined in this period to describe a situation in which an innovation was adopted in theory while the classroom practices remained unaltered in any fundamental sense. Jerrold Zacharius, a key member of the PSSC physics team, expressed the feelings of many when he commented that it was easier to put man on the moon than reform the school science curriculum (Silberman, 1970, p. 171). The other reason for the frustration was that these curricula were very ambitious, and did not cater to the needs and abilities of the majority of pupils.

David Layton, a historian of science, has identified three issues that became dominant in the design of science curricula in the 1970s and 80s: 'the changing and, at times, competing goals of science education [science for the specialist *vs* science for all]; the construction of non-elite curricula which are perceived by learners as having 'social meaning and usefulness' [science education in cultural contexts]; and the problems of converting planned into actual change' (Layton, 1986, p. 100).

Two examples, the first from Canada, and the second from the Asia/Pacific region, illustrate the extent to which it had become necessary by the 1980s to redefine the goals of science education in relation to the three issues mentioned above. The Science Council of Canada commissioned a major four-year study in 1980 and produced a report titled *Science for Every Student*. The study looks at the future options for science education in relation to the personal and community development of Canadians. To quote some extracts from

the report, Canada needed science education that could (a) develop citizens able to participate fully in the political and social choices facing a technological society; (b) train those with a special interest in science and technology fields for further study; (c) provide an appropriate preparation for the modern work world; (d) stimulate intellectual and moral growth to help students develop into rational, autonomous individuals (Science Council of Canada, 1984, p. 13). In relation to 'science for informed citizens', the Canadian study took the view expressed in the 1972 Unesco report *Learning to Be*:

> Lack of understanding of technological methods makes one more and more dependent on others in daily life, narrows employment possibilities and increases the danger that the potentially harmful effects of the unrestrained application of technology--for example alienation of individuals or pollution--will finally become overwhelming (Faure et al., 1972, p. 66).

The second example of the goals of science education comes from the deliberations of a regional meeting held at the Unesco Regional Office for Education in Asia and the Pacific (ROEAP), Bangkok, in September 1983. Nineteen countries in the region participated in the meeting, and the results are contained in a report, *Science for All* (APEID, 1983). Many of these countries had already developed new educational policies that took account of endogenous economic and social development. In many of these countries, the universalisation of primary education has a high priority, together with a strong emphasis on the development of community-based non-formal education and training for out-of-school youth and adults, to complement the formal system (Layton, 1986, p. 13).

As stated in the report, the nations of the region 'have now learnt that to achieve endogenous development, gain true self-determination and sustain healthy advancement, it is not sufficient to have just an elite cadre of experts. The whole population needs to be able to appreciate, and in their own respective ways, participate in [the] responsible use of science and technology for development' (APEID,

1983, p. 15). Science education, then, is to be truly for all, with 'all' meaning not only children in primary and secondary schools, but also 'out-of-school children and youth, including those who should have been in schools under the universalization of education process; the work force including the large number of illiterates; and the educated adult section of the populace' (APEID, 1983, p. 17).

It should be noted that within the formal education system 'science for all' is not intended to be an alternative, lower status programme, but an essential core component, respectable in its own right, with perhaps some additional topics for those students who might take up specialised studies in science. It is important, however, that this minority should have followed a 'science and society course stressing the social responsibility of the scientist' (APEID, 1983, p. 22). In the non-formal sector it will need to be related to practical problems in a community and to the extension of existing crafts and technologies.

The report specifies basic criteria for the selection of the content of 'science for all' as quoted below:

(a) It should be perceived by the learners as immediately useful in their real world or as having social worth by its economic or community value. In other words it should lend itself to experiences and practical use that are meaningful to the learners;

(b) It should improve the living conditions of the learners, or increase their productivity, and contribute to the well-being of the community and to national development goals;

(c) It should be based on daily life experiences of the learners' needs, relate to the resources of their real world, and must have obvious application in their work, leisure or homes;

(d) It should include natural phenomena which will create wonder and excitement in the learners;

(e) It should enable learners to acquire and master useful and employable skills and intelligently use these skills;

(f) It must consider cultural and social traditions, and seek to complement these and not clash with them unnecessarily;

(g) It should make the learner recognize and appreciate the importance of science and technology in national development; and

(h) It should enable the learners to utilize wisely the resources in their environments and to live more harmoniously with nature and society (APEID, 1983, pp. 20-1).

It is interesting to note the similarities in the approaches to science education emerging from the *Science for Every Student* (Science Council of Canada, 1984) and *Science for All* (APEID, 1983) reports. It should be noted that in one form or another, each of the three issues identified by Layton (1986, p. 10) is central to most recent proposals and practices associated with the redefinition of science education worldwide, including our own region. Perhaps the most challenging issue that should be addressed by curriculum planners is that of preparing teachers for curriculum change.

It is now appropriate for me to turn my attention to the Pacific region and make some observations. In the past 25 years or so, a number of developments have taken place in the region in improving the quality of education and access to schooling.

The University of the South Pacific (USP) was established as a regional institution in 1968, and for the first fifteen years or so, the main focus of the University was to prepare teachers for the expanding school systems of the region. Many countries were also becoming independent nations during this period and they saw the replacement of expatriate teachers with trained local teachers, and the development of relevant curricula and examinations as a priority.

Responding to regional needs, the early 1970s saw the establishment of the UNDP/UNESCO/UNICEF Curriculum Development Project based at the USP. Project consultants worked with educators from the region to develop curriculum materials for years 7-10 in Science, Mathematics, Social Science, Home Economics and Industrial Arts. The Project also acted as a spur for the establishment of Curriculum Development Units in many countries of the region. The materials developed by the Project have since been revised, extended and adapted to suit the needs of member countries.

As a natural consequence of these reforms in curricula, the regional governments saw the importance of improving the assessment and examination systems. The result was the establishment in 1981 of the South Pacific Board for Educational Assessment (SPBEA), a regional body based in Suva.

Apart from these regional initiatives, individual countries have also made a number of efforts to bring about improvements in their educational systems.

Despite all these developments and efforts, a number of concerns still remain to be addressed in the area of science education. My own extensive study of science lessons in primary and secondary schools in Fiji (Muralidhar, 1989), and a later survey of science teaching in the USP region (Pillai et al., 1991) have brought to light a number of problems in the areas of curriculum, teaching, learning and resources. It is interesting to note that some of these concerns were also highlighted at the 6th High Level Consultation of Senior Pacific Educators held in Western Samoa in 1992 as follows:

> If there is one subject matter which has the potential to offer significant returns on investment for both the individual and the country concerned, it is unquestionably science education. ... Reforming science education can impact on the protection of the environment, the population growth rate, personal health and welfare, and the quality of life. It offers the

possibility of increased relevance, higher student motivation, reduced per capita costs, improved teacher retention, a larger number of overseas study options, and better quality education, of particular interest to isolated schools.

During the Consultation, four issues of concern to all the Pacific States emerged:

1. Curriculum: What subject areas should be included in the science curriculum? What should be valued? Should we emphasise the relationship between science and everyday life?

2. Teachers: How should training programmes be organised? Who gains access to pre-service courses? What in-service training will be needed to improve the teaching and learning of science? How can trained science teachers be retained in the teaching force?

3. Philosophy of science education: How should science be taught and assessed? Should we continue with the current content-based approaches which place a heavy emphasis on memorisation or should we move towards process-based approaches which stress student understanding, critical thinking and the enjoyment of learning about science? What, if any, is the place of vernacular language of science?

4. Resource requirements: To what extent can and should localised resources be used? Is science which can only be taught using conventional laboratory equipment in the best interest of our countries?

The meeting suggested the creation of a standing advisory group to monitor science education programmes in the region, with the mandate to look at all aspects of science education, its goals, content, teaching methods, assessment, and cultural appropriateness.

As a sequel to the 6th Consultation, Unesco and the Institute of Education at the USP established an independent Advisory group to identify the problems in science education and to suggest strategies to address them. This group met in March 1994 and produced a document which covered six key areas: Curriculum, Teachers, Examinations and assessment, Resource requirements, Dissemination and use of information, and School and the community.

The recommendations of the group were endorsed by the 7th high level Consultation held in Suva during May 1994. This was followed by a survey of science education in the Pacific Island Countries (PICs).

The next step was to bring together educational planners in the PICs to prepare Project Formulation Frameworks (PFFs) for the six components of the programme. This workshop took place in September 1994 at USP and the PFFs were produced.

These documents were sent to regional governments for endorsement and inclusion in their bids for the round of UNDP funding beginning in 1997.

In May 1995 a Consultation of Pacific Directors/Secretaries of Education was convened to obtain reaffirmation of national commitments to a science education initiative for Pacific Island schools. The meeting also reviewed a draft of the Science Education in Pacific Schools (SEPS) document. My understanding is that the document was endorsed with some minor amendments.

We are all eagerly waiting to see further developments with respect to the implementation of this third major regional education project--the first being the UNDP/UNESCO/UNICEF Curriculum Development Project of the early 1970s, and the second being the ongoing Basic Education and Life Skills (BELS) project.

What is interesting here is that the issues and concerns raised by the PICs are very similar to the ones outlined in the *Science for Every Student* and *Science for All* reports, and clearly demonstrate the

importance attached to science education by the PICs. I would now like to look at the implications the three issues, mentioned earlier, for school science and teacher education in our region.

The first issue deals with the two important but competing outcomes demanded by school science: 1. Preparing trained specialists; 2. Preparing a scientifically literate population. It seems, at least initially, that each requires a separate tailor-made curriculum. Many developing countries have opted to resolve this dilemma by offering a *Science for All* version of the curriculum at lower levels of schooling and offering separate science subjects at higher levels. With the limited resources available for curriculum development activities, most school systems in our region have adopted this model. In many countries in our region the prime need is for revising existing curricula, developing resource materials to support them, and providing professional support for teachers. We cannot afford the luxury of offering alternative curricula in science.

The second issue relates to what we might call teaching science in a cultural context. This involves, for example, taking account of 'children's science', traditional knowledge, cultural contexts, and issues that are of relevance to particular communities, both in the design and delivery of the curriculum. Seen from the constructivist perspective, if some children, and adults, in a community believe that when one gets an electric shock, the blood of the person will flow through the wires to the electric company (King, 1983, p. 8), then it is important to understand what 'theory' led to this belief when we teach children about electric currents. Although these issues are important, it is not clear, in a practical sense, how these considerations can be incorporated into curriculum materials, teaching and assessment, especially when we consider over-worked and inadequately qualified teachers. Layton adds another dimension to the issue of relevance:

> The dilemma at the heart of this problem is that cultural congruence has usually been achieved only at the expense of debasing the currency. This is the

> historic curriculum trap, of constructing a curriculum well matched to clients and contexts, only simultaneously to disadvantage those who follow it because of its specificity and, often, reduced status (Layton, 1986, p. 22).

This reminds me of the creation of vocational and community schools in the region as an alternative for the not-so-able pupils, and the fate they have suffered because many parents are reluctant to send their children to these 'low-status' schools.

Despite these dilemmas, it is important for curriculum planners in science education to be sensitive to the cultural and community contexts in which the curricula operate. There is also much to be learned from the large body of research on 'children's science', and this should be an integral component of teacher education curricula.

The third issue relates to the understanding of the processes of curriculum reform which I mentioned earlier in my presentation. Fullan (1982) and Olson (1982) have identified two issues that are crucial to understanding curriculum change: 1. The work context and the constraints under which teachers work; 2. Achieving a shared meaning of an innovation with teachers. Science teaching, especially in our region, is very demanding when one considers the pressures put on teachers: preparing lessons; setting up activities; working with inadequate resources; and coaching for examinations and producing 'good' results. Given these constraints, and the absence of any incentives for extra effort, most teachers look at the costs and benefits of an innovation as it affects them. In this situation, one can sympathise with the teachers if the immediate day-to-day problems that confront them take precedence over other curriculum issues, however important. For an innovation to be successful, the people involved must understand the work context of teachers and the capacity of the context to adopt the change.

The other related issue is that of sharing the meaning and philosophy of an innovation with the very people who are required to implement

it in classrooms. Unless teachers are convinced that the change is for the better, they are reluctant to take the risk. Forcing teachers to adopt the change will result in the teaching of the new curriculum in old ways, and will result in an 'innovation without change'. There is a very interesting parallel here with what we have learned from research studies on 'children's science'; despite exposure to school science, children tend to hold on to their own explanations of science phenomena, and they can hold two views at the same time--one to satisfy the teacher and the other to satisfy themselves. Abandoning an idea that has been useful and familiar, and embracing an unfamiliar idea is difficult and painful for most people unless the process is handled with sensitivity and a great deal of thought. The advice offered by Marris to curriculum reformers is worth quoting here:

> When those who have the power to manipulate changes act as if they have only to explain, and when their explanations are not at once accepted, shrug off opposition as ignorance or prejudice, they express a profound contempt for the meaning of lives other than their own. For the reformers have already assimilated these changes to their purposes, and worked out a reformulation which makes sense to them, perhaps through months or years of analysis and debate. If they deny others the chance to do the same, they treat them as puppets dangling by the threads of their own conceptions (Marris, 1975, p. 166).

To summarise what I have said so far, for an innovation to take root, deliberate efforts must be made to involve teachers in all stages of the process, complemented by well planned on-going in-service workshops with provision for two-way dialogue and feedback. This is especially important in our region where we are traditionally used to the top-down approach.

Reforms in science education require the efforts of many--efforts at the individual level, school level, national level and at the regional level. We also need the support of regional and international funding

agencies and educational organisations. On our part, I am happy to report that the restructured BEd (Secondary) programme we made available at the USP in 1994 has been a great success. You might be pleased to note that the majority of students in this programme are majoring in science subjects. Based on responses from the region, and our own view that we need better teachers in primary schools, we are also developing a BEd (primary) programme especially for in-service teachers.

It is also appropriate at this juncture to place on record the contributions made by the Institute of Education (IOE) over a number of years throughout our region. The Institute continues to be active in the professional development of educators through various consultancies, workshops and seminars, and publications. Three recent activities completed under the auspices of the IOE are worth mentioning here: 1.Commonwealth Secretariat Regional Workshop to develop monographs for training trainers in science and technology education, held at the USP from 29 April-4 May 1996; 2. USP-UNESCO Regional Workshop on Innovations in Mathematics, Science and Technology Education, held at the USP from 9-12 December 1996; 3. Teacher In-Service Training Course held at the USP Sub-Centre, Santo, Vanuatu from 6-31 January 1997.

Based on the survey of science teaching (Pillai et al., 1991) in the region, the USP has established science and computer laboratories in most USP Centres so that students and teachers in the region can pursue some USP science courses in their own countries. Many science staff at the USP are also active in promoting science in schools through workshops and competitions organised under the auspices of the South Pacific Physics Society and the Chemical Society of the South Pacific. I am happy to report that this very week, as part of the Inter-Congress, we have brought in twenty two teachers from the region for a physics workshop, thanks to the generous assistance given by the Canada Fund.

We are also encouraged by students wanting to pursue postgraduate studies and research at the USP in the field of science education. We

need to know more about the status of science teaching and learning in our region, and study issues such as the role of laboratory work in learning science, language and the learner, and cultural and community contexts in science education. The documented results of such local and regional studies should be of great value to curriculum planners, teacher educators and science teachers.

With the strengthening of existing institutions, and the creation of new institutions in some countries of the region, we are also seeing improvements in the quality of and access to higher education. The establishment of the National University of Samoa (NUS), the proposed restructuring of the Solomon Islands College of Higher Education (SICHE) and the planned upgrading of the Teachers' College in Vanuatu, are some examples of these developments.

All these initiatives, collectively, should pave the way for developing human resources in the region through better science teaching and learning in our schools and colleges in the years to come.

A further point is worth mentioning at this juncture: In our discussions during the writing of the SEPS documents for funding, the working group saw the preparation of teachers as the priority area in science education, especially at the primary level. Teacher education and support were seen as crucial in bringing about improvements in school science. This is especially so when today's science teachers have to cope with a number of controversial and contemporary topics in science. The need to build in appropriate incentives and rewards to recognise and retain good science teachers was also recognised. I strongly believe that we must also learn to stand on our own feet and make more use of the expertise available in the region instead of looking outside for assistance at every opportunity.

In conclusion, science teacher educators and policy-makers in the region have an important role to play in designing and implementing both pre-service and in-service programmes that will produce teachers who are better educated, who are confident in handling science lessons, who can go beyond the textbook and the teacher's guide,

and who can motivate their students.

Charles Beeby, a well known New Zealand educator, once remarked that to be an optimist in matters related to education, one must either be very young or very old; the young have yet to experience the frustrations, and the old have seen it all and have grown to be patient. We all seem to fall somewhere in the middle of the scale but I am optimistic about the future.

References

APEID (Asian Programme of Educational Innovation for Development). 1983. *Science for All; Report of a Regional Meeting, Bangkok, 1983.* Bangkok, Unesco Regional Office for Education in Asia and the Pacific.

Faure, E. et al. 1972. *Learning to Be.* Paris/London, Unesco/Harrap.
FULLAN, M. 1982. *The meaning of educational change.* Toronto, Ontario Institute of Educational Studies Press.

Fullan, M. 1982 The meaning of educational change. Toronto, Ontario Institute for Studies in Education Press.

King, K. 1983. Technology, Education and Employment for Development. Report of a Technical Workshop on Science, Technology and Education Research in East and Central Africa. Nairobi.

Layton, D. 1986. Innovators' dilemmas: recontextualizing science and technology education. In: *Innovations in science and technology education, vol. I* (pp. 9-28), D Layton (Ed), Paris, Unesco.

Marris, P. 1975. *Loss and change.* New York, Anchor Press/ Doubleday.

Muralidhar, S. 1979. *An exploratory study of a science curriculum in action: Basic Science in Fiji.* Unpublished PhD thesis, Monash University, Melbourne.

Olson, J. (Ed.) 1982. *Innovation in the science curriculum.* London, Croom Helm.

Pillai, G., Bonato, J., Muralidhar, S., & Wah. R. 1991. *Survey of science teaching in the USP region through distance mode.* Suva, The University of the South Pacific.

Science Council of Canada. 1984. *Report 36. Science for Every Student.* Ottawa, Ontario, Canadian Government Printing Centre.

Silberman, C. E. 1970. *Crisis in the Classroom.* New York, Random House.

UNESCO. 1983. *Science and Technology and National Development.* Paris, Unesco.