GENERAL REPORT: SCIENCE, TECHNOLOGY AND EDUCATION

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It would be presumptious of me to attemt to summarise in one brief paper, the plenary speeches, commission reports, an account of the proceedings of the Dutch Speaking Society's panel meeting ang the pre-conference publications based on the clear analysis provided by the host society and the CESE committee. All of these features facilitated informal discussion at one of the best prepared conferences I have attended.

Consequently I shall reflect selectively on what I have read and heard this week in the light of the analysis provided and in terms of my own approach to comparative education research.

Since Guy Neave referred to cycles of societal change in his paper and since L Cerych listed some of the lessons to be learned from comparative research in the field I make no apology for referring to the 1954 Year Book of Education - which was my introduction to substantive Comparative Education research - prepared under the inspiration of Robert King Hall of Teachers College, Columbia in collaboration with the University of London Institute of Education. This Year Book - a pioneer in the field - dealt in comparative perspective with relationships between technological development and education.

From it we learned several lessons some which have been stressed from time to time during the week. Some new lessons were mentioned by Cerych. The most important of all these lessons is that relationships of the kind we set out to examine are extremely complex. I conclude, therefore, that if we are to make progress there is need for a clearly articulated method of research. Theory of Social Change.

In view of the complexity of the relationships between aspects of society and to analyse the problems created by technological innovation, a theory of social change is needed which provides a way of classifying features of most if not all, societies. Most of the nineteenth and twentieth century theorists - and the point was made by Cerych - stressed that in the face of technological changes some, or a majority of, people have difficulty in adjusting mentally - in terms of attitudes, knowledge and behaviour - to institutional changes. A theory is needed, as

Neave mentioned, to identify both change and continuity in societies. There are several classical theories from which to choose. Marx, Ogburn and Mannheim among others classified societies in ways which make it possible to identify scientific, technological and institutional changes and which point to the slowness with which a majority of people adjust to such innovations.

Theories, however, should not be taken as representing the real world or to stereotype individuals. As Margaret Sutherland pointed out, it would be unwise to assert that all teachers are attitudinally incapable of responding to the introduction of computers into school classrooms. It is also less than useful to generalise about new technologies as though their impact is bound to be the same under all circumstances. Or that all innovations are likely to be equally well received or equally strongly resisted in all societies. Each technological innovation should be treated as unique and its consequences examined in detail and in a number of different nation states - if in Comparative Education we are going to continue to make national systems the basis of comparisons.

To illustrate this point Plomp, for example, reeled off a host of new technological artefacts based to be sure on the invention of semi conductors.

> "... computers, cable systems (satellite communication digital telephone networks, broadcast technologies), storage technology (silicon chips, floppy disks and hard disks) video technology and video disks and information services (e.g. videote systems, information networks electronic conferencing) as though each of them were similar in terms of their acceptability wide use and impact.

Though far more demanding in terms of research, it is highly desirable to select for analysis a specific innovation - historical examples migth be the wheel, the plough, the printing press, the steam engine and the internal combustion engine - and work out how and against what resistance it was introduced and what were its societal effects - politically, economically and educationally. Perhaps a simple example will illustrate the point. In many countries the sale of home micro computers with software games is phenomenal. Millions of children - of all ages - play these games to fill their leisure. From which social class or nation the majority come depends on the cost of the computer, the availability of supplies and so on. It seems unlikely, however, that the use of home computers to play games is restricted by serious doubts about whether they are desirable, although it would be unwise to

assume that they are universally approved of. On the other hand, attitudes to the use of similar computers for educational purposes may vary quite considerably. Their use in US schools preceded by several years the introduction of them into virtually every primary school in England and Wales. The willingness of teachers to use them, the desire of pupils to learn from them clearly varies greatly. Moreover the ability of teachers to use them effectively and the ability of pupils to learn as a result of CAL is probably even more variable. They are not a universally accepted panacea.

A comparative dimension reveals the dangers of generalising about the introduction and efficacy of similar hardware and software into different nations. The technological innovation and the problems it creates may be common - and consequently the starting point of a comparative analysis - but the outcomes are likely to be very different and will depend upon particular national circumstances. Among these circumstances according to Dore are national pride and consciousness for which schools have some responsibility and which mobilises responses to development. He writes:

> "A nation's schools have a lot to do, in the first place, with the level of national consciousness and cohesion which is an important factor determining the ability of the State to mobilise the resources necessary for the drive to catch up."

On the other hand as Wolfgang Mitter pointed out in his introductory remarks that the undesired effects of a desired innovation are not always recognised before the event and to anticipate these unwanted consequences comparative educationists have a role to play.

Problem identification

Having stated that a theory of social change is needed to identify the problems arising from technological innovation and having warned against generalising about innovations and the reaction of individuals to them, I now propose to make some methological generalisations which may not be accepted, but will not be subjected either to empirical verification or empirical refutation. They are intended to provide a framework within which coherence can be given to the many comments made and arguments advanced during the course of the week.

1. It seems reasonable to assume that through the work of scientists and engineers, relationships exist between scientific generalisations and technological innovations - namely through inventions. Any unilateral causal relationship between the two is problematical. After all it is likely that a simple crowbar was used

before the principles of the lever were articulated. It may further be assumed that is is through social institutions that inventions have an impact on individuals in society at large. For example the steam engine is based on scientific principles relating to heat transfer and the relationships between the force and the pressure and volume of a gas or vapour. Technologists invented steam power driven machinery and other individuals created factory and railways systems which directly influenced the lives of a very large number of individuals.

2. Some inventions and their further development have a direct impact through institutions on the life of individuals. Other inventions do not. For example through the banking system technological innovations have made it possible for individuals to cash cheques far more quickly than before. Similarly the speed with which travel agents and airline staff can check on the availability of seats on a particular flight has been greatly increased as a result of the introduction of computers. The impact of other innovations on individuals is less direct; for example unless it is dropped, the influence of the H bomb is indirect and mediated through political systems. Since Hiroshima direct contact with the preparation, testing and the results of dropping an H bomb has been limited to a small number of scientists and technologists, and a tiny number of unfortunate Japanese fishermen.

3. Time intervals between the statement of a scientific principle and its realisation in an invention and in an institution vary. Newton's Laws made it possible eventually for men more than two hundred years later to reach the moon - a universally acknowledged achievement. The internal combustion engine was based on Carnot's cycle. Decades later travel in automobiles and jet aircraft is now accepted virtually everywhere by everyone. Yet many urban dwellers now campaign against the unanticipated and unwanted effects of exhaust fumes on the atmosphere.

4. Since these relationships should not be regarded as deterministic there is no necessary sequences of events. In solving one problem - how to get from A to B more quickly - human beings create other problems - for example atmospheric pollution. Assumed relationships should therefore be seen as providing a framework within which problems and solutions to them can be analysed.

5. Into these equations, relationships between aspects of an educational system and scientific discoveries and technological inventions can be assumed. They allow us to examine the

problems technological innovation creates for educationists and the extent to which educational solutions to societal problems can succeed.

On the role of education in the promotion of technological innovation and implicity societal development there was no consensus. For example W. Hörner denounced the imperialism of the scientifid disciplines as "in France one denounces the imperialism of mathematics". On the other hand, Huang Shiqi writes:

> "very ridiculous follies were committed in this period (1966-76) - for example physics was taught in connection with the functioning of tractors, diesles, electric motors and water pumps at the cost of the systematic elucidation of priniples; - at a time when educators all over the world were concerned with up dating science education in schools".

Yet at present in the USA, certainly in the forefront of technological innovation, Wasser provided figures which show how the balance there has shifted from liberal academic studies to instrumental studies.

HE Students in HE	1964	1977
Academic Discipline	48.4%	42.1%
Instrumental knowledge	51.6%	57.9%

Of the instrumental studies a growing number deal with computer science. Indeed indigenous systems of vocational training are often seen as the answer to desirable and and rapid 'modernisation'.

Dore however raised important questions about relationships between scientific discoveries, technological inventions and institutional innovations.

Inventions and institution may be transferred in ways which make it possible for 'late developers' to jump a stage in the translation of general scientific principles into societal institutions. Fundamental to the success of this process is that individuals in the host country learn how to run these institutions without incurring undesired consequences. Lack of knowledge make some of the unwanted outcomes of technological innovation unavoidable.

Take for example the H bomb and its societal consequences. They certainly give strength to Donnie Lawrence's belief, quoting Douglas Sloan that peace and war issues must become the crux of all education. It is time, he argues for university dialogue to initiate the universities toward their key role of achieving

peaceful aims in a world of rapid communications and transactions. Thus, methodologically technological innovation can be regarded either as a solution to perceived problems or as problem creating. Most educationists see their role as that of helping to solve rather than create societal problems.

Technological innovation as a solution

The analyses made in the 1954 (World) Year Book of Education were based on the then widely shared assumption that technological development was a, if no the, solution to a wide range of societal problems particularly those found in pre-industrialised societies and colonial territories. Many of these problems had been created by heightened expectations which were difficult to satisfy. In particular aspirations had been raised by the United Nations Declaration which laid down that everyone had the right to work and the right to education. The UNESCO Charter resolved doubts about the role of education by stating that is could ensure peace and rise in standards of living. These aspirations found expression in demands from colonial territories for independence (many of which were soon to be granted). Given the economy of many of these territories political independence did not guarantee educational or economic independence.

Post 1945 national circumstances influenced the outcomes of policies designed to promote economic growth. In many industrialised countries, particularly those of Europe and Japan first priority was given to the tasks of reconstruction. The differential rates at which recovery took place in these countries illustrate Dore's thesis that it is possible for a nation - which has pride in itself - to leapfrog other nations. Under post war circumstances impoverished nations and those facing economic reconstruction after a damaging war needed help from the USA. The Federal Republic of Germany and Japan received it. Britain's colonial territories were granted substantial aid. The USSR refused aid from capitalist countries in the form of either capital or technical assistants. Political motives influenced the extent to which rapid development was purchased at the cost of dependency. Levels of education influenced success.

Aid in the form of capital succeeded in Europe and Japan because skilled human resources were available. Successfully to transfer technology into countries where industries were poorly developed demanded (see Dore) technical assistants at one level or another and in sufficient numbers to keep the new technology working. For many years the Americans ran the oil industry in Saudi Arabia while training local personnel to do some of the jobs needed.

In the less industrialised world the speed with which policies were formulated and adopted by host countries also varied. In the process of formulating policy the recipients may be suspicious of the donors' intentions; as for the adoption of policy, opinion in the host country may be divided regarding modernisation and its effects on the possibilities of maintaining or establishing national identity and authenticity. Several references were made to this dilemma in the papers of M. Benachour, F. Mina, Mrs. Shauoam and, of course, Dore who warned that in rejecting dependency nations migth find it harder and slower to catch up. Nevertheless as Hauoam points out:

> "At the same time there was need to embark on the swiftly moving train of modernisation sweeping the world, an important condition of recognition and acceptance in a fast changing and developing world".

The dilemma for the newly indepentdent independent nations was acute. On the one hand, as Plomp made clear, that "mainly because of economic arguments such as competition, cost effectiveness and pressure from the computer and communication industry business and industry are demonstrating a 'natural affection' toward NT and its applications".

However, the transfer and implementation of new technologies without being dependent on foreign personnel depends not only on the attitudinal and behavioural changes but on the development of an adequate educational system. According to Huang Shiqi:

> "A much discussed theme in Chinese educational circles is how to carry out educational reform in the light of the nation's drive for modernization and how to make education oriented to the needs of the future and the nurture of globally minded citizens."

Thus there was, and is, a widespread desire on the part of people's everywhere to use new technologies (whether indigenous or 'borrowed') to modernise with all speed and to gear education to further this end. Implicitly such a process means the acceptance of new technology and a high tech model outlined by T. Cerdeira. But, he asks, should education be expected to respond to the technological demands of a high tech society? Cerdeira, claims with Mina, that education should not be expected to respond to the new technology but should influence the direction taken by processes of change. This view articulates very well the unwillingness of some educators to go along uncritically with the application of new technologies because they raise social and political problems. It does not respresent simple conservatism but a reasoned rejection of many features of modernising societies, and suggests that new technologies create as many problems as they solve.

Technology as problem creating

Cerdeira and others see new technologies as problem creating rather than as problem solving. In many developing countries choice of policy has itself created problems. In India Gandhi favoured a policy of rural development while Nehru wished to advance India economically through industrialisation. It is difficult to point without hesitation to a country which without an industrial infrastructure has made a great success of the application of new technologies in agriculture. Indeed in the 1954 Yearbook of Education many examples were given of the failure of Western experts to improve the economies of dependent nations through the introduction of so called 'modern' farming equipment and methods. The British groundnut and the poultry farm schemes in Taganyika and Gambia were disastrous failures. Attempts to clear the bush in Nigeria to provide more land for farmers were equally unsuccessful. 'Modern' methods of farming in India required a chemical industry capable of manufacturing artificial manures in quantities beyond the capacity of India's industries. 'Modern' farming has thrived, noticeably in Denmark during the nineteenth century, where there already exists a well established educational system. The same can be said of the USA and Canada where fast ripening corn has been successfully introduced; and of New Zealand where the production of lamb for the European market was encouraged by the introduction of refrigerated ships.

On the whole farming communities either successfully resist the introduction of new technology or find that without an industrial infrastructure and a well developed formal system of education the introduction of new machines, methods of intensive crop raising, new plants and the like raise problems which have rarely been solved. The problems created by these innovations have been and are still all too obvious.

One reason for these failures as Dore reminded us is the unwillingness of Third World countries to accept from donors anything less than the latest and the best kinds of technology. In some cases, it is necessary. For example in the oil rich nations the most advanced technology is needed if development is to take place. Even so success is not inevitable. The OPEC nations have succeeded in a way that perhaps has eluded Nigeria. On the other hand late starters in the process of industrial development have overtaken pioneers like Britain and even to some extent Germany. Japan and Korea are examples of such late starters.

The problems created by the successful introduction of new technologies in these countries are less obvious than in agricultural countries. It should be noted however that rapid industrial growth may well lead to political instability. The

economic success achieved by the Japanese after 1868 may have been the forerunner of the ultra militarism of the 1930's. Economic recovery in the pre world war II Germany may have been promoted by and contributed to the rise of Hitler. It is hard to say - but the political problems arising from the application of new technologies in industry should not be overlooked.
Other problems are all too evident. Against the commitment that everyone has the rigth to work, levels of unemployment in the industrialised countries are now unacceptably high. At the same time there may be available jobs which cannot be filled because they require highly skilled personnel. The aspirations of women, partly promoted by their introduction into industry in times of war, have changed. They wish to enjoy the same right to work as men. As Sutherland points out however the opportunities enjoyed by women are more restricted than for men in spite of programmes devised in Greece for example, to initiate "women into jobs traditionally reserved for men" and in the Netherlands to "encourage girls to take training courses that have traditionally been a male reserve". With many men out of work the position of women is made more serious than it might otherwise have been.
Enough was said during the conference to confirm that while there is no agreement on the desirability of pressing ahead with technological innovations regardless of their consequences it was clearly recognised that in spite of reservations the introduction of new information technology, in its many forms had created an information society. As W. Decoo pointed out in a spirited defence of them, teachers, had helped to create the information society as the result of the role of education in a dynamic relationship. If this is the case then changes in educational systems too can be seen as problem creating. In any case, it is certainly true that during the conference considerable attention was paid to the implications for educational systems of new information technology and the information society. Again the range of the discussions, in spite of the admirable framework provided by the Dutch Speaking Society, is too great for me to do justice to it. Consequently I propose, again selectively, to place frequently conflicting comments about education, schools and teachers within the taxonomy accepted by the International Bureau of Education.

Aims and Objectives

Certainly the information society has created problems educators are expected to solve. Most people probably agreed with Joseph Katz when he commented that in the information society everybody was overwhelmed by the mass of information available and the power of the media to deliver and disseminate it. At the same time