2.3 Science, Technology and Development: Lessons of the Last 30 Years

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The new decade is an appropriate time for reflecting on the lessons of the past and fc looking at possible future trends. There seems to be a new optimism about the potential of science and technology, and of new advances in these fields. This is reflected in the World Bank's report on Africa, and in the House of Lords report on science aid. It is some 30 years since a similar enthusiasm was apparent and it is therefore relevant to consider the lessons which have been learned over this period.

Some Science and Technology Policy Issues with Implications for Development

1. Sources of New Technology and Methods of Acquisition

Should new technology be made or bought (ie. endogenous or imported)? The history of technology acquisition over the past 100 years indicates a heavy emphasis on imported technology.

Decade of the 60s: The 1963 UNCSAT conference typified the attitudes to this issue prevalent during the early 1960s. This was largely a 'supermarket' approach, with the technology of developed countries displayed for purchase by developing countries. Later in the decade it was apparent that there were problems with this approach: the available technology was often not appropriate to the conditions of developing countries, and costs were not affordable; restrictive practices associated with licensing agreements made costs higher than necessary and often prohibited the export of goods manufactured. The developing country policy response to this was, in the main, defensive.

Decade of the 70s: Developing countries experienced static or declining productivity in relation to the same technologies used in the West, for instance in the production of textiles, copper and chemical fertilisers. This implied a need to reimport technology in order to stay competitive. One policy response was for developing countries to develop the skills needed to change and improve technology, in some cases (such as South Korea and Taiwan) very successfully; this could be described as a 'boomerang' effect.

Decade of the 80s: Marked by a decline in the flows of technology from developed to developing countries, owing to debt crises and shortage of foreign exchange, and to an unwillingness to transfer technology to newly industrialised countries.

The experience of the past 30 years has shown that technology transfer is an issue of critical importance and that there is a need for local technical capability to absorb new technology.

2. The Nature of Science and Technology Activities

This has been an area of much confusion. What capabilities are required, and in what order of priority? There is now a reasonably good consensus that the following capabilities are necessary.

(a) Capacity to make decisions, aided by technology assessment capability;

(b) Capacity to use technology and to operate machinery;

(c) Capacity to change technology, to diffuse and utilise it; in other words, the capacity to innovate. This implies research and development, design and creative engineers, and a skilled workforce;

(d) The availability, not just of isolated skills, but of an integrated system;

(e) An environment conducive to innovation. This implies supportive government policies, suitable rewards within enterprises and widespread education in science, including problem-solving techniques.

In the past there has been too much emphasis on research and development. Only 5-10% of qualified scientists and engineers (QSE) are engaged in research and development in the advanced countries (the rest are in teaching, training and production), yet most aid programmes have concentrated on this dimension with the result that in many developing countries, 10-15% of QSE are engaged in R and D.

3. Location of Science and Technology Activities

In the 1950s and 1960s those models of the organisation of science which were transferred to the developing countries were built on what appeared to be essential institutions in communist and capitalist countries. In communist countries, for example China and Cuba, research was based in academies of science, together with a little research in universities. In capitalist countries, activities were based on such institutions as: industrial research organisations, eg. Battelle or CSIRO; universities and agricultural colleges; science and technology information systems; standards organisations; and science councils, etc. However, adherence to this model meant that what was not transferred was that part of the science and technology system which is based within enterprises. This is, in fact, the part of the system which is critical for economic and social development. Most of the activities taking place elsewhere are trappings which support the technical change activities within firms. In the USA and Japan, for instance, most research and development is carried out by firms. Most of the incremental technical change occurs there, as does a vast amount of training.

As we enter the 1990s, it is time to redress the balance within the science and technology system. Government incentives, and more efforts in foreign investment projects, could contribute to this end.

4. **Nature of Technical Change: Radical or Incremental?**

There is a tendency to place too great an emphasis on radical breakthroughs, as opposed to step by step incremental improvements. This is the case not only in traditional industries such as tanning, but appears to be equally important in the oil and aircraft industries. This has human resource implications in relation to the balance between the concentrated efforts needed for a few radical breakthroughs, and the creative engineering skills necessary to introduce incremental changes.

5. **'A Policy for Science and Technology' versus 'Science and Technology Within a Policy'**

One needs to consider both (a) the health of the science and technology system and (b) the utilisation of that system in achieving economic and social goals. There are both supply side policies - the supply and dissemination of knowledge - and demand side policies - the way in which science and technology is blended with other inputs (eg. capital, labour, education) to reach development objectives. Science councils have frequently been charged with both supply and demand and have had little impact other than oversupply. On the other hand, those government departments responsible for sector policies may have little understanding of technology issues, and this equates with an absence of demand. Many governments have been inclined to include science and technology almost as an afterthought to their policies, but there has recently been increasing recognition of the need to develop policies specifically for science and technology.

There are many other issues which need to be addressed, but these five have been selected for two main reasons. Firstly, there are still many misconceptions, and knowledge and understanding on these points is not widely disseminated. Secondly, each of the above points has implications for human resources development.

China Case Study

Some of these points are illustrated by a recently completed joint study undertaken by SPRU and the Chinese National Research Centre for Science and Technology for Development (NRCSTD) (1).

In the early 1980s, China opened its doors to foreign companies for joint venture offshore oil exploration. China wanted rapid development in this area, and the joint venture agreements included a technology transfer clause. After the first two years it appeared that things were not going as well as expected. The SPRU/NRCSTD joint study was therefore welcomed, and extensive interviews were conducted with both Chinese and foreign participants. A number of reasons for the difficulties were discovered.

Secondary reasons included communications (language differences, differing educational backgrounds, disparate management attitudes), views on training (the Chinese participants considered the training offered to be too elementary and were sceptical about on the job training for roles such as drilling supervisor) and the views of the foreign oil companies on lack of Chinese strategy, and lack of Chinese resources to absorb what was on offer. The primary reason, however, was a disparity of view about what was meant by technology transfer. The oil companies considered that this implied teaching the Chinese to do tomorrow what the companies were doing today or, in other words, transferring know-how. The Chinese, however, wanted to master the available technology and gain access to proprietary technology. In other words, they wanted both know-how and know-why to be incorporated in their own body of knowledge. This caused problems because the know-why resided at the oil companies' headquarters with their research and development and special engineering departments. There was also a difference of approach to the question of technology transfer between the staff at headquarters and the operating company staff.

This case study illustrates a number of points: technology transfer is a complex process and requires substantial effort on the part of both supplier and recipient; the importance of incremental technical change; and the need for new approaches to training.

Trends Influencing the Future Ability of Developing Countries to use Science and Technology

Some of these trends are not obviously caused by science and technology, but will influence science and technology policies.

1. Debt

Shortage of foreign exchange limits the ability to import technology. Debt also means there is a lack of resources for research.

2. Global Environmental Issues

Acid rain, CO_2 emissions, possible global warming, and deterioration of the ozone layer are all matters of current public concern. Political pressure for new technologies which can contribute to sustainable development may lead to new funds being made available for development.

3. New Approaches to Knowledge Generation

These include: UN/industry collaboration; international collaboration in precompetitive research, such as the EC Framework programme; inter-firm collaborations and strategic alliances in the areas of research, design, production and marketing; and globalisation of technology. Will the Third World be included or excluded from these developments?

4. **Science-based Technologies**

Information technology, biotechnology and new materials offer both threats and opportunities for the Third World. They have many characteristics intrinsically of benefit to developing countries, including possibilities for flexible manufacturing, small scale operations and energy efficiency. Information technology may provide substantial opportunities for education, and biotechnology for health, agriculture and mining. Potential threats include: lack of access to technology; in the case of biotechnology, privatised agricultural research, and the possible threat to important export crops, such as vanilla in Madagascar; and, in the case of new materials, threats to commodity exports.

5. **Democratisation of Eastern Europe**

Will this lead to more resources becoming available for development, or less? The possibility is that foreign investment may be directed more towards Eastern Europe, and there may therefore be less available for developing countries.

Each trend poses threats and new opportunities for those in the Third World who are responsible for using science and technology for development. It will be those countries which can recognise the threats and opportunities and which have a capacity for rapid learning and an ability to embrace innovation which will cope best with the surprises and opportunities of the next decade. This implies a major investment in human resources for building endogenous science and technology capabilities and innovative skills.

References

1. For further details see C H G Oldham, A Warhurst, Lao Yuan Yu and Zhang Xiaobin, Technology Transfer to the Chinese Offshore Oil Industry, SPRU Occasional Paper No. 27, SPRU, University of Sussex, November 1987.

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