

# 1 Education, Technology and Development Revisited

## A Review of the Links

There is an important three-way link between education, technology and development that is becoming critical in an age of globalisation. Technology has always been a major driving force in the development of nations. At the same time the direction and pace of technological progress have been greatly influenced by the development goals and policies that constitute every nation's vision for the future. The link between technology and development is widely understood and has long been a feature of policy-making and strategic planning in most countries. There are very few countries in which development goals and policies do not embrace some strategy or direction for technological progress, or for the application of technology to achieve set objectives. In the same way, policies and strategies in the areas of science and technology are usually anchored in a vision of development for the society. This is clearly illustrated in the country papers for 13CCEM, extracts of which are reproduced here.

The necessary link between technology and development is widely perceived as education, which has long been acknowledged as an important source of the kind of knowledge-making that underpins progress in science and technology. For some nations it was important to be at the cutting edge of technological development in order to retain competitive advantage in the fields of socio-economic and cultural development, or to assert a military superiority that would safeguard their society. For others the main challenge was to ensure that they were in a strong position

*'Any type of development without the help of science and technology is not possible.*

*It is therefore essential to provide high national priority to scientific and technological considerations in the overall development strategy of the country.'*

*(Bangladesh Country Paper)*

to make systematic use of existing technology to increase economic productivity and improve the quality of life for their population. For another group of nations the top priority was how best to take advantage of the new opportunities offered by technology, to assist their rapid transformation into modern, newly industrialised societies. Yet other nations were concerned with the challenge of using technology to combat deep and persistent under-development in their societies, or to catch up in a perceived development

*'The basic objectives of the Technology Policy are the development of indigenous technology and efficient absorption and adaptation of imported technology to national priorities and resources.'*

*(India Country Paper)*

*'The broad objective of the Government is to increase the role of science and technology in the attainment of economic and social development, by bringing about social transformation ... and improving the quality of life.'*

*(Jamaica Country Paper)*

race. Despite such a diverse range of priorities and areas of concern, nations typically turned to their education systems to help prepare the specialist manpower and produce the kind of knowledge that would harness technology to their development goals and priorities. Their national policies and strategies clearly sought to link educational goals and objectives to those of technology and development.

Later on, it became increasingly evident that while the build-up of specialist manpower may be necessary for some aspects of development, it does not in itself

*'national aspiration for development reflects the need to increase substantially the national stocks of technicians, engineers, technologists and scientists' (Pakistan Country Paper)*

provide an adequate platform for achieving meaningful and balanced development. The need to prepare non-specialists for a society dominated by technology, and the need to keep technology within manageable social and political boundaries, helped to broaden nations' concern with linking education to technology and development. Thus, in addition to educating technology specialists, it became important to educate policy-makers and the general population about technology, and to do so in a manner that would prepare them to cope with various social and political roles in a technology-dominated future.

Technology increasingly came to be regarded as an integral part of general education. Major initiatives were taken to diversify general education systems and incorporate relevant aspects of technology in the education provided for all learners in the system.

The emphasis was on using education to serve the goals and objectives of technology and development. Education was expected to prepare a cadre of specialists in technology, as well as to produce a technologically enlightened citizenry. There was only a weak link and some token concern with using technology to serve educational goals and objectives. This was mainly confined to a rather moribund field known as 'educational technology'.

It is important to appreciate that the current arguments for investing in technology for education are very different from those used in the past to make a case for the field of educational technology. The old rationale was largely about improved pedagogy and so focused mainly on teaching and learning aids. In contrast, the new rationale for investing in technology for education is much wider and deals with more fundamental and complex issues. This makes it imperative for all governments to act more systematically in addressing the issue of policies and strategies for investment in technology related to education and development. We live in a new age and we need to take a new approach to dealing with these issues as we tackle the major challenges facing us in education and development.

We are experiencing a steady progression from a purely technological age to what has been termed the 'information and knowledge' age. The key technological developments of the recent past are not predominantly about economic productivity, but more to do with innovative ways of producing, storing, transmitting, accessing and using knowledge and information. It is generally acknowledged that these developments are the direct result of the very rapid and revolutionary advances in information communication technologies (ICT) of the past two decades. A recent phenomenon is the steady decline in value of most manufactured goods and physical assets as automation has peaked and economic valuation has altered quite radically in favour of knowledge-based services.

Nations now gain a competitive edge through their capacity to innovate and stay ahead of developments that pertain to information and communication technologies. In many ways information and knowledge have become the new gold standards that deter-

mine prosperity and security. Thus the most important assets of nations are not raw materials, physical goods or economic production, but human resources keyed into the information and knowledge revolution. Increasingly, the competitiveness and prosperity of nations are critically dependent on the level of education and training of their population, and particularly their capacity to cope with, and take advantage of, the continuous explosion in knowledge and information that is readily accessible through the new technologies. A key implication of these changes is that the role of education and training in development has become more critical than ever before. There is a new and fundamental sense in which *education is development!*

As societies progress from a purely technological age to the new age of globalisation, the most important need is for technology to serve education and development goals. Knowledge and information are the new forms of wealth and hold the key as the driving force for the development of individuals, communities and nations. The main challenge therefore is how to ensure that the population in general can have access to the means of developing the necessary skills to cope with and function effectively in the new age of information and knowledge. These 'how to' questions are typically about technology. The challenge is to use technology to facilitate the education and training of the population for the new age of globalisation.

Essentially this provides the strongest linkage for education in the three-way link that binds education, technology and development. This is a vital argument and represents the strongest rationale for investing in technology for education. It is a deep and systemic argument that ties investment in technology not only with progress in education, but (more importantly) with the development process itself. It represents the key strand in a reciprocal link through which education, technology and development can become mutually reinforcing within a dynamic framework for progress. It also represents what is increasingly seen as a fundamental human right for every citizen to have access to the means of connecting with the forces that shape their life-chances in a global era. This in a sense equates education with empowerment for development.

## Why Invest in Technology for Education?

Some nations may decide to invest in technology for education for the 'glitz factor': The technology is there; it is fashionable to have the latest and the best, and it gives a sense of progress to use state-of-the-art technology. This can be described as the 'technology for its own sake' rationale. Other nations may base their investment decisions on the genuine case for improving the efficiency of their education systems or for some other benefits intrinsic to education. For instance, data bases and computerised records in education systems have clear advantages and benefits. This is the 'technology for educational benefits' rationale. A third rationale may be external to education and concerned with developing skills for the labour market. Each of these three rationales can be a valid basis for making decisions about investment in technology for education, but none is sufficient to provide an imperative for nations to make such investments in a systematic and sustained manner.

In contrast, the three-way link gives a necessary and sufficient rationale that makes it imperative for nations to invest in technology for education if they are serious about

national development in the new era of globalisation. As the process of globalisation advances and reaches the farthest corners of human settlement, individuals and communities will become more assertive about their right to have access to the means of survival in the new dispensation. It will no longer be a matter of whether they should have access to the kind of education that empowers them for development, but how best to ensure that they do have such access. The use of public and private resources to facilitate such access will invariably raise issues of equity and social cohesion as well as efficiency and cost effectiveness. Technology will play a major role in the way countries deal with these and other emerging challenges. It will therefore require sound policies and pragmatic strategies to ensure the best investment decisions.

Such decisions have far-reaching consequences for individual and community development, as well as for social cohesion, economic competitiveness and the social progress of nations. Against this background, it is clear that decisions about investing in technology for education are not simply a matter for education policy-makers and officials.

## The Basics of Technology and Development

Technology may be defined in simple terms as ‘a means of doing or making things and acting on our world’. In this sense it is an important feature that distinguishes humans from most other animals. It is also a major characteristic that reflects the level of development of one society or nation in relation to another. Hence when we rank countries in terms of development, our judgment is based partly on their level of technological progress. Most countries therefore place great emphasis on technology as a critical factor in their development strategies. Technology helps to determine the level and efficiency of production of goods and services in society. It is therefore one of the most important factors that shape a country’s competitiveness in the global market-place. Technology also has a great influence on the general quality of life in any society through its impact on work and leisure patterns, living conditions and environmental safety. It is therefore a defining feature of contemporary culture. Table 1.1 illustrates the impact of technology on development.

*Table 1.1 The Impact of Technology on Development*

| <i>Development area</i> | <i>Kind of impact</i>                                                                                                             |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| Economic Development    | Improved efficiency in production of goods and services, leading to advantages in areas of trade, investment and wealth creation. |
| Social Development      | Changing patterns of work, relationships and income levels, leading to changes in the distribution of wealth, status and power.   |
| Cultural Development    | Changing settlement patterns, resulting in changes to environment, leisure activities and general quality of life.                |

Technological progress in any country usually depends on policies and strategies put in place by political leaders as well as by professional decision-makers and practitioners in

various fields relating to the production of goods and services. In this regard there are, in theory, at least three broad principles that can be used to guide technological development. First, there is the principle of endogenous development, or 'home-grown' technology, which uses indigenous knowledge, skills and resources to advance the production of goods and services. It is important to appreciate that, in a historical sense, every society has its own indigenous technology that relates very closely to the local culture and environment. These may not be the most advanced or efficient technologies, but they usually give a strong indication of how to improve technology in an appropriate way for that society. It is also important to appreciate that while technological progress in some societies has been largely driven by endogenous efforts, every society has had to borrow from others in the process of technological development. However, this has not produced an open system of exchange where each country can freely borrow and adapt technology from others. Ownership and control of technologies represent a major factor in the relative power and competitiveness of nations in the modern world, and one of the most significant features that divide developing countries from developed ones.

The second principle is wholesale acquisition of technology from outside the country. This involves importing and making direct use of products, processes, techniques and services that have been developed by another country. It is usually the key principle underlying rapid modernisation, in which advanced goods and services are simply purchased and transplanted into a society that has the requisite wealth to afford this approach. For development purposes this principle carries an expectation that technology will take root through the imported products, processes and services. It is one of the main principles that underlie and drive international trade or the exchange of goods and services.

The third principle is that of selective borrowing and adaptation. This involves importing certain strategically selected products, processes, techniques and services, which are then modified or combined in some way for use in the local socio-economic and cultural context. This is a case of grafting useful technologies from outside to what already exists in the society.

It is essential that countries are clear about which major principle or combination of principles they are adopting as part of the strategy for investing in technology that will make a change in education and development. This obviously depends on such factors as the strength and reliability of their indigenous technology; their purchasing power to import external technologies on a substantial scale, and the mix of resources and expertise that can enable them to adapt external technologies to local needs. As stated above, ownership of technologies and the terms governing their exchange constitute a critical divide between developed and developing countries. High emphasis on importing external technologies has implications for increased pace of development as well as for increased dependency on others if these technologies do not take root in the local economy. Conversely, high emphasis on endogenous technological development has implications for slow growth as well as for greater self-reliance. The adaptation of external technologies pre-supposes a certain level of technological capabilities in the local labour pool, which may not exist. Factors such as these are important in making decisions about national strategies for technology and development. Table 1.2 (page 22) summarises the three broad principles used to guide technological development.

Historically, much attention has been given to those aspects of technology that relate to economic productivity. Therefore the landmarks of technological progress tend to be

defined in terms of phenomena such as agrarian reform, industrial revolution, mass production and automation. However, human progress, and the technologies that underpin it, need not be measured purely in terms of economic productivity. Indeed the major landmarks of technological development have also highlighted critical social and cultural changes in society. They have reshaped work-force organisation; changed the labour market, and influenced working relations as well as the work environment. More importantly, major advances in technology have greatly influenced land-use and human settlement patterns. They have also had a major impact on the distribution of wealth and power in society, as well as on family and social life generally. In these and many other respects, it is evident that the impact of technology is holistic and all-pervading. Technology affects all aspects of our lives in very profound ways, as individuals, families, communities, nation-states and even as 'families of nations' such as the Commonwealth. In its broadest sense therefore, technology is development!

*Table 1.2 The Guiding Principles for Technological Development*

| <i>Kind of principle</i>                                                        | <i>Outline of the principle</i>                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Endogenous development                                                          | This is about using and improving on home-grown technology, which is an integral part of the local culture; e.g. India has several centuries of civilisation during which its own traditional technologies have played a major role.             |
| Development through wholesale acquisition of technology from external sources   | Countries that can afford this often depend on the lasting impact from such importation of external technologies; e.g. Brunei is in a position to import external technologies on a massive scale in order to transform the pace of development. |
| Development through selective borrowing and adaptation of external technologies | Where a high level of skills is available locally, a country can embark on selective borrowing and adaptation of technologies most relevant to its requirements.                                                                                 |

## Taking a New Look at Technology and Education

When we explore the use of technology in education from first principles, it seems quite evident that we are concerned mainly with ways of communicating information and knowledge. This raises the issue of language as a means of communication, which is central to the progress of human society. It is through language and communication that we acquire the kind of knowledge and understanding which help us to function as productive members of our communities. These are the tools that enable us to access the centuries of accumulated knowledge that is the heritage of human progress. They hold the key to our ability to generate new knowledge that can be passed on to others and made available to future generations, and they serve as a major comparative indicator of national development. Countries with low levels of literacy, for instance, tend to be relatively under-developed compared with those with high levels of literacy. Even within countries one of the greatest measures of inequality is when segments of the population remain illiterate in the face of sophisticated progress for other population groups.

Therefore, when we explore the use of technology in education, attention should be given to the history of technologies relating to information and communication, and the ways in which they have influenced the development process. It is this dimension of technology, and its implications for education, that is the main focus of this book.

We live in an era of rapid technological change that promises ever-increasing levels of prosperity and growth for some countries, while threatening a greater degree of marginalisation for others. This paradox has become a defining characteristic of nations in a new age of technological ‘haves’ and ‘have-nots’ that is most evident in the area of information and communication. Hence some analysts talk of ‘information rich’ and ‘information poor’ countries as the new divide in the world. To understand the full implications of this situation for education and national development, we need to explore briefly the rise of the new technologies that are related to information and communication in the broadest sense.

For educational purposes, technology is not only about hardware and software, but also, and importantly, about procedures, processes, structures, systems and patterns of use. In educational terms, technology is about means towards certain ends, having largely to do with thought processes, information flows and human communication. To the extent that technology can bring about improvements and advantages in these areas, it can enhance the process of education. It is therefore important to analyse changes in technology in terms of their impact on information flows and human communication, as well as human thought processes.

Language is at the heart of human communication, and is therefore the main vehicle for every form of education. The natural state of language use (the spoken word) has a range of advantages and disadvantages when used on its own, as in face-to-face encounters. For instance, it can be highly interactive and takes place in real time, but it is also time-bound and confined to a specific location. A basic contention of this book is that the history of technological development in the field of information and communication is fundamentally about efforts to overcome these barriers of time and space. It can also be argued that every major technological development has not only brought advantages, but also introduced new problems to contend with.

The invention of writing (and reading) marked the first major advancement in the use of language for information and communication. The capacity to encode thought and ideas in writing made it possible to produce, store, transmit and retrieve knowledge and information in a much more permanent and reliable form than through ‘word of mouth’ and human memory. Thus in the educational process, once learners master the business of reading and writing they achieve a significant breakthrough from the world of oral tradition. A new world opens up for them in terms of their ability to communicate with the past, present and future. This not only enables them to access information and knowledge, but also to create information and knowledge.

Writing is one of the most important milestones in the use of technology in education, and its impact is relevant today. In development terms, there is a major difference between pre-literate and literate societies. Even within a given nation, those communities that have yet to benefit from writing and reading are always at a great disadvantage in relation to the rest of society. It is important to appreciate, however, that while the invention of writing offered distinct communication advantages over simple ‘word of mouth’, it also had relative disadvantages. For instance, communication by writing results in a loss of the interactive and real-time dimension that is a significant feature of

face-to-face encounters. More importantly, in terms of education and development it opened up the first major divide (literate versus non-literate) that still plagues us today.

Many later developments in technology can be classified as elaborations of the reading and writing milestone. Thus the invention of the printing machine made possible the kind of mass production and dissemination of information and knowledge that was not available with manual writing. In principle this opened the way for a system of mass education and the widespread dissemination of knowledge and information. However, the production and dissemination of knowledge was still impeded by barriers of time and space. Indeed, educational book publishing is still a fairly elaborate process with substantial time lapse between completion of a manuscript and printing of the book. Then there is the need to physically transport books to various destinations in the marketing chain before they eventually become available to the end users. All of this, of course, involves significant costs. Therefore, it can be argued that while the invention of printing opened up new possibilities and made available new opportunities for mass education, it also introduced a new divide in the development process. Essentially this is a divide that is still with us, and is best defined in terms of those who can afford ready access to a wide range of educational materials (books, etc.) and those who cannot. The issue of access to books and learning materials is one of the major determinants of quality and effective learning in any education system.

It is also the case that printing and the publishing industry have precipitated new power structures, in terms of ownership of (and control over) information and knowledge. The powerful determine what counts as worthwhile knowledge that should be published for educational use, while the powerless are often reduced to being passive consumers of other people's knowledge. Many countries and local communities still face a major problem in this area, in terms of the relevance of the educational materials available to them. To the extent that they cannot afford to develop and produce their own materials, they could become trapped in a cycle of cultural and intellectual dependency that has a negative impact on education and development. The invention of a wider range of reprographic technologies, including photocopiers, ink duplicators and desktop publishing, could have an ameliorating effect on this kind of problem, but it is still an issue for decision-makers to take into account when dealing with investments in technology for education. The case study on electronic publishing illustrates some of the exciting and promising possibilities for addressing these problems through modern information and communication technologies.

Other technological developments that help to bridge the gap of time and space without putting non-literate persons at a disadvantage are the radio, telephone and television. In each case there is some progress as well as some new problems. New opportunities for mass communication were created by the invention of these technologies. Radio and television provide mainly one-way mass communication (although two-way versions exist); the telephone is the prime example of real-time interactive communication across space. The wired versions of these technologies have restrictions in terms of the spread of their physical grid. There are also major restrictions relating to capital and operating costs of these technologies, for the end users as well as the providers of the services. Invention of wireless versions of these technologies marked a critical milestone in information and communication, as the most remote rural communities became able, for instance, to access radio broadcasts through transistor radios. Also, the wide availability of cheap power cells (batteries) and such inventions as the clockwork radio,

which relies on human energy (winding up) rather than power cells, have helped to bring costs down. It is fair to say, however, that for many reasons, in most countries the potentials of these technologies have never been fully exploited for education and development.

A third category of technological developments relates mainly to human thought processes. This includes audio/video recorders and computers, which make it possible to store and retrieve information in a more reliable manner than through the human memory. This category includes information and data processing technologies such as calculators and computers. Generally all technologies that have to do with artificial intelligence would also fall into this category.

Subsequent technological developments in information and communication have to do with breaking down old barriers of time and space. They make it possible to generate, store, transmit, access, retrieve and process information and knowledge at increased speeds, and with increased efficiency and flexibility. In short, current developments in technology have opened up almost unlimited possibilities for us in terms of information flow and human communication, as well as in the area of human thought processes. In turn, these possibilities hold out great promise for what we can do in education if we invest properly in technology. Hence the current enthusiasm and strong advocacy for investing in technology for education and development.

In the face of such enthusiasm and advocacy we need to be reminded that our primary focus and purpose have to do with education and development. Despite the attractive promises of technology, we know that there are no simple solutions to the complex issues and challenges in these areas. As Malcolm Skilbeck expressed it at 13CCEM in Botswana, 'What goes on in even the poorest school is infinitely more complex than what a powerful computer can do!'