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Education, Technology and Development: A Perspective

N V Varghese

NATIONAL INSTITUTE OF EDUCATIONAL PLANNING AND ADMINISTRATION

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N V Varghese

NATIONAL INSTITUTE OF EDUCATIONAL
PLANNING AND ADMINISTRATION
17-B, Sri Aurobindo Marg
New Delhi - 11 00 16
(India)

EDUCATION, TECHNOLOGY AND DEVELOPMENT : A PERSPECTIVE

ABSTRACT

History of development is the story of domination of one nation over the other. But the 'technology' resorted to, to facilitate this, has undergone changes over the period. At present technology forms the main instrument of domination of the poor by the rich nations. Moreover, technology, in the context of unequal interdependence among nations, perpetuates dependence. As a consequence, the development of the less developed countries continues to be dependent. And hence, technology-import, very often, becomes a threat to self-reliant development. Therefore, this paper argues for a discouraged and discriminate import of technology. This can be facilitated by constituting a professional body at the national level to deal with matters concerning technology. The suggested body will discourage indiscriminate import of technology and thus prepare the ground for developing an indigenous technological base. Education can become an important tool both in the generation and dissemination of indigenous technology by revitalising the now defunct 'innovation chains'. Education can be of help at different stages in this process - at the levels of basic research, applied research, schools and through non-formal systems of education.

Education, Technology and Development: A Perspective*1*

1. Introduction

This paper is an attempt to draw a perspective on the nature of relationship between education, technology in the context of self-reliant development. It shows that education and technology should be seen as an integrated tool for economic development. Not only that these three elements are integrated, but also that they form an integral part of the system itself. Development in the context of unequal interdependence becomes dependent for the poor countries. In the present day context dependence is perpetuated through technology. Therefore, less developed countries, for self-reliant development, have to develop their own technology base. Development of an indigenous technological base may conflict with the existing practice of technology-import. Therefore, the paper strongly argues for setting up a professional body at the national level under the control of the state to look into the matters related to technology-import. It is further argued that any import of technology, if at all needed, should be with the recommendations of this national agency. This will facilitate 'horizontal absorption' of technology without becoming victims of dependent development. The development of indigenous technology should be based on the social needs and national goals. The educational system can play an important role both in the generation and dissemination of indigenous technology. In the dissemination process, education can become a good agent by revitalising the now defunct 'innovation chains'.

The general plan of the paper is as follows: Section 2 discusses the definition of technology. Section 3 then tries to analyse technology in the context of changing perspectives on development where it is shown that at present technology forms an important instrument of domination of the poor countries by the rich Section 4 discusses various facets of indigenous technology in the context of self-reliant development. Section 5 provides a brief account of the pattern of technological development in less developed countries in general and India in particular. Section 6 is devoted to a historical account of educational development in India and in Section 7 an attempt to draw parallels between educational and technological development in India is made. Section 8 argues for the setting up of a national agency to co-ordinate and recommend the judicious/ import of technology. Section 9 shows how the educational system can be used to generate and disseminate technology, and finally section 10 draws conclusions from the study.

2. On Defining Technology

Technology is a term which is very often defined in ambiguous terms. Therefore, it becomes essential to define technology. Technology is a concept that includes all those practices that are part of a cultural milieu (Vyasalu, 1977) which helps in converting the blue print of development into a realised goal. Very often, technology is confused with techniques. Technique is a specific method of producing a commodity whereas technology refers to the gamut of production processes in the economy in its socio-cultural context, i.e. technique is product-specific and technology is society-specific.

Technology is a broader term which includes different techniques. But an aggregation of techniques by itself will not constitute technology. It has something more than that. Technology has an inherent imprint of society where it is developed. And therefore, it can be said that technology carries in itself an organisational structure and institutional setup of society whereas techniques need not necessarily connote these. In this sense, it is quite possible that different countries may have similarities in the techniques employed; but it will be less realistic to assume that their technologies are the same. Countries following opposing political systems may have common techniques. But it may be erroneous to infer that they have the same technology also.

Technology consists of techniques based on principles of science. But it should be distinguished from science: science implies 'know-why'; and technology denotes 'know-how' (Parameswaran, 1973). 'Know-how' was as important to the 'nomadic hunter' as is to the 'robot-man' with perhaps only difference being on 'know-what'. In this sense, technology is as old as man himself and takes different forms depending on the necessities of the stages of development of societies. Technology develops with the development of societies, and therefore, it is difficult to talk of technologies independent of the society where they are produced and stage of development of that society.

Again, technology can be defined as an abstract concept embracing both tools and machines used by society and relations between them implied by their uses (Dickson, 1974). These tools and machines are used by man as a means of changing the state of his material environment. In this sense, technology is the sum total of man's endeavour to interact with nature and to exploit his environmental endowments in the most gainful way possible.

Technology need not be always related to development of specific techniques directly used in production to increase the output. Many a time

production can be increased by better control and supervision - i.e. technology of organisation. The factory technology was evolved because of the needs of capital to concentrate production in one place to control the produce and the producers (Marglin, 1974). In this sense, technology represents a hidden structure of society at a given point of time (Rothman, 1978).

Specific forms of technology are very often introduced to extract more labour from the labourer in the shortest possible time. The more the worker is tuned to a particular machine-technology the less the freedon he enjoys in the work. And it is here the 'control function' of technology becomes more obvious.

There are various concepts of technology in vogue:*2*

a) 'appropriate technology' (Ministry of Industry, 1974; Schumacher, 1972) is an application of knowledge and technical methods which are appropriate to socio-economic environment of any particular country;

b) 'intermediate technology' (Kodikara, 1981) which is neither highly modern nor primitive. In the Indian context, it aims at maximising employment per unit of output; and

c) 'alternate technology' which in the context of less developed countries can be closely associated with the idea of indigenous technology.

In the remaining part of this paper we will analyse the multifaceted relationship between education and technology in the development process. This will be attempted by showing how technology has assumed an envious position in the recent development debates on the one hand and the contribution of education towards the development and dissemination of technology on the other.

3. Technology in the Context of Changing Perspectives on Development.

The perception of development has undergone drastic changes ina the post-World-War II situation. Initially, the West believed that "thee problem of development was roughly of the same nature as that of post-warr reconstruction" (Hirschman, 1979). In the sixties, resulting from thee 'stages of growth doctrine' (Rostow, 1960), development was seen as aa linear path and primarily a matter of growth rather than institutional andd

social changes. Following from this, the rich countries were to supply the "missing components" (Streeten, 1979) to the developing countries to break the bottlenecks. This conception rationalised and encouraged trade, aid and technical assistance from the developed to the less developed countries. It, thus, legitimised the capital flow from the industrialised West to the poverty-stricken East.

By late sixties and early seventies the idea that development did not trickle down to the down-trodden and thereby the slogan of "growth with redistribution" (Chenery et.al., 1974) assumed importance. With this the poor became dear all over the world.*3* However, the idea that dominated the seventies was dependencia, according to which rich-poor relationships produce and maintain the under-development of the poor countries - either in terms of the rich 'underdevelop' the poor (Frank, 1967) or in terms of 'development of under-development' (Amin, 1974).

These changes in perception brought new awareness to the Third World countries. Realising the potential dangers of the developing consciousness and emerging consensus among the poor countries, the West showed increasing concern about the 'development'of the less developed countries. Resulting from this, in the Second development decade, both the developed and less developed countries began to equally voice their concerns on development of the Third World countries which were manifested entirely in different forms. Though the developed countries covertly attempted to conceal their diagonally divergent conceptions of development, very often, they surfaced and resulted in open confrontations. The developed countries, suggested such strategies of development to the poor countries that could maintain their dominance intact.*4* The institutional mechanisms that they resorted to, to maintain their domination over the poor countries varied to suit the changing situations.

The less developed countries, on the other hand, as a reaction to these strategies of development evolved their own strategies to shatter the serfdom and servitude that they were tolerating for a prolonged period. The advocacy of 'zero-sum game' in the place of 'positive - sum game', shift from international-harmony to open confrontation and the call for the South-south co-operation are the offshoots of such a reaction.*5* And in this, technology increasingly occupied a central position. The less developed countries realised the reality of technology being used as an instrument of domination by rich countries.

'Technology of Dominance' and Dominance of Technology in Development.

Domination of one nation over the other-stronger ones over the weaker ones - is not a new phenomenon. There were forces which took different forms to facilitate such domination over the years. Historically one can see that the 'technology of dominance' or the obverse of it- 'technology of dependence'- took different forms and it assumed sophistication over the centuries. In consonance with the levels of human development, the earlier forms of dominance was established through crude and naked forms of conquest and plunder; in the modern period through commerce, trade and war, political domination and thereby colonialism were established. With the wide-spread de-colonisation process, the technology resorted to, to dominate poor countries was through international trade involving unequal exchanges. The latest form to assume significance, is perhaps, through science and technology (Vyasalu, 1976), the diffussion of which to the less developed countries takes place through Multinational Corporations (Nukhovich, 1981). Therefore, in modern times, it is the technological dependence and the resulting neo-colonialist tendencies, which keep the less developed in a 'blissful state of under-development".

Science and technology constitute the main instruments of domination in the changed circumstances of the present-day context. More specifically, in this process "science constituted the ideology and technology the praxis of that ideology" (Kao et.al., 1982). Modern technology is concentrated in rich countries and it is oriented to suit their conditions (Singer & Ansari, 1977). The extent of over-concentration or monopolisation of technology is evident from the fact that 96% of the Research and Development (R & D) activities takes place in advanced countries (Rahman, 1980). Thus, the control over technology, which obviously lies with the advanced countries, has become the major instrument of domination of one nation over the other. It is interesting to note that, this is true not only in international relations of North-South but also in the domestic power relations of developed nations (Ernst, 1981). Therefore, it may be argued that it is the technological dependence that is to be corrected if poor countries have to emerge from their state of under-development and from the depths of poverty.

The attempts by the rich to enforce new and more sophisticated forms of unequal relations and thereby unequal sharing of resources and fruits of development between developed and less developed countries became clearer from their policy formulation in the seventies.*6* The developed countries advocated a strategy of development by reducing trade barriers o

all kinds and professed a liberal policy of technology-import for the less developed countries. And quite often, the international rules in this regard "are ambiguous and geared to the strong treasury and foreign policy interests of the industrialised nations" (Malmgren, 1976).

Whatever be the form one adopted, the essential feature of such a policy was detaching development from the natural environments of the country concerned. This constraints the potential possibilities of development of the less equal partners. It may be interesting to note that at a time when less developed countries were trying to de-link development from the metropolis, the rich countries were trying to persue a policy whereby the developmental efforts of the poor countries are detached from their own soil. The technology - import, or what is euphemistically termed as international diffussion of technology, helps the dominant partners by reducing the possibilities of self-reliant development in less developed countries and thereby forcing them to maintain the existing technological dependence.

4. Technology for Self-reliant Development

Following from the realisation that technology perpetuates dependent development the poor countries increasingly based their development strategy on 'self-reliance' both as an ideology and as a policy (Pozoolno 1976). 'Self-reliance' becomes meaningful only when these countries are free themselves from the latest 'technology of dominance' namely, the technological dependence. Therefore, control over technology becomes the most important goal in their march towards self-reliance. This calls for a comprehensive and coherent technology policy in consonance with and as a part of their national plans. And technological self-reliance, which is basic to overall self-reliance in the present context, should cover both the ability to generate, adapt and use technological systems to meet the social needs. And this may call for a reliable control over the areas of partial technological dependence, if at all needed.

Accordingly, economic development for the less developed countries is a process of social transformation and institutional changes based on fullest exploitation and utilisation of all resource endowoments of their environment in the most efficient way possible. Development, for them is not only a matter of adding to total output but also a question of eqitable distribution of what is produced. As a matter of fact, technology has an important role in both processes, because, the technology chosen will decide the mechanisms of improving output and the institutional arrangements for its distribution. In this sense, technology policy

followed in a particular country can be taken as an index of the path and direction of its development.

But can this technology be exogenously super-imposed on any economy? If not, how can it be developed? The technology developed in an alien nation may not help in both cases. Therefore, it goes without saying that the technology needed for this purpose should be born from the soil of the same economy. It is in this context that the development of indigenous technology as counterposed to the import of technology becomes important.

In recent times the controversy is centred around 'transfer of technology' versus 'indigenous technology'. There are groups among nations and within a country who strongly favour or oppose import or transfer of technology. Needless to say, those who oppose technology-import propose development of indigenous technology in its place. Invariably, as we have seen, the advanced countries advocate technology-import for developing countries. More interestingly there are groups in developing countries too to favour import of technology.

The crux of the argument for import of technology in India lies in the crisis and stagnation facing our industry.*7* The low purchasing power and therefore the narrow demand base of the economy create difficulties for the sale of the manufactured goods in the Indian market. Since their technology is tuned to similar products selling in the world market, the Indian industrialists, motivated by pure profit considerations, seek markets outside where, of course, they have to compete with the products of advanced international technology. To themselves to compete with sophisticated western technology, they argue for import of technology. In other words, so far as the ownership and income distribution pattern remain the same, markets will continue to be narrow and therefore technology will be sought to be imported. This type of argument is in no way different from the advocacy of the western countries on technology import. This may be due to the coincidence of motives of the indigenous private industrialists and the foreign private companies. This again, need not be accidental. But the basic question is who benefits by this transfer the state, the vast majority of the people or a few industrial concerns who maintain their dominance over our industrial structure?

The process of diffusion of technology from developed to less developed countries is by no means a matter of purely transfering "Shelf knowledge". It brings with them a culture and organisational set up which is alien to the receipient nation*8*. Moreover and perhaps more importantly, the import of technology, as we have shown earlier, creates dependency on the technological superiority of the donor countries

(Truptei, 1981; Petkoff, 1981). Therefore, those who argue for liberal transfer of technology fall victims of dependent development which is anti-development. "This import or transfer of technology as it is being called now, is another story of disadvantageous relationship which keep the developing countries in a state of dependency" (Rahman, 1980).

The technology transfer takes place in many forms, the most usual being either direct investment or some form of co-operation between the multinational corporations and domestic corporate sectors. The after-effect of imported technology is that it perpetuates a pattern of growth in less developed countries which is completely divorced from the needs of their society. And this shatters the prospects of employment generation and self-reliance. Thus, in the long run it adversely effects the interests of the country as a whole including those few who would have benefited in the initial stages. Under these circumstances, what is immediate is to develop and alternate technology.

This alternate technology by its very definition will be an indigenous technology. A technology born in our soil and environment and which will exploit the natural and human resources of our country. Indigenous technology does not imply primitive technology; it is neither anti-modern technology too. What is argued is only for a technology which will not lead to dependency in the development process.

Can this indigenous technology be uniform for all regions - say, rural and urban areas - of the country? Following from the differing levels of development among regions, there arose the concept and the prospect of urban areas exploiting the rural areas. Concomitant with this the choice of technology was posed as urban versus rural technology. And unfortunately the selection of one meant the rejection of the other. This, however, is an unnecessarily extreme view of the problem. What is necessary is to see technology in the urban areas and in the rural areas as complementary rather than competitive to each other. It is to be noted that development by relying on the rural technology alone is difficult and that depending on urban technology alone is dangerous.

Every country will be having a range of technological possibilities. The more the inter-dependencies, the less costly the technology diffussion becomes. The less costly technological diffussion the more speedier the possibilities of innovations. And speedier innovations and quicker adaptations of the same within a country will lead to broader technological base at the shortest time. Therefore, realisation of the inter-dependencies between rural and urban areas in its mutually reinforcing complementarity should form the basis for any plausible technological

planning in India (Reddy, 1977). Rural development cannot take place without urban development. But one should not be pursued at the expense of the other; it should be mutually supportive. In other words, development of rural and urban areas should be correlated in a symbiotic and mutually reinforcing manner rather than posing it as a choice between mutually exclusive categories. So also with technology.

Our country, given its diversity, may not be able to continue with an equally uniform level of technology in all regions. Therefore, indigenous technology will be one where modern and less-modern technologies co-exist. However, the attempt will be to develop the less-modern technologies into modern technologies concomitant with the levels of development and resource endowments of that particular region. More specifically a technology indigenous in nature and which increases productivity without displacing hands as counterposed to the existing system characterised by capital intensity and labour displacement is argued for. Unless and until the grandeur of science and the remoteness of technology are de-mystified, they cannot become tools in the hands of villagers, to see an intimate role of these tools in the solving their problems (Reddy, 1978). This can be achieved only though indigenously developed technology. As Helleiner (1977) notes "ultimately the long-run development of indigenous technological capacity is more important thanthe negotiation of a more suitable price for the short-run imports of technology". And quite often alien technology is looked upon as a threat to this process (Robertson, 1981) which is clear from the pattern of technological development in India.

5. Pattern of Technological Development in India

Technological development is not uniformly spread among alll countries in the world. The institutional setup to diffuse technology differs not only from developed to less developed countries but also it varies between different sectors and regions within a less developed economy.

Technological development, in developing countries effect only individual, isolated and frequently unconnected production units. Many a time technological development in the less developed economies are prompteed by external stimuli and the innovations penetrate as separate additions to the existing productive capacity (Skorov, 1978). This nature of technological innovations and their diffusion does not permit it to spread to broad-based production sectors (Prakash & Varghese 1983). The British colonialism was chiefly responsible for such pattern in India. Colonialism

in India destroyed the then existing industries and crafts and disrupted the process of development of science and technology (Rahman & Chaudhary, 1980). Not only that the British advent destroyed the existing crafts but also it eliminated the potential possibilities of developing any such indigenous technology. More over the British capital made in-roads only to some selected pockets which again complemented the peculiar pattern of industrial development in India.

As a consequence of these factors, the industrial development in India took a peculiar form. It formed isolated centres of modern manufacturing production units and infrastructural facilities amidst the mass of technically backward small scale crafts. There developed a highly advanced (but small) modern sector which uses sophisticated western technology surrounded by a large traditional sector functioning at low levels of technology (Hallak & Caillods, 1980). The creation of modern sector industry also followed a particular pattern. It began with import substitution, leading to manufacture of consumer goods of sophisticated nature to meet the demands created by the privileged minority (Rahman, 1980).

The other aspect of this development was that these 'advanced centres' became potential protagonists of technology-import. Even this import of technology and its after effects had a different pattern in India when compared with other countries. Unlike in the case of countries like Japan, the imported technology was not incorporated properly. The non-existence of 'horizontal linkages' and mechanisms of 'horizontal transfer of technology' between the sectors of same levels of development made it difficult to disseminate and the spread techniques involved in the imported technology.

Countries like Japan ensure that the technology imported by a company, either private or public, is absorbed, improved upon and exploited throughout the country, and this process is described as 'Japan Incorporated' (Udgaonkar, 1982). In our country this is relatively non-existent. If any firm imports technology, they keep it as a secret to reap the short-term profits arising out of the monopoly position they enjoy by virtue of the possession of the information. Neither the concerned firms nor others study and master over the techniques incorporated in the imported technology. This, many a time, forces us to continue to be dependent on the donor countries for its repair services and other technical assistance.

Still another factor resulting from the nature of industrial development in India is the creation of R & D both in the public and private sectors. But at present it is confined to some selected organisations. Very often, these organisations are kept aloof from other smaller units. This narrows down the possibilities of spreading the R & D activities. And therefore, this pattern minimises the potential contribution of R & D in the societal sense.

Following from this, our present R & D activities fail to generate indigenous technology on the one hand and to diffuse the already received technology on the other. Generation of indigenous technology is constrained because many firms which have R & D departments are engaged either in short-term innovations of immediate importance or in the import of technology. Diffussion does not take place, because of lack of linkages, with other sectors especially traditional sectors, even though they are involved in similar activities. Again, since the traditional sectors lack institutional backup and competitive capability, their potential to develop indigenous technology is also equally weak. Moreover, the present day educational system, on which R & D activities are relied upon, also constraints the possibilities of developing indigenous technology. This is obvious from the pattern of educational development, especially during the colonial period.

6. Pattern of Educational Development in India

Education in India, even now, is not free from the hang-overs of colonial influence. India had a fairly well established system of education from time immemorial. Even when the English came the then existing indigenous education system was comparable with any country in the world. But this system of education (since it was rooted in Indian soil) was an impediment to the flourishing of the colonial philosophy. Therefore, the British deliberately destroyed the then existing indigenous system of education in India and introduced in its place what is now characterized as modern education. Since it was transplanted to and exogenously super-imposed on a backward economic system, it neither flourished in the way it did in western countries nor it helped in developing the then existing system of education. In Indian soil it had a paralysing growth paralysing both its natural growth and the growth off the indigenous system of education.

During the colonial period, education was used as an instrument to consolidate the political domination that the English had achieved. Their interest in education was chiefly centred around two goals: (a) to

produce cheap lower level administrative staff like clerks; and (b) to obtain the support from the upper-middle class sections of Indian society. This objectives were achieved through their policies of 'filtering down' and 'two-tier system' of education. Through the curriculum, the English always tried to orient education to impart their cultural values to the Indian students who were drawn chiefly from upper-middle class families. This policy in the latter periods rewarded them with a supportive intelligentsia who in their attitudes and behaviour were, perhaps, more English than the English themselves. In this sense, education became a source of cultural imperialism (Carnoy, 1974).

Consistent with their policy for colonial development, thesystem of education that they implemted aimed at two-pronged objectives: (a) westernise the urban areas; and (b) urbanise the rural areas; and they followed a system of education which essentially meant (i) elementary education in vernacular to teach the three R's; (ii) secondary education to teach English language; and (iii) higher education to fulfil the main objective of spreading western knowledge through English. (Naik, 1982and 1983).

One peculiar feature of English education in India was their emphasis on general education and the neglect of scientific and technical education. Scientific and technical education being the essential ingredients of indigenous technological development, a neglect of the same not only created a gulf between the colonial power and the colonies, but also increased the disparities at least on two counts: (i) between types of education; and (ii) between levels of education. This, in the later periods, led to the intellectual dependency of the colonies to the colonial powers. Again, in the colonies, because of the co-existence of English and vernacular education, a gulf was created between the elite and the masses. English education was seen as a recruiting source to elite classes. Since the higher educational institutions were located in the urban areas, the English educated and thereby the elite also were located around the metropolitan cities. To add to this was the fact that the English education withdrew talents from rural to urban centres.

As a result of this policy the educational system contributed to the dualistic pattern of development between urban and rural areas. In fact the educaion system was singularly uniform and aimed at creating a few westernised individuals in the urban industrialised pockets of the country (Naik, 1982). Thus the English education created enclaves of higher learning in the midst of illiterate vast majority of people.

The English education had one thing in common, whether it was practised in rural or urban areas, that it systematically detached those educated from the natural work environments. To quote Altbach & Kelly (1978), "In the colonial situation the school was detached from those indigenous cultures, in the languages and in the social values they taught. Colonial schools were set up as alternatives rather than as complements to the colonial educational practices. Colonial schools never held out the prospects of integration into indigenous culture to those who attended them". And this educational process produced an elite class who adhered to the philosophy of "all that is rural is bad, all that is urban is better and all that is foreign is best" (Reddy, 1978).

This does not mean that there were no attempts made to indianise education. Especially during the national liberation movement the idea of mass education got momentum. The attempts by Gokhale for universal education, Gandhiji's concept of Basic education are standing examples of the endeavours made by our national leaders to Indianise education. Despite their attempts, the success in this front was marginal. The story is not substantially different in the post-independence period. The inherited colonial structure still dominate our educational system and makes it all the more insensitive to the changing national goals.

To sum up, the English education in India contributed in making her intellectually indebted to Britain and this was a part of their general policy of domination. The same education is also partly responsible for the dualistic pattern of development that India witnessed. This pattern of educational development had its implications for the development of an indigenous technological base.

7. Education, Technology and Dualistic Development

From the discussions in the previous two sections certain common features that emerged in the process of development of technology and education in India can be observed. It is a fact that both education and technology in their development process were systematically detached from the majority of people and from their natural environment. The exogenously super-imposed system of western education on a village based and agriculturally dominated economy destroyed the growth prospects and development potentials of the then existing educational system. In its regenerative aspect, the transplanted educational engine did not function properly. And as a result education was divorced from natural environments and work conditios.

Similarly, the alien western technology introduced and encouraged by the English, gradually detached the people from utilising their natural endowments in a more meaningful way. The British technology, modern, western and sophisticated, when super-imposed on a primitive colonial economy destroyed even the then existing village technologies and it belittled the chances of developing any technology by exploiting the existing natural resources. Therefore, our development continued to be dependent in one form or the other. Following the argument, our attempt should be to endogenize technology and education. This endogenisation can be successful only through indigenisation of technology and education. In other words, indigenisation and endogenisation are two aspects of the same process moving simultaneously in the same direction orienting towards a self-reliant technological base.

The first and foremost need in the education sector to endogenise and indigenise technology orienting towards self-reliant economic development is to wipe out the still persisting remnants of vestiges of colonial education. Colonial education emphasised on teaching rather than learning; on cramming rather than creative thinking, on examination oriented study and conditioned the whole education system to an alien culture and environment. One of the chief long-term defects of English education in India was that it did not orient itself to the generation of knowledge. What it did actually was just a transfer of the received knowledge from other countries. This again detached education from work places. The technology that was practised and the education that was provided had nothing in common. This undermined the role of education in the context of technological development.

The technology practised during the British period was of English-based and therefore the scope of indigenous R & D activities was very limited. Since the British did not emphasise on technical education, the possibilities of developing R & D activities for a future period also was constrained. Therefore, what is need for the development of indigenous based technology is to re-orient education more towards 'knowledge generation' process rather than to the present practice of transfering the obselete western knowledge. In otherwords, the education system should be able to provide the germs of technological development through its R & D activities.

The development of the proposed indigenous technology becomes meaningful if and only if the dissemination process of the technology that is developed takes place in other sectors of the economy. At present in India, this dissemination process is defunct or absent. Firstly, we have

seen that in the case of imported technologies 'horizontal absorption' or 'India incorporated' does not take place. And therefore whatever marginal attempt is made dies out in the same firms. The absence of such a process arising out of the short-term profit considerations of the importers of technology makes the benefits of technological transfer highly individualised and it obstructs possibilities of learning and reproducing any useful skills embodied in imported technology.

Secondly, even the indigenously developed technologies are not disseminated to wider sections. Whatever innovations made remain in the laboratories only. This is due to several factors such as: (i) the technology generated is in the advanced modern sectors only. Their interactions with the traditional sectors are very limited. And, therefore, the scope of spreading the already developed technology is very limited; and (ii) since these sectors increasingly associate themselves with the international market, the technology developed also will be to meet the demands of the foreign market. Therefore, even if these technology is permitted to interact with the traditional sectors, it may be dificult to absorb them.

The two points discussed above point to the basic defect in our technological development, i.e. (i) technology is not adequately developed; and (ii) whatever technology is developed is not disseminated to other sectors. This is because of the absence of 'innovation chains'*9*. Innovation chains is the term used to signify the whole process of taking technological development from the stage of fundamental research to the producers and users of the products (Menon 1982). Therefore, our attempt with respect to indigenous based technological development should be to develop well defined 'innovation chains', and make it function properly and continuously on the basis of a feed-back system. To start with, this needs a proper perspective planning of the economy and identification of areas of priorities. Based on this, the technology can be designed and the educational system can be planned. In the functioning of this process we can see the inter-relationship between education and technology more closely and clearly.

Since we cannot de-link ourselves completely from the international context, it is also equally important to see how the innovation chains will be affected by the import of technology. The policy of technology import if at all needed, should not conflict with the attempts to develop indigenous technological base. In otherwords, a definite policy of technology-import becomes an essential element in planning for developmen

of indigenous technology. A question can be posed at this point: what can be a helpful technology-import policy? This we will attempt in the following paragraphs.

8. A Policy for Import of Technology

The 'innovation chain' can become functional if technology is seen as an integral part of the development process. What is needed as a pre-condition for a proper generation and diffusion of technology is an integrated perspective planning at the national level whereby inter-linkages between education, technology and other sectors of the economy are clearly drawn.

In this paper the argument is for development of a sound indigenous technological base. One question may be asked: can the import of technology be altogether avoided in the process of building up an indigenous technological base? The answer may be in negative. But at the same time, it is strongly felt that the existing forms and the institutional arrangements governing the import of technology in our country are counter productive for an indigenous technological development. However, this should not be mis-understood for a complete de-linking of our technological development from the international scene. On the other hand, it is equally strongly felt that an indiscriminate import of technology by various uncoordinated agencies, as at present, is harmful in the longrun. But at the same time one may not be able to rule out the possibility of importing technology at least in some selected sectors, provided it will not perpetuate dependence to the donor countries. Therefore, in this regard, the need is for setting up a professional agency like science and technology (S&T) to coordinate various activities in the sphere of technology. This agency should be given considerable freedom to recommend the necessity, if at all, for the import of technology. And if imported, this agency should initiate steps to master the techniques embodied in it so that in the later stages these techniques can be endogenised and improved upon.

To be more specific, the paper argues for discouraging the indiscriminate import of technology by various agencies. Any import of technology should be on the basis of the recommendations of a national level professional body specifically set up for this purpose. This national agency in consultation with the research and related institutes, will identify the sectors where technology import is unavoidable Identification of these areas will help in showing the direction in which our technological development should concentrate. And this national level

agency should be under the control of the government, so that it will not be a victim of short-run profit considerations.

To sum up, the central argument of this paper with respect to import of technology is that a central agency under the control of the government should be set up to take all crucial decisions regarding the import and diffusion of technology to different selected sectors. And the present practice of private individuals making arrangements for import of technology and getting it legalised should be stopped. This will help in developing indigenous technological base without creating much problems even in the transformation period itself. Moreover, this forms the basic assurance for the development of indigenous technological base.

9. Education, Generation and Dissemination of Technology and Development

As we have seen earlier the role of education in economic and technological development is important. Education and technology, in this context form an important integrated tool for economic development. Not only that these three elements are inter-related but they form an integral part of the system itself.

There are always two contending points of view regarding the relationship between education and technology. There are some who argue that education should precede technological development and others argue that technology should precede education. We feel that it is again a misconceived view aiming at treating these two as seperate entities. On the other hand, a better view would be to treat education and technology as an inseparably mixed categories of the same process. Trying to analyse them in isolation will only give a distorted picture. In fact, education contributes in developing new technologies and technological development enriches the further development of education. Their mutual interactions enrich each other; more so in the context of development in the modern period.

Economic development in the modern period is different from that in the earlier days. It has assumed so much of complexity that it, very often, outstrips the comprehension of any single individual. And a proper analysis and study of development requires a well-defined research setup. The research and development activities become important in this context.

Apart from this, the germs of development in the present context are born out of laboratory experiments. The innovations generated and the

information required are provided by the R & D departments. And in this sense, the pool of information and knowledge created by scientific research i.e. R & D, forms the basis of modern economic development. The basic knowledge generated becomes a part of innovation process through its concrete form manifested in technology. And the dissemination of this technology to the diverse regions becomes important to facilitate a strong ground for development.

In fact, it is the educational institutions and the research institutes which carry out the R & D activities in the country. Even the personnel for the R & D activities in the corporate sector is provided by the institutions of higher learning. The role of education is not only confined to the production of technology, but is extended also to the diffussion and dissemination of the same to various segments of the economy. In this sense, education is an active agent of technology diffussion and dissemination. Thus education through R & D activities, stimulates development and through its role as an agent of diffussion of knowledge facilitates development.

In the remaining part of this section, we will attempt to show how the educational system can be helpful in generating and disseminating technology for a self-reliant economic development. This is attempted by phasing the educational system into different stages of technological development.

a) At the Level of Basic Research

In the present-day world, technological innovations are the result of research and development (R & D). Since, R & D being the main source of technology generation the role of education should be initially sought here. Basic to any R & D activities is innovations. And basic to innovations is research. In other words research forms the basis of technological development in the present-day. At the same time, the question of what kind of research - Basic or Applied - becomes important. There can be many good reasons either for emphasing basic research or for emphasing applied research. Even when one accepts the importance of applied research, it should be noted that basic research in fundamental areas is necessary for further development of technology. Because it forms the basis for the 'innovation chains'. In fact, "basic research is important not only for its own sake, but also because of the solid foundation it provides for applied research and development" (Planning Commission 1980).

Areas touched upon by basic research should be in consonance with the nationalpriorities. Given the fact that very often our research activities follow either the winds of western fashion or of internal political romanticism, the selection of priority areas assume importamce. And it is here the suggested professional agency at the national level can play its due role by providing a proper orientation to the areas to be touched upon by the R & D activities. Existing higher educational and R & D institutions should be phased out if they do not transform into centres of S & T Sub-ordinated to social needs and centres of knowledge for human betterment (Rao et.al. 1982).

But all the colleges and universities may not be able to carry out this task. Therefore, it should be entrusted to a few selected universities and institutes. Given the level of low financial allotment to R & D activities, this way of concentrating in selected few places will provide adequate facilities. This will be better than, spreading thin the resources to many and ultimately each of them fail to carryout research successfully because of financial constraints. In other words, selectivity both in terms of fields to be covered and institutions to which the task of carrying out basic research is essential for its bloosoming.

The financial allotment to research and development is very meagre in our country. Therefore, the selected institutions should be adequately equipped and finance should not be a major constraint to them. In our country, it is noted, the financial allotment lags behind the number of technical personnel additionally employed, over the decades (Malhotra, 1979). Though finance is a major constraint, an adequate provision of it by itself will not promote research in the needed direction. This requires sensitising the R & D departments with the production needs of the economy. In other words, these institutions should have close links with the production units and vice versa.

Needless to say, these linkages form the core to develop relevant technology. Any technology, even if indigenously developed, will be of marginal help if it is not born out of the necessities of the present-day context. The laboratories should not be the place to decide the areas of priority. The needs are felt in the production units located at various diverse regions of our country. And it is these linkages between those who are producers and those who are users of technology which should form the basis for developing the relevant technology. That is to say, the basic research activities should be seen only as a helping tool to convert the technological needs into a concrete usable form.

b) At the Level of Applied Research

The technology that is concretised by the basic research activities may not be directly usable to many sectors. And it is at this stage of 'innovation chain' that the applied research becomes important. Bulk of the colleges and universities where facilities for basic research do not exist should concentrate on applied research. The basic research carried out by the selected institutes should form the basis for applied research. Fundamental research primanly aims at comprehension and conceptualisation; in applied research it is primarily manipulation and control. Each has a characteristic function and each obtains stimulation from the other. There is an exchange between the two; the relation is not linear but multi-dimensional, not sequential but organic (Holtzman, 1978).

Applied research by linking it self with the results of the basic research on the one hand and with the regional needs on the other can produce better results in development process. This will help in disseminating technological innovations to the varied needs of different regions of our country. And in this process educational institutions become agents of diffussion of technology and thereby a crucial link in the innovation chains.

Basic research looks into the overall technological needs of the economy by keeping linkages with the production units. The applied research, on the other hand keeps linkages between the region-specific needs of the economy and the results of the basic research. In the working out process, applied research activities will convert the initially developed technology in usable form at the regional level.

c) At the School Level

The next link in the innovation chain is the schools. Colleges are not widely spread in our country as schools are. Moreover, colleges generally represent persons belonging to better socio-economic groups. In this sense, by keeping the technological diffussion links closed at the college levels, we keep technology away from the masses. The schools will be a better agent in this respect, provided the curriculum structure is oriented towards this direction.

The applied research carried out in the regional centres will be in consonance with the local needs. This can be made more useful by making facilities to utilise the results of the applied research. The local

needs, the resource endowments of the locality etc. can be studied through wide-spread local-based surveys. Depending upon the local potentials, the development programmes can be oriented towards the national needs. By introducing vocationalisation*10* at the school stages, the local needs can be connected to realistic targets. In India an attempt in this direction is made in the context of vocationalisation of education at plus two stage. Many states are actively implementing the policy of vocationalisation. The success of these activities depends on the effectiveness of the local surveys where the resource potentials are reliably identified. In this way the applied research undertaken by the regional colleges can be disseminated to rural areas which will help in the development process by fully utilising the local resource endowments.

d) At the Grass Root Level: Non Formal School Systems and Science Movements

The dissemination process outlined above leaves vast majority of our people (who are outside the school system) out of the 'innovation chains'. Perhaps, one way by which they can part-take in the development process is through organising non-formal systems of education. Through non-formal systems the rural and urban poor can be taught how to do the same things in a better way. By giving demonstration classes on specific problems which the people are in direct and lively contact, the mass can be made aware of the necessity of the suggested development programmes. This can be given by the young scientists during lean agricultural seasons.

There were attempts in our country towards this end. The 'Krishi Vigyan Kendras' (IAMR, 1977) organised in different parts of the country are standing examples of this process. Through these kendras the farmers can be educated in lines of the indigenous technology developed and their applications to day-to-day lines. The working group on S & T (Planning Commission, 1980) suggested for a rational rural resource corps of young professionals to cover tribal drought and flood prone areas. A similar corps of professionals can be of much help to the marginal farmers.

The other way to take science and technology to the rural areas is through wide-spread Science Movements.*11* Many a time, illiteracy and ignorance of the rural poor force them to depend on superstitions. This acts as a constraint to spread any new ideas. Strong science movements are most helpful in this regard because it keeps the people open to new ideas and permit them to reciprocate. This will facilitate the dissemination process easy and the innovation chains complete.

One may see that education system described above as an agent of generation and dissemination of technology is closely linked to different stages of technological development. It is these linkages on the one hand and its linkages to local community on the other, which will facilitate the working of innovation chains complete.

Let me end this section with a note of precaution. The working of the 'innovation chain' as described above should not be misconstrued for a system whereby technology is something which trickles down from top to bottom. On the other hand, what is attempted is to show how technological needs at the grass root level can be concretised through R & D activites on the one hand and how the concretised form of technology at the laboratory level can be diluted and disseminated to its direct users - namely the people. It is hoped that a proper working of the system described in this section, will make technology a useful tool in the hands of the people to change their material environment for the better. And economic and social development will depend on to what extent the indigenous technology developed reaches the masses and how effectively they use them in their mundane activities.

10. Conclusion

The attempt of this paper was to show the importance of technology in the development process and the contribution that education can make towards this end. It was shown that the 'technology' resorted to, by the rich countries to dominate the poor has undergone sophistication to suit the changing international relations. And at present technology is one of the important instruments of domination. The import of technology contributes to this process by perpetuating dependent development in less developed countries. Therefore, the paper argued for a discouraged import of technology. In this connection, the suggestion is for setting up of a professional body at the national level to deal with matters related to technology. It is hoped that this body will identify the areas or sectors where technology import is unavoidable and also provide guidelines for developing indigenous technology.

In the present day context, therefore, development of indigenous technology becomes an important step towards self-reliant development. Generation of technology, even if indigenous, will not by itself ensure development. An equally important factor is the dissemination of the generated technology to the various sectors and regions of the economy. This is more so in the case of a country like India because of its vastness and diversity. It was shown, in this paper, that education can become an

active agent both in the development and diffussion of indigenous technology. Using the concept of 'innovation chains', it was argued that education can respond to different phases of technological development.

At the level of basic research, education can help in the generation of technology. Or in other words, basic research should form the basis for further technological development. Since all the institutions in the country may not be able to carry on basic research satisfactorily, it was felt that it is better to entrust this task to some selected institutes. At second phase-at the level of applied research-the regional colleges which are not carrying out basic research can specialise in applied research. At the stage of applied research the applications of the basic technological innovations made at the level of basic research can be concretised to suit the regional needs. At the school level, the results of the applied research carried out in the colleges, can be transformed in such a way as to make it more applicable at the local levels. Since in our country, schools are more wide-spread than colleges, this will take technology closer to the people. Again, if diffusion is confined to the school system alone, it will leave out a vast majority of people from 'innovation chains'. Therefore, the non-formal systems of eduction can be of much help in this regard.

Lastly, the Science Movements can be the best means to popularise science and technology. Through these Movements people become receptive as they are exposed to new ideas. And in this way the technology developed in the laboratories can be taken to the masses. Development of any economy depends on how effectively people are able to use the technology. And the process described above, will facilitate technology to become an important instrument in the hands of the people to change their material environment for the better.

NOTES

1. Some of the ideas contained in his paper were presented at the Second Convention on Futurology and Seminar on Technology Future for Rural Development in 2000 A.D., organised by Jawaharlal Nehru Technological University and Indian Council of Management of Future, Hyderabad, May 2-4, 1982. I am grateful to Professor Tapas Majumdar, Professor Moonis Raza, Mr. J. Veera Raghavan, Dr. Brahm Prakash, Dr. J.B.G.Tilak, Mr. Dinesh Abrol, Mr. A. Mathew, Dr. K.Sudha Rao and Dr.K.Sujatha for their comments, suggestions and encouragement in the preparation of this paper in this version.

2. In this paper no attempt in made to elaborate on these concepts since these do not form the primary objective of the study. However, the idea of indigenous technology, as it forms basis for technological development for self-reliant development, is a recurring theme of this paper. For distinctions between different concepts of technology see Vyasalu (1976, 1977).

3. It is interesting to note the impact of this slogan in India. "The political consensus which the Indian National Congress Party maintained for longtime, was shattered in 1967. During the next few years the the poor in India emerged as the darling of all political parties" (Minhans 1979). Consequently, the Draft Fifth Five Year Plan (1973-78) observed that growth and reduction of inequality are both indispensable for a successful attack on mass poverty and realised that the distribution aim is particularly relevant to the goal of attaining a national minimum. And the Draft Fifth Five Year Plan for the first time explicitly spelled out and adopted 'Minimum Level of Living Approach' (Rudra, 1978).

4. The argument for filling the technological gaps in less developed countries by the advanced countries, the functioning of the multinational corporations etc. are new strategies adopted by the rich countries. The Brandt Commission Report and the discussions that followed it highlighted the strategies adopted by the rich countries in the changed situations.

5. In the seventies, co-operation versus confrontation became the key issue for discussions on international relations. The general feeling that was widely spread among the emerging newly liberated countries was that the old harmony benefited the rich countries and the new confrontation was intented to be used to change the rules of the game in favour of the poor countries (Streeten, 1979, Gupta & Srivastava, 1981).

6. The New International economic order and the reaction to it by the South-South countries show this trend. The argument for international diffussion of technology, the functioning of Multinational corporations in developing countries are examples to this (Helleiner, 1977, Nukhovich, 1981).

7. There are alternative explanations for the crisis and stagnation of Indian economy. For example see Nayyar (1978), Shetty (1978), Patnaik (1979).

8. As a matter of fact "the international transfer of technology has been instrumental in perpetuating the hierarchization of North-South but also of South-South relations with all its inherent implications for under-development, misery and potential global conflict (Ernst, 1981).

9. This concept of innovation chains in the context of technological development was first outlined by Lord Blacket in the first Jawaharlal Nehru Memorial Lecture: See Menon (1982).

10. The importance of vocationalisation was adequately emphasised by the Education Commission Report (1964-66). Accordingly, 10+2+3 system was adopted by the government in 1968 in National Policy Statement on Education. It was finally accepted at the state level in the 1972 conference of the Director of Public Instructions. And it is implemented in different states of the country since 1976. See NCERT (1983).

11. The Science Movements help in salvaging the people from the orthodox superstitional beliefs and expose them to the modern scientific development. Apart from creating a conducive atmosphere to make the people more receptive, science movements also helps them in doing things better. At present science movements are spreading in the country. States like Kerala and Maharastra have shown a lead in this process.

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