Knowledge Matters for Development

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Introduction

People in rich countries enjoy more than 100 times the income[1] of those in poor countries. They experience high material standards of living, longevity, freedom from diseases associated with ignorance, and unprecedented power to transform their environment using their knowledge and skill. However, 75% of the 6 billion people with whom we share the planet live where income is less than $3000 per person per year and over half where it is below $750[2]. For them things can look very different. Poverty remains widespread, food security is not assured, life expectancy is impaired, and health is often fragile. Over 100 million children do not attend school at all. In much of the developing world less than a quarter of children complete secondary schooling, and fewer than one in twenty study at higher education level[3].

Much of what needs to be known to reduce poverty, malnutrition, and disease is known. The problems revolve around whether those who need to know have access to and understanding of the ideas and relevant technologies - an education and training problem - and whether, when they do, other conditions for the application of knowledge and skill exist - a socio-economic and political problem. The two dimensions are not unrelated. More aware, capable and educated societies are more likely to encourage democracy, equity and well being, than are societies hampered by ignorance[4]. They are also more likely to have the economic resources to sustain higher living standards and the choices in life styles that lie at the heart of development.

The reasons for the relative wealth and poverty of nations are complex. It is one of the propositions of this lecture that knowledge and skill lie at the core of development, and that science and technology education have a special role to play. Politics and ideology matter to development, but they matter less in the long run, as the economists say, than the accumulation of knowledge and skill, and their application.

The historical case is powerful. There is no significant biological difference between ourselves and those who lived at the time of Alexander the Great. There is a stunning difference in our ability to transform our environment according to our preferences (and, perhaps, our continued ignorance). The recent experience of some Pacific rim[5] countries that have transformed their developmental status is striking. It shows that rapid development can happen, and change the wealth of nations. This group of countries encompasses a range of political ideologies. These are societies that invested heavily in education, and in science and technology. They are also societies which display confidence in the future and which show little predisposition to adopt the post-modernist position that science is "just another set of narratives" with no more significance than any other (Eagleton quoted in Harvey 1995)[6].

Globalisation is creating new challenges for development, not least in terms of its impact on jobs and livelihoods, and the knowledge and skills on which they depend.

New information and communication technologies (ICTs) offer novel possibilities for learning. More than ever before, international influences are shaping education systems. If these developments are to lessen, rather than increase poverty, and the deprivations associated with ignorance, clear thinking is needed. Stakeholders in the education and development process need to revisit the implications of *Development in a Divided World* - the title of one of the books that started the journey to where I now find myself[7].

This lecture makes a contribution to this process. First it reviews some of the ways knowledge and skill, and science and technology, have shaped development, and development thinking. Second, it identifies some key features of the context within which educational development takes place. Third, it explores aspects of globalisation and their implications for educational investment in developing countries[8].

The Meaning of Development

Definitions of development are elusive. Let us take a recent one.

"Human development is the process of enlarging people's choices…. choices that are created by expanding human capabilities….. what people can and cannot do in their lives. At all levels of development a few capabilities are essential for human development….These are to lead long and healthy lives, to be knowledgeable and to have access to the resources needed for a decent standard of living…" (Streeten UNDP 1999:16)

For changes, and choices, to be developmental there has to be a consensus that some conditions of life are preferable to others. There is general agreement that freedom from disease, adequate nutrition and food security are basic human needs that should be met everywhere, and that improvements in the conditions of life are desirable e.g. adequate housing, clothing, communications, energy. Other things can be included. Streeten's choices add political, social, economic and cultural freedoms, opportunities for being creative and productive, and the recognition of human rights. Many of these things benefit from more, rather than less education. Several are clearly linked to competencies related to science and technology.

Thirty years of debate has resulted in most contemporary definitions of development recognising that educational investment plays a pivotal role in the achievement of many valued development goals[9].

If participation in education is included in the list of goals as a right, as it is in the UN Charter on Human Rights, or as an indicator of development, as it is in the widely cited Human Development Index of the UNDP[10], then education becomes part of the *definition* of development, as well as a means to achieve it.

In a nutshell, development is not happening unless more people are becoming more educated. It will not happen unless more people acquire more knowledge and skill.

Why Knowledge Matters

Development is both a technological process, and a cultural and socio-economic shift. Education systems matter for development because they have become the vector through which knowledge and skill can be acquired and applied. Much, but not all, of what has been important in the long run of development has had a science and technology flavour. This is my reading of development. It stems from my training as a scientist and a continued fascination with the interplay between technology, science, and development. This was first awakened through my time reading physics, and then through my mentors at Manchester in science policy. It was reinforced by the opportunities created for me when I came to IDS and Sussex in the early 1970s and by Ron Dore in particular. Always curious, always challenging, Ron is another one of the reasons why I am here today.

The importance of knowledge and skill for development can be illustrated in three ways.

First, history contains myriad examples of how economic development and social change have been associated intimately with the accumulation of knowledge and the applications of technology. Jared Diamond provides a very readable account of the role played by innovations related to food production, transport and warfare in the long sweep from pre-history (Diamond 1999). The development of agriculture, the refinement of metal tools, and the domestication of animals as sources of power, released populations from the precarious existence of hunter gatherers. They enabled societies to develop which generated surpluses. These surpluses allowed some individuals to take on specialised roles, not least those that promoted the accumulation of knowledge. Stable civilisations developed language, mathematics, and reading and writing. What distinguished those civilisations that developed early (e.g. in the Fertile Crescent, China, Egypt), from those that did not, was a combination of technological innovation, complemented by other conditions (social stability, favourable location, purposeful leadership)[11] necessary for development. The technologies used preceded the development of modern education systems and what are now recognised as the methods of science and technology. But, they depended on thinking skills that were the forerunners of systematic methods of enquiry. Manifestly, these skills were passed from generation to generation through learning that was organised rather than serendipitous.

Any historical account of development has to recognise the key role played by technological innovation and the inevitability that those technologies which offer superior performance will displace those that are less efficient. And that those who possess them will have power over those who do not.

The familiar story of the development of clocks provides but one illustration of how important technological innovation has been for development. Maritime colonialism[12] depended on the ability to answer the question "Where am I?". On land the answer was not difficult; on the sea it was[13]. John Harrison finally succeeded in producing chronometers that could keep time on board ships, which are now to be found at Greenwich. In so doing he solved the problem of longitude (Landes 1983, Sobel 1996). On the way, he invented the ball race and the bi-metallic strip – two innovations with widespread applications today. His technology was largely self

developed, but it built on previous generations of clockmakers' ideas. The methods he used involved scientific reasoning. Science educators would like to think he would have progressed faster if he had had a formal science education[14]!

The development of the technologies of reading and writing was special. It enabled ideas to be transferred across the generations unaffected by the vagaries of memory. Their existence created the need to learn how to read and write, and hence the need for organised methods of instruction. Literacy began to allow ideas to spread within and across societies, less trammelled by hierarchy, secrecy, and superstition than would otherwise be the case. Literacy remained restricted to elites until the invention of printing. Technology created printing[15], printing created the potential to share knowledge widely. At the beginning of the 21st century we need to remember that at least 900 million adults are still illiterate. If they had all completed basic schooling successfully this would not be the case, and they would be less likely to be poor and marginalised.

Second, the industrial revolution generated rapid development and transformed rural, agrarian societies into urban, manufacturing economies (Landes 1969,1998). It is true that many of the first innovators had limited education, and were practically rather than theoretically orientated. However, they did live in a world where literacy was becoming more common, and an accumulation of knowledge and skill made the previously impossible, practicable. As the process of industrialisation gathered momentum, and technological innovations increased in complexity, the benefits of an understanding of underlying principles became clear. Later innovations began to acquire the character of designed solutions to well specified problems, explored using the intellectual and empirical tools for enquiry associated with science and technology. The more it became possible to design solutions to production problems, the more efficient at generating wealth the industrial development process could become. Though education, and more specifically schooling, may not have been the only or the most important factor that catalysed the first wave of industrialisation, it can hardly have been irrelevant. It provided literacy, and access to ideas, to large swathes of the population. It created opportunities to acquire knowledge and skills that were too complex for casual acquisition, or too scarce to be acquired directly from those who possessed them.

It can be argued that economic development occurs in waves, linked to technological innovations which spawn changes in production, distribution and organisation, and which wax and wane as one cycle evolves to the next[16]. Four waves have been linked to the process of industrialisation. First, mechanisation (textiles, iron working, water power, pottery 1770-1840), second steam power and railways (machine tools, mass production of iron and steel 1840-1890), third, electrical and heavy engineering (cables, armaments, steel ships 1890-30), fourth, Fordist mass production (vehicles, aircraft, consumer durables, synthetic materials, petrochemicals 1930-1980). Each of these cycles depended on higher levels of knowledge and skill. Self taught artisans could adapt and improve water power technology and pottery glazing. They could not develop commercial jet aircraft, or synthetic materials with predictable properties. These needed formal education and training.

A fifth cycle may be under way. Globalisation is changing patterns of economic activity, employment and the knowledge and skills on which wealth generation

depends. It is linked to the development of new information and communication technologies (ICTs). Satellite communications, mobile phones, computers, data storage devices, and integrated information based services are infusing economic life in rich countries. The new technologies depend on sophisticated hardware fabrication, analytic insight and imagination in the design of software, and thoughtful application. They have been developed in countries with high levels of general education and training, and strong science and technology capabilities. They are associated with a growing "digital divide".

Lastly, for some the most striking feature of development in the second part of the twentieth century has been the transformation of countries around the Pacific rim. Few predicted that Singapore, Hong Kong, Taiwan and South Korea would grow at unprecedented rates of 10% or more for a quarter of a century and come to account for significant shares of world manufacturing and trade. Singapore and Hong Kong are now richer than the UK in terms of national income per capita[17]. By the mid-1990s the value added in manufacturing in South Korea was 65% of that of the UK, though it had a population 25% smaller. Hong Kong had become the seventh largest exporter and the sixth largest importer in the world with a population of only 7 million (Dicken 1998:27 et seq). Malaysia, Thailand, Indonesia, and the Philippines had growth rates which were consistently between 5% and 10%[18]. China's growth since the end of the Cultural Revolution has been stunning at over 10% per annum since 1980 (World Bank 2000:210). For anyone as fortunate as I have been to witness first hand these transformations, some of the messages are compelling.

There is much evidence that these East Asian countries benefited from a well educated labour force which had a relatively high level of skill endowment (World Bank 1993:43). Basic education was near universal in advance of periods of rapid economic growth in all the countries (Tan and Mingat, 1992:15, Lewin 1998). Much of the export led growth that they experienced was in high value products with high knowledge content. Many of these products, and the associated production processes, had a scientific and technological base. It is educational investment at secondary level and above that is most closely associated with the export-led growth of these countries (Wood and Ridao-Cano 1996:28). Skill accumulation occurred as a result of this investment, at the same time as skill intensity in industry and services increased, creating a virtuous circle for development.

The story of rapid development in these countries is complex. Many other factors in addition to education played a part[19] and these differed in importance between countries (Fukuyama 1995, Castells 2000). However all the countries did invest heavily in their education systems, and most targeted science and technology as a priority[20]. Without such investment growth would have been compromised. Further confirmation of the value of knowledge and skill accumulation comes from the recovery of the Asian Tiger economies that some pronounced dead after the currency crisis of the late 1990s. Dead Tigers do bounce. Their investments in human capital have remained a motor for growth.

The journey so far will come as no surprise to those familiar with the vast literature exploring the benefits of investment in human capital. This implies that economic growth cannot be explained by increases in land, labour and capital alone. What growth remains unexplained may be best understood as the result of increases in

productivity resulting from improvements in the quality of the labour force (through higher levels of education) and from innovations in technology (which depend on the application of knowledge). The arguments and the evidence need no repetition here[21].

When I first came to Sussex there was much debate about whether the role of education systems in development was best understood as an investment in human capital by individuals and states, or as a mechanism which allocated occupational and social roles in stratified societies. Human capital theory was under attack. Dependency theorists argued that schooling in developing countries was often oppressive, marginalising, and an obstacle to development. It was derived from colonially inherited models attractive to transnational elites, but of little utility for the mass of the population. Screening theory was fashionable - the idea that school systems identify more and less talented students and set them on different tracks without necessarily adding much to their capabilities (Berg 1970, Arrow 1973, Dore 1977)[22]. Rich country research suggested that home background, and other non-school variables, largely determined achievement, not the quality of schooling (Coleman 1966, Jencks 1972, Halsey 1977), though other research suggested that schooling might be much more important in developing countries[23]. Some went as far as to advocate de-schooling society - a prescription that seemed especially punitive for those in poor countries, many of whom were already unschooled (Illich 1972).

The Diploma Disease research on which I worked (Dore 1976, Oxenham 1984, Little 1997) suggested that later developing countries acquired the social technology of modern education systems under very different conditions from their development in early industrialising countries[24]. In particular, their importance in social role selection for scarce opportunities in modern sector employment, might overshadow their educational purposes. As a result they were prone to suffer from excessive amounts of examination orientation. This could lead to the trivialisation of knowledge, defined narrowly by examinations that promoted recall rather than higher cognitive skills. Arguably, there were adverse consequences *both* for those who succeeded (they were excessively examination orientated, their learning was dominated by the acquisition of discrete information to be recalled, their motivation to learn was extrinsically determined) and for those who failed (they lacked skills relevant to livelihoods, could apply little of what they learned, and suffered low self esteem). In Dore's words "learning to *get* a job might displace learning to *do* a job".

The Diploma Disease studies, and subsequent work (Lewin with Stuart 1991), did produce evidence that supported some of these propositions. Learning and teaching the developing countries we studied, did suffer from pressures arising from ritualised selection procedures, much of what was learned and taught was of dubious relevance for the majority of students.

But it did not have to be. If examination and assessment systems could be directed towards outcomes that had utility; and if *educational* qualification could be linked less directly to selection in the labour market, then perhaps schooling could make a more effective contribution to development. The conclusions did not contradict human capital theory.

Since these studies were undertaken, the neo-liberalism of the nineties has eclipsed the dependency and screening theorists. Governments, agencies and individuals

behave as if they believe in human capital theory - so also do many economists when considering school choice for their children! The de-schoolers have also disappeared from sight. It is now more obvious to me than it was 25 years ago, that those countries that have transformed their developmental status really *do* have more effective education systems than those that have not. And that successful promotion of scientific literacy and more specialised investment in science and technology has paid dividends.

What might we conclude from this part of discussion?

Development is about expanding choices, and the growth in resources that makes choices possible. Many of the things that are widely valued depend on knowledge and skills and the opportunity to apply them productively. Increasingly education systems, especially at secondary level and above[25], are at the core of the development process. As societies have become more complex, and the technologies on which they depend acquire higher "entry prices" in terms of knowledge and skill, those states and individuals who have invested in education have reaped economic and social benefits. Development has happened, the world economy has grown, and more have benefited than have been marginalised. It has not been a zero sum game where every winner needs a loser[26].

Before turning to discuss some of the challenges created for education by globalisation, it is useful to pause and remind ourselves of some of the realities that confront educational planners in poor countries.

The Education and Development Context

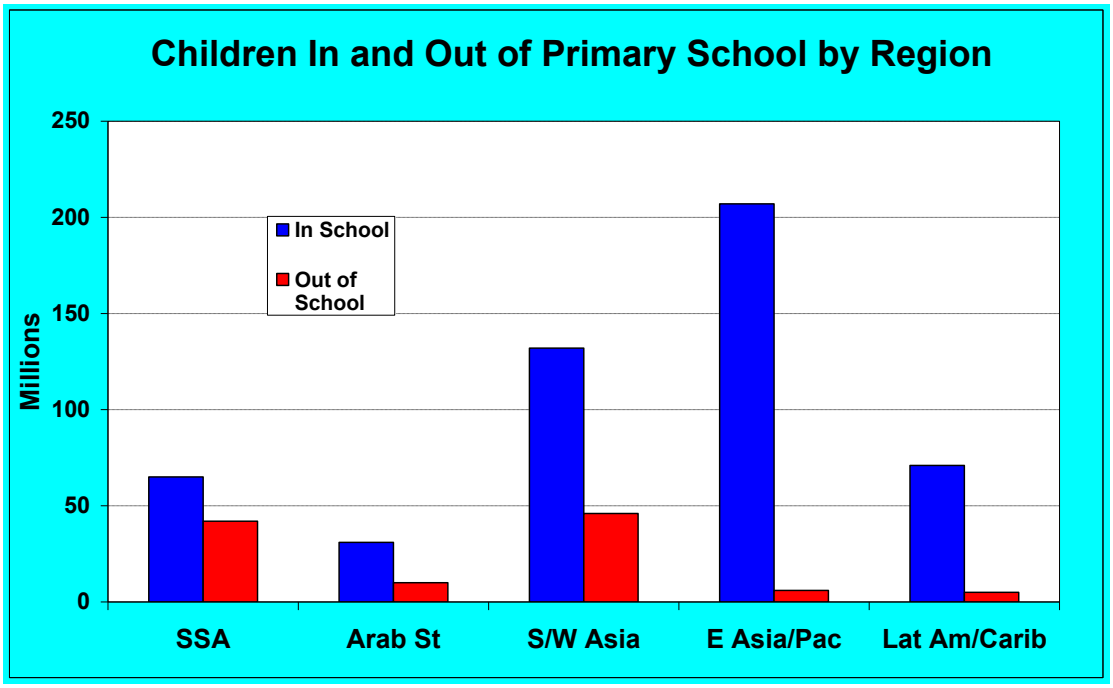
Three key factors shape educational development prospects. These are participation rates, dependency rates, and resource availability.

Participation

The 100 million children who do not attend school at all are located primarily in Sub-Saharan Africa and South Asia (about 18% of all children in developing countries) (Chart1). In these countries access to primary schooling remains a priority, but not to the exclusion to investment at higher levels. More than 60 million children do not attend secondary school in Africa (over 70% of those of school age) and over 180 million in Asia (over 45%), mostly in South Asia. Two thirds of the countries with low secondary enrolment are in Sub-Saharan Africa (Lewin and Caillods 2000:5).

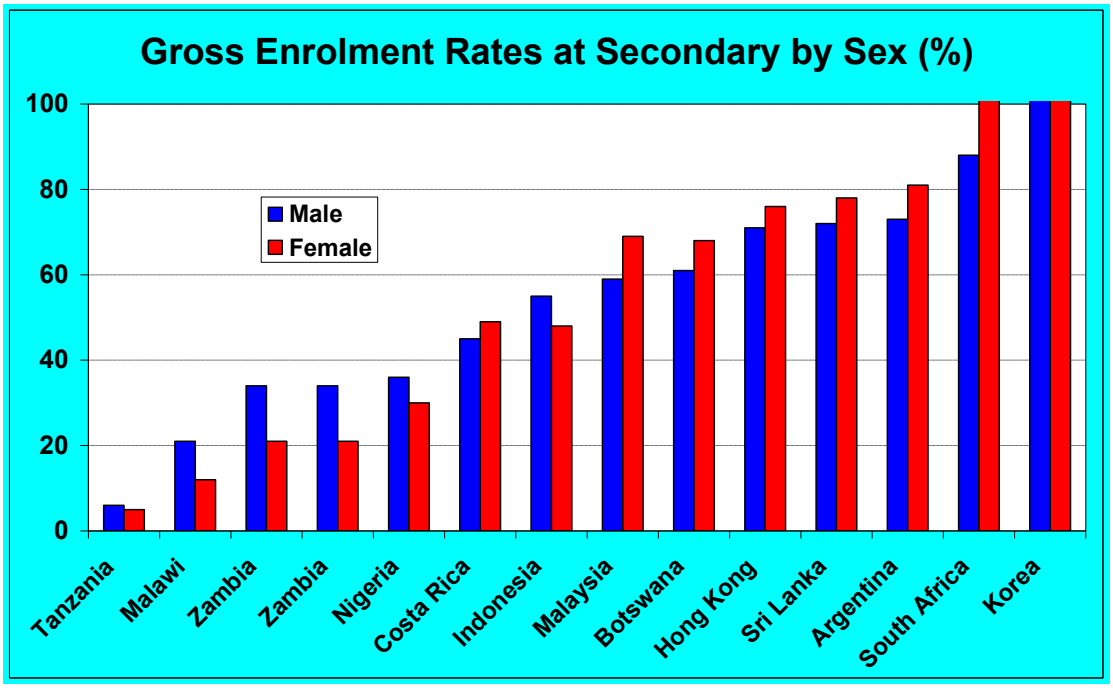
Chart 2 shows male and female enrolment rates[27] at secondary for selected countries. This indicates an upper limit to the proportion of pupils who might study science and technology[28]. It also implies that countries with low enrolment rates at secondary have more boys than girls enrolled, and those with higher enrolment rates have more girls.

Chart 1



Source: UNESCO Database 2000

Chart 2



Source: Lewin and Caillods, (2000)

Table 1 separates out all countries into four groups – those with enrolment rates at secondary below 40%, 40%-70%, 71%-90% and over 90%.

Table 1 Average values of GNP per capita, population growth, Gross Enrolment Rates at Primary (GER1) and Secondary (GER2), and % of females enrolled as % of males.

Country Group	Number of Countries	GNP per capita 1995 (US$)	Population growth rate % 1995	GER1 1995	GER2 1995	Primary female as % male 1995	Secondary female as % male 1995
V.Low GER2	44	590	2.9	80	21	81	70
Low GER2	37	2 550	2.1	106	56	97	100
Mid-GER2	34	5 830	1.2	101	80	98	106
High GER2	31	17 260	0.8	102	107	99	102

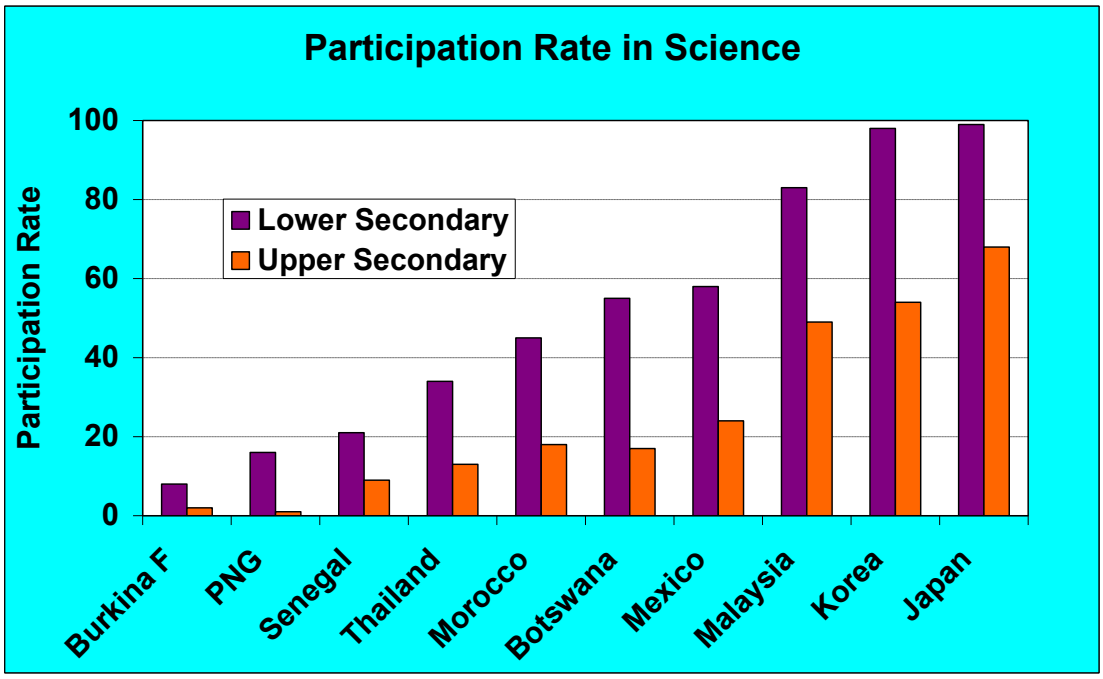
Source: Lewin and Caillods 2000)

Table 1 shows that countries with the lowest levels of participation in education have low GNP per capita, and high population growth rates. Gross enrolment rates at primary are over 100% in all but the first group of 44 countries (out of 146). Average female primary enrolment rates are similar to those of males except in the very low GER2 group. Strikingly, male enrolment rates exceed those of females in secondary schools in 90% of very low GER2 countries; female enrolment rates equal or exceed males in 70% of all other countries. Higher rates of secondary enrolment seem to favour females. These averages conceal the fact that in particular countries the picture may look very different. What we can conclude is that primary enrolment remains a substantial problem in the poorest countries, but not in others, and that secondary participation is well below levels that ensure that most complete the secondary cycle in a much larger group of countries.

Chart 3 shows estimated participation rates in science as a percentage of the age group for selected countries. The range is very wide - 5%-100% at lower secondary level and 2%-60% at upper secondary[29] (Caillods, Gottelman-Duret and Lewin 1997:31).

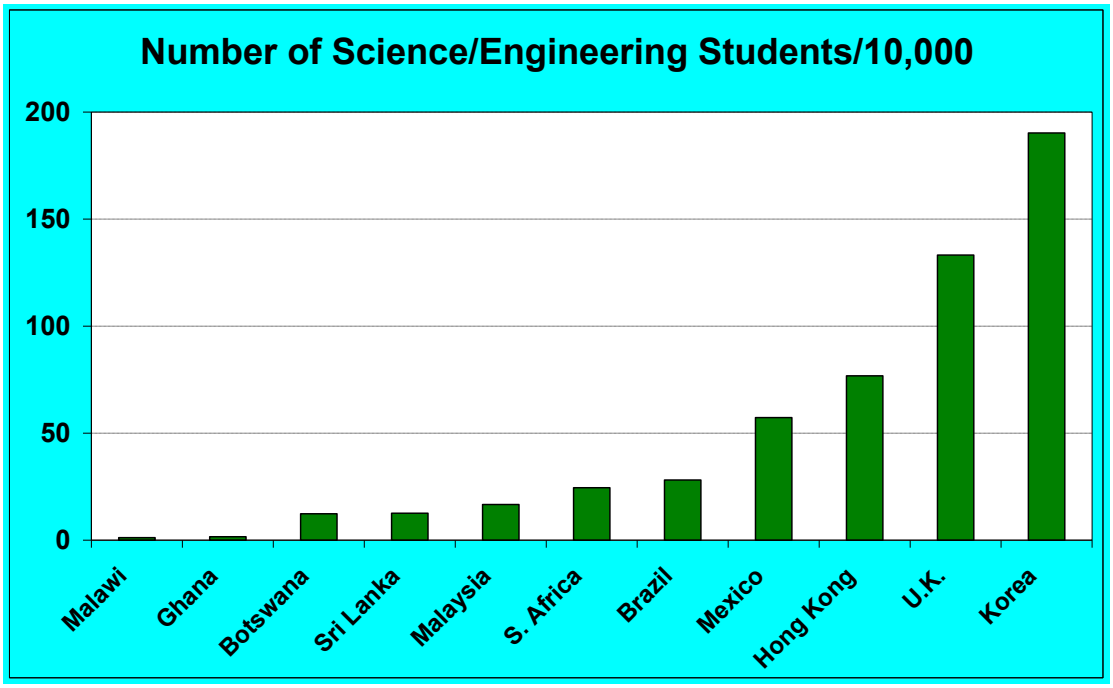
Chart 4 shows the number of science and engineering students in different countries. In Sub-Saharan Africa there can be less than 2 science and engineering students per 10,000 people, in Korea more than 180.

Chart 3



Source: Caillods, Gottelman-Duret and Lewin 1997

Chart 4



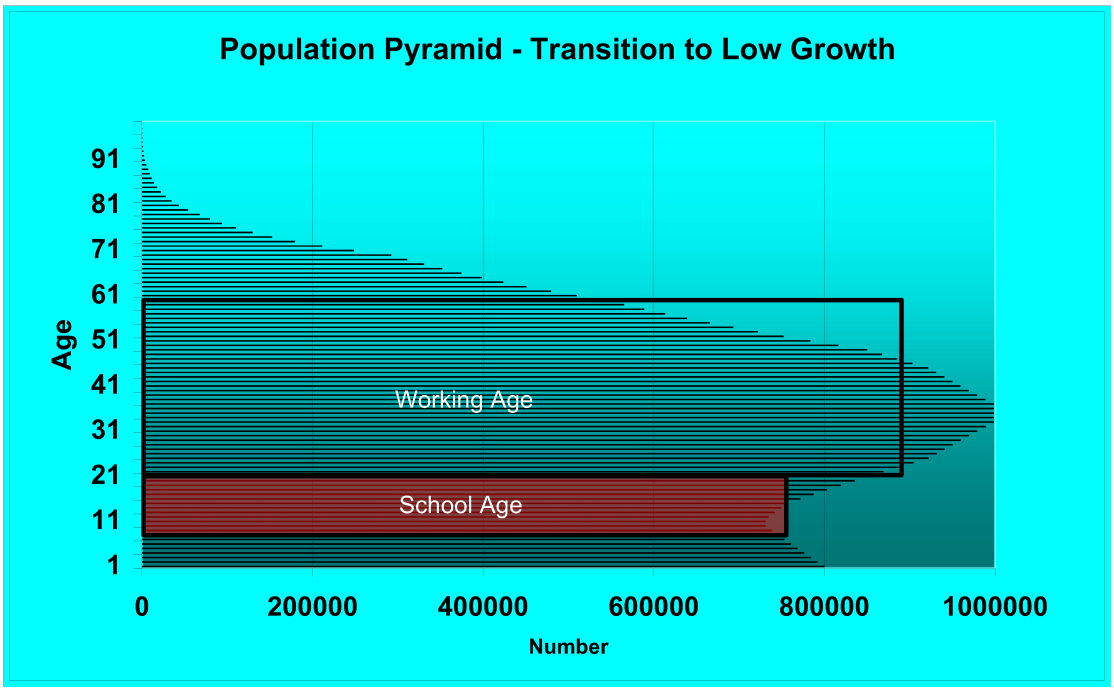
Source: UNESCO Database 2000

Demography

The greater the ratio of children to those of working age in the population, the more difficult it is to provide sufficient school places. In Europe 0-14 year olds comprise about 25% of the population from 15-65 years; in Sub Saharan Africa this proportion is over 85%. Dependency rates are high where population growth rates are high. If population grows at 3%, twice as many schools, teachers, textbooks etc. will be required every 25 years. In some Asian countries the number of children is falling[30] – allowing the amount invested in education per child to grow without increases in public spending, and facilitating high levels of secondary enrolment.

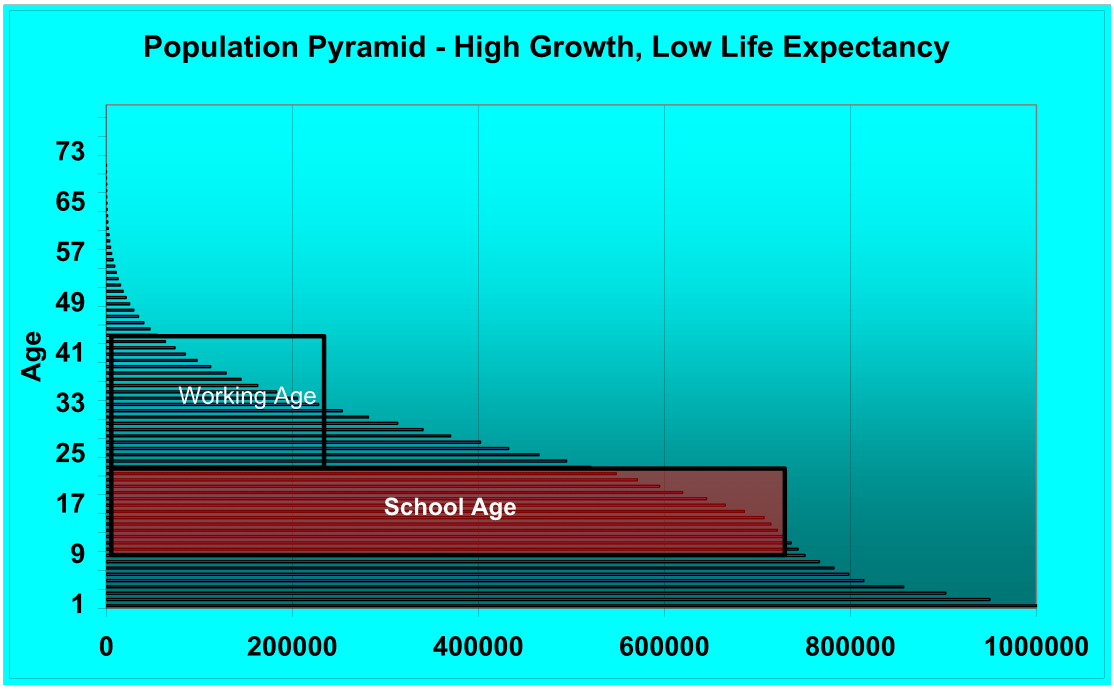
Demographic transition to lower growth has occurred widely[31], except in Sub-Saharan Africa. Falling birth rates lead to a greater ratio of those in the workforce to school age children making it possible to invest more per child an increase participation rates at sustainable levels of cost. Chart 5 illustrates this. Many studies show that fertility, infant mortality and children's health are linked to years of schooling, especially for girls (Cochrane 1979, Cochrane et al 1980, Berhman 1991) - more educated women tend to have fewer children, leading to lower dependence rates and higher enrolments for the same allocation of resources.

Chart 5



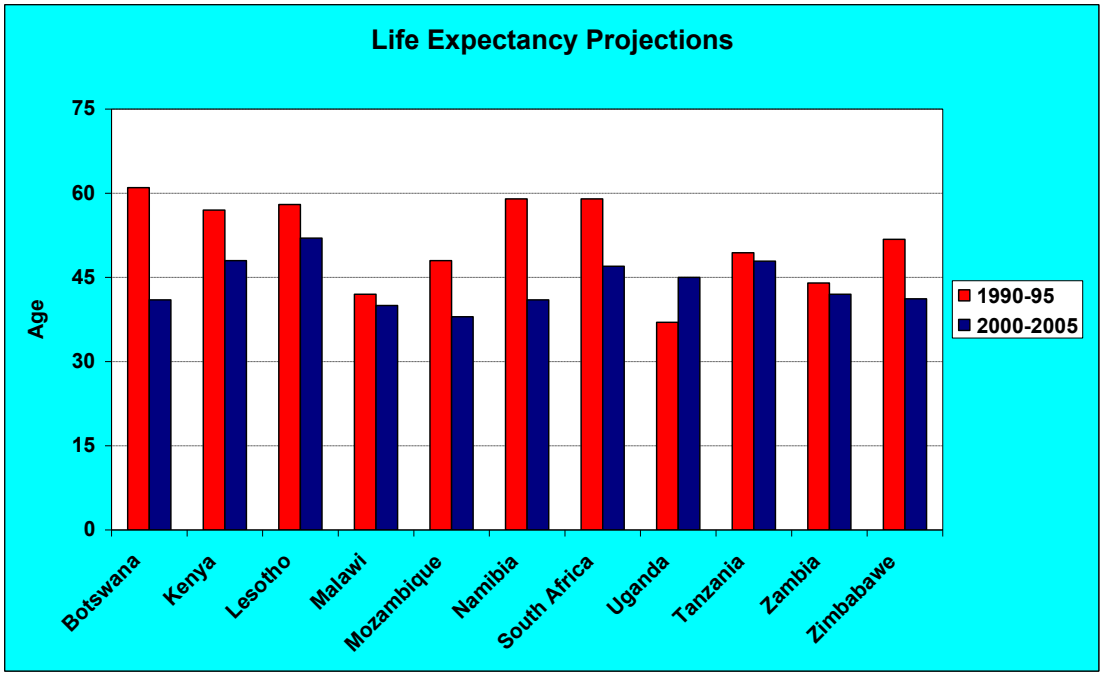
By contrast, where there is high population growth and low life expectancy, the ratio of those in the workforce to those of school age will fall. This makes it difficult to raise participation rates since the fewer workers are supporting the education of larger numbers of learners in schools. Chart 6 illustrates this.

Chart 6



Africa's high population growth rates may be changing. HIV/AIDS is the most serious threat to development in those countries worst affected[32]. Life expectancy is projected to fall by 10 to 20 years in more than 10 African countries over the next decade (Chart 7).

Chart 7



Source: UN Population Division 1998

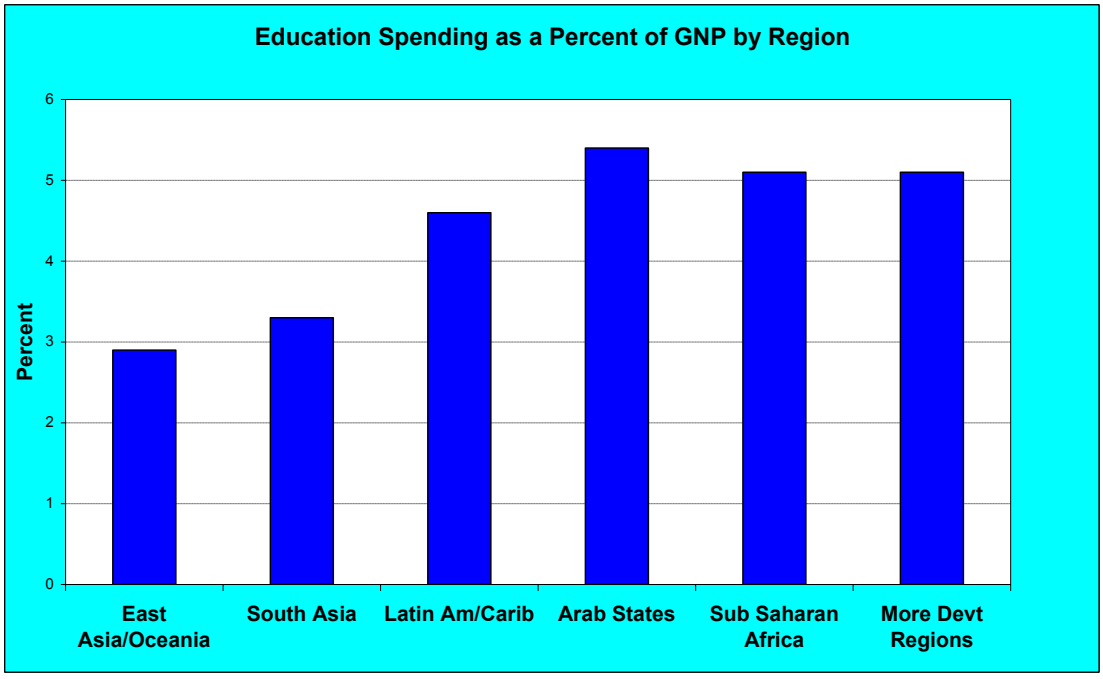
Other parts of the world are also seriously affected by HIV/AIDS. If health education campaigns are successful it is possible that pessimistic projections will prove unfounded[33]. If not, there will be far reaching implications for participation, teacher supply, science and technology curriculum, and educational finance.

HIV/AIDS is an educational problem (and a science education problem) both from the point of view of the public health awareness that can reduce new infections, and in terms of the knowledge and skills needed to develop methods of medical intervention in relation to its transmission and treatment[34].

Resources

Globally, public expenditure on education represents about 4.8 % of GNP. Sub-Saharan Africa exceeds this (5.1%); East and Southern Asia allocate significantly less - around 3%. Somehow they manage to deliver more education for less[35] (Chart 8). Within these averages there are wide variations. Namibia and Botswana allocate more than 8%, whilst Zambia commits a little over 2%; Malysia over 5% and Pakistan no more than 3%. This indicates very different levels of public commitment to education.

Chart 8



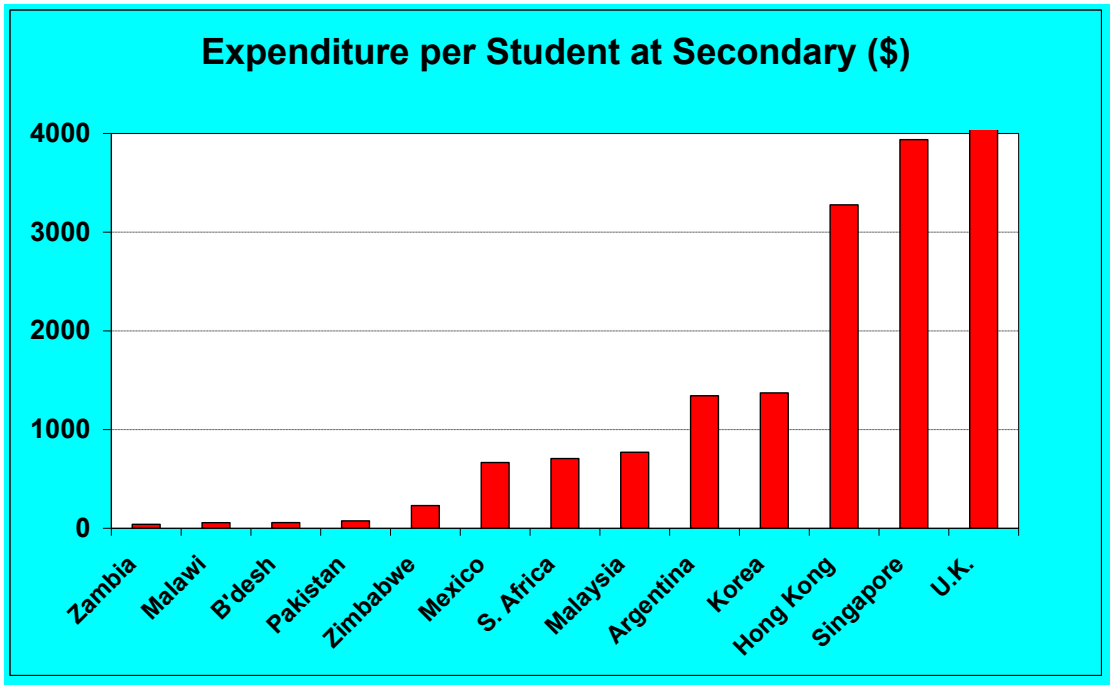
Source: UNESCO Database 2000

The amounts of money these percentages represent give some idea of the resources available. Malawi allocates about 5.5% of GNP to all educational services (about US$ 120 million). It is used to educate nearly 3 million primary school students, perhaps 150,000 secondary students and a few thousand undergraduates[36]. This is about the same as the annual recurrent budget of the University of Sussex!

The richest countries allocate more than $5000 per secondary student per year; the poorest less than $100 (Chart 9). If 10% of expenditure is retained for non-salary

expenditure and 20% is allocated to science and technology education, then the amounts available in the poorest countries can be as low as $2 per student per year[37]. At higher education level the comparable figure is about US$50 in Sub Saharan Africa.

Chart 9



Source: UNESCO Database 2000

From this and other data we can make the following observations.

> Participation at primary remains problematic in parts of Africa and South Asia, especially in the poorest countries.
>
> Participation in secondary schooling and in science is low in a much larger group of developing countries. This results in very small numbers following science and engineering to higher education levels. This has consequences for labour markets and for development strategies.
>
> Demographic transition to lower population growth rates and dependency ratios facilitates higher enrolment rates and resources per child.
>
> Educational spending as a proportion of GNP is low in some regions but not all. It buys different enrolment rates. The real amounts available to support science and technology education can be very small in the poorest countries.

It is against this backdrop that we now turn to consider knowledge matters and globalisation.

Globalisation

Globalisation has many definitions, possibly as many as the number of authors contributing to the field. At the last count Amazon.com lists 104 book titles including the word "globalisation". A simple (economic) definition is that globalisation is defined by the development of international markets and the lowering of transaction costs, otherwise encapsulated in the word "liberalisation". National and international economic policy has shifted substantially since the 1970s to favour marketisation and the reduction or removal of barriers to trade (UNDP 1999:29). Although there is some consensus that something is happening which is different, there is a lot of disagreement about what it is, and whether it is to be welcomed or resisted[38].

Some conservatives contest whether globalisation represents real changes. They note that in the nineteenth century Europe and North America dominated world trade and imposed "global" institutions on others. Although trade seems to have become more globalised, with exports rising rapidly, 80% of foreign direct investment remains concentrated in only 20 out of 190 countries. How globalised are the other 170[39]? Nevertheless, it is true that multinational corporations have expanded their share of trade[40]. They were responsible for more than one third of world exports by the mid-1990s, bringing with their activities commonalities in products, processes, employment and training practices between countries.

For social theorists (e.g. Green 1997), Giddens (1999), Castells 2000) globalisation extends well beyond the realm of economics. Trade in goods with a cultural dimension has become a vast enterprise - fast food franchises, CNN, media narratives from Disney to Diana, and Manchester United shops in Malaysia[41]. By some measures the USA's largest export industry is not computers, aircraft or cars; it is films and television programming (UNDP 1999:33). These shape the way people think, what they desire, and their values and their actions. The growing mobility of workers, and of jobs, between countries, leads to new social dislocations. As many as 150 million people live and work outside their countries of origin legally, and many more illegally. Tourism brings millions of people into cross cultural contact, and sometimes conflict. Very large numbers of students travel abroad to study; many more take courses, the design of which is determined by rich country tastes and preferences. Increasingly education, qualifications and training services are being traded across borders and into developing countries (Little 2000) (e.g. by examination boards, publishers of educational texts and software, suppliers of consultancy services, and through satellite university campuses[42]).

The implications for education systems of economic liberalisation and the globalised diffusion of cultural artefacts have many nuances (Hallak 1998). The consequences of embracing policy associated with liberalisation (e.g. markets, competition, privatisation, student fees) have been far reaching. China's Open Door policy in the 1980s and its embrace of virtually unregulated capitalism - " the socialist market economy" - across most economic activities is but the most striking triumph, if that is what it is, of free market economics.

When I first started working in China after the Cultural Revolution the Communist party permeated every activity of ordinary people. Income inequality, and incomes were low; school participation rates were high, and there was relatively little variation between schools in curriculum, teachers' salaries, costs per child, and availability of

learning materials. Mao's famous dictum that "good thoughts lead to good deeds" was being replaced by Deng Xiao Peng's pragmatic "the only criterion of truth is practice", "cats that catch mice deserve the cream" and "let a few people get rich" (Lewin, Little et al 1984, Lewin, Wang et al, 1984). Sixteen years later our recent study showed astonishing variations between urban and rural schools. City school finances have been transformed as a result of official and unofficial uses of assets (renting out buildings, selling playgrounds for commercial development), charging of fees, requiring "donations" for enrolment to prestigious colleges, and running businesses from taxis to kindergartens (Lewin, Qu Heng Chang et al 2000). School children follow international sporting events, dress at the cutting edge of fashion, aspire to possess mobile phones, and ambitiously pursue individual success. Neo-liberalism has thus come to China in a number of vigorous, unpredictable and potentially socially disruptive forms.

What are some of the more specific issues that globalisation invokes for educational development? I comment on three arenas – employment and skills, the impact of ICTs, and possible implications for the curriculum.

Employment and Skill Issues

Reich (1993:173) has drawn attention to how rich world labour markets are segmented in terms of routine production workers, in-person service providers, and symbolic analysts[43]. The latter "solve, identify and broker" problems by manipulating symbols. Included in this category are people who "call themselves research scientists, design, software, civil, and biotechnology engineers", and "even a few creative accountants". Their tools "May be mathematical algorithms, financial gimmicks, scientific principles, psychological insights about how to persuade and amuse, systems of induction or deduction, or any other set of techniques for doing conceptual puzzles". This already sounds like a case in favour of emphasising investment in science and technology education. Reich sees symbolic analysts as a motor for growth, arguing that "even the most impressive positions in organisations are vulnerable to worldwide competition if they entail easily replicable routines. The only true competitive advantage lies in the application skills in solving, identifying, and brokering new problems". Each nation's primary assets "will be its citizen's skills and insights". By this account even the Ford Motor Company needed to, and was becoming, post-Fordist in its organisation, and the skills it needed in its work force.

The services of production workers and symbolic analysts (and to an increasing extent for in-person services[44]) are traded globally. They benefit from higher rather than lower levels of knowledge and skill, which need to be associated with a whole range of other attributes[45] to be traded competitively. Increasingly jobs, as well as people, migrate. The software industry in Bangalore has successfully captured substantial amounts of work from companies who find it cheaper to employ (relatively) well paid Indian computer professionals. Airline ticketing is now routinely serviced from centres in developing countries where labour cost are low, international languages are spoken, and workers are reliable and well educated. The NHS processes its dental records in Sri Lanka.

Recently, a UK based dot.com company[46] sent five tons of data to China to create a data base from the register of electors (Times August 26th). I logged into this site out of curiosity. Within five minutes I established the names and telephone numbers of all the residents in my street, including home based businesses, obtained an ordnance survey based map of my location, and an aerial photograph of my house. I could have this for anyone in eight European countries. More was on offer at a price. Scary, perhaps? An illustration of the supremacy of the symbolic analyst? Yes. Worrying for low skill employees, especially in rich countries? Yes. A challenge for 21st century education? Most certainly, in terms of the implications of who does what and where in terms of knowledge and skill, value added, and the marginalisation of those on the wrong side of the digital divide.

Globalisation has encouraged the movement of production with mature technologies down a staircase related to factor costs. Where labour costs are an important part of the cost of a product, it is the quality of this labour, its technical skill, language abilities, and motivation that create comparative advantages. These derive in significant part from educational investment. At any given level of labour cost those countries which can offer a more highly educated labour force are likely to attract more inward investment, whether it is in industry or services, and add more value[47].

Where does this lead in terms of development and educational futures? We have noted the success in terms of export led growth, of high rather than low skill strategies. This has clearly worked for countries like Singapore, Korea and Taiwan (Castells 2000). But what of the poorer developing countries, especially those in Africa and South Asia?

Adrian Wood's analysis of land/worker ratios and average years of schooling in a range of developing countries reveals different distribution patterns for Africa and other regions over time, and between countries in Africa (Wood and Mayer 1999). The basic propositions are that Africa is resource rich (large amounts of land per worker), and relatively poorly educated (low average years of schooling). By contrast South Asia, the other under-educated region of the world, has high population density but low levels of land per worker. Arguably, these circumstances lead to different patterns in the composition of exports. The share of manufactures in exports is low in Africa because of the relative abundance of natural resources. In contrast, South Asia has a much higher proportion of manufactured exports because of its relative lack of natural resources.

The implication drawn is that if South Asian countries want to move from labour intensive goods and services, which only require low levels of skill, to those with greater value added, their best chance is to follow the footsteps of the Asian Tiger economies and emphasise manufacturing (and services) with higher levels of skill[48]. Manufacturing led growth may not be a wise choice for many African countries. The handicaps imposed by high transport costs, poor infrastructure, small domestic markets, and low skill labour, mean that competitive advantage will remain elusive. If so, 'the problem then becomes: how can African countries break out of their low-trade, low skill rut?' (Wood 2000:2). The suggestion is that a continued focus on primary products, coupled with attempts to process and add value to them with more educated and skilled labour, is more attractive.

Skill accumulation remains the best option for both regions. Investment in education, especially above the primary level is crucial. Science and technology education have a special role to play. Their potential value for manufacturing is obvious. Two examples illustrate other possibilities. Horticultural exports from Africa have been growing very rapidly (out of season and exotic vegetables, flowers etc). Efficient production and marketing depends on an integrated system that can ensure quality and is sensitive to the perishable nature of most produce. It also requires technical skills in horticulture. More value can be added by those who understand the science. Tourism is another area targeted for growth. As with horticulture, it requires an integrated set of skills to develop and manage tourism, especially if the ambition is to move upstream into the markets that supply tourists, which is where most value is added. Penetration of these markets requires competencies in communication, information processing, finance, and organisation. It also benefits from investment in the kind of science and technology that increases the numbers of technical and service sector workers who can operate and maintain tourist facilities (in hotels and catering, transport, communications) at appropriate levels of quality and reliability.

Information and Communication Technologies

ICTs and the transformations in learning processes and access to knowledge have far reaching implications that are poorly understood. Advocacy of the imaginable often precedes the demonstration of benefits to learners under realistically available conditions. "Vapourware" is common. Most development agencies are committed to supporting access to ICTs, and reducing the "digital divide"[49]. ICTs can enable many things - access to learning materials at a distance, connectivity between learners and teachers, flexible scheduling of learning, improved educational management and methods of assessment (Lewin 2000). The realisation of these benefits depends on reliable access at sustainable cost.

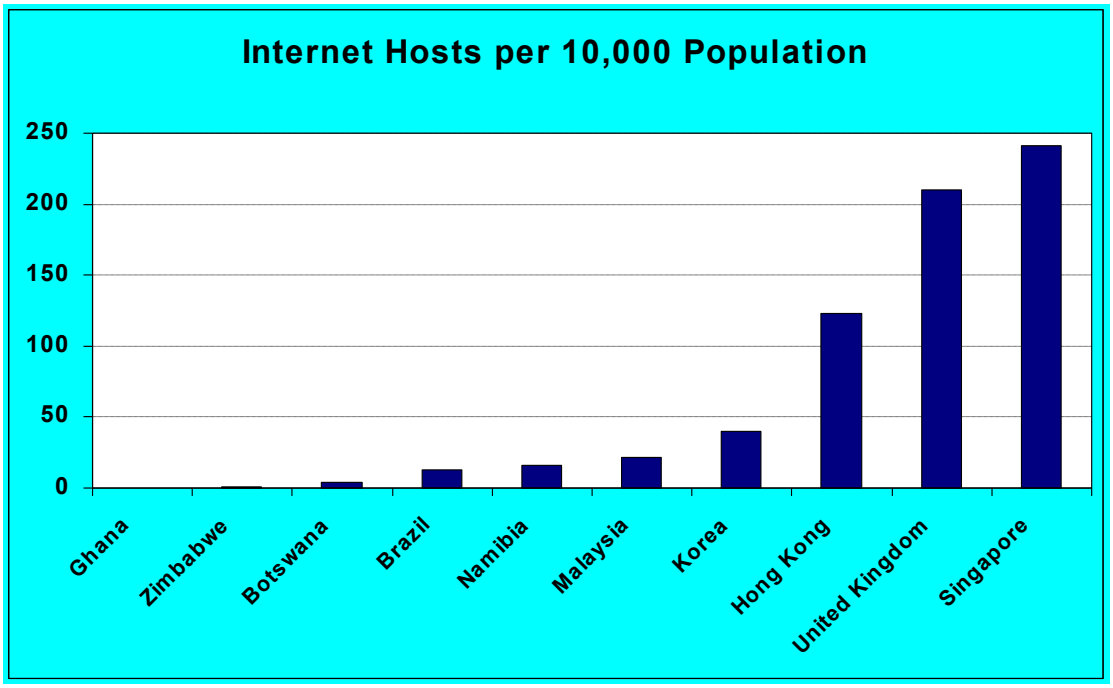
Costs arising from hardware, software and infrastructure are often underestimated. Hardware may be becoming cheaper, but it is not that cheap when compared to the amounts available per child in the poorest countries. Remember that expenditure can be as low as a few dollars per child per year at secondary, and say US$40 at tertiary level in the poorest countries.

The problems are worse. Quality software has high initial development costs. The enforcement of intellectual property rights has encouraged concentration, product standardisation, and monopolistic practices in pricing. Software is increasingly rented rather than sold, creating a recurrent cost burden. Continued dependence on major software producers and their tastes, preferences and prices is difficult to avoid.

Lastly, telecommunications infrastructure is critical for connectivity. Asian Tiger economies provide telephone access of 50 lines per 100 population or better. In much of Africa line access is below 1 per 100 (World Bank 2000:266). Connectivity varies enormously. The US had over 6 million internet hosts in 1996, compared to 23,000 in Singapore, 2,400 in Indonesia, 90 in Zimbabwe and 60 in Uganda (Mansell and Wehn 1998). Chart 10 shows the number of internet host per 10,000 people for selected countries in 1998. As noted above, the numbers of students in science and engineering in the poorest developing countries can be below 2 per 10,000 compared to less than

one per 100 in rich countries. This gives some indication of the availability of those who can technically manage and develop ICT systems.

Chart 10



Source: World Development Report, World Bank, 2000

Educators need to remember print remains by far the cheapest learning technology. It also does not require power or electronic devices to access. Radio and audio are also relatively cheap. CD-ROMs can have more than forty times the development costs of print if they contain interactive routines (Perraton and Hulsmann 1998:17). These come with all the on costs of equipment and maintenance. In addition, connectivity brings line charges, and, if it is interactive, the costs of the time of those interacting have to be considered. Literacy remains a pre-requisite for access to learning materials; on the internet this is often in English) [50].

The short run implication of this analysis of educational opportunities and resource constraints is that the digital divide is likely to grow rather than shrink, not least because it is a moving target[51]. Mass access to global connectivity in the poorest countries is unrealistic over the next decade. Too many antecedent conditions need to be satisfied. For minorities, concentrated in the professions, in business and amongst the wealthy, participation in global networks offers real advantages, which may or may not be shared. If there is a public strategy it will be one that provides selective access for intermediaries (e.g. teacher educators, in-service co-ordinators, curriculum developers) who can diffuse benefits to the broader community of education professionals[52].

Middle income developing countries can and will acquire adequate infrastructure to allow mass access to ICTs. By some accounts Korea already has as many broadband users as the US. The multi-media corridor in Malaysia and its "smart schools" may take off. The possibilities exist to exploit the technology to reflect local preferences for learning systems and contest the "Northern" hegemony of the internet. If this is to

happen, it will be achieved by those who acquire knowledge and skills from secondary and higher education. It will also depend on a sufficient supply of science and technology trained workers necessary to maintain and develop ICT infrastructure.

Development agencies can make a difference. They can invest in telecommunications infrastructure; encourage the development of professional networks amongst curriculum developers, teacher trainers, and examiners; subsidise software applications at affordable levels of cost; promote quality assured diversity in learning material available on line; evaluate the cost effectiveness of old and new information technologies, including print and radio; and support science and technology education. Selective investment is essential if waste is to be avoided. Discriminating choice in the use of ICTs and the internet is critical. The Economist may be right when it argues that ICTs are very good at those things which are "data intensive, time sensitive, and just plain dodgy". The latter are to be avoided (Economist 2000:19th Aug,2000:60).

Learning Issues

So far I have said little about educational process and curriculum. How and what students learn is at the heart of the educational endeavour. It is tempting and provocative, though possibly misleading, to see school systems, which replicate their form throughout the world, through Fordist eyes. Fordism, remember, is a production system characteristic of the fourth wave of industrialisation. In Fordist systems products are standardised to minimise variations in inputs and process, production is planned to maximise efficiency and minimise labour costs, innovation in products and processes is intermittent, and quality is controlled after manufacture by specialised workers who inspect output.

Post-Fordist production is different. In this production systems are designed to accommodate a wide range of variations in basic products which can be produced flexibly to meet changing consumer demand. Labour is regarded as an asset whose potential to contribute to production should be maximised, rather than being regarded as a costly input that should be minimised. The workforce at every level is encouraged to suggest innovations that will improve process and products. Responsibility for quality control is distributed across the workforce and defects are rectified at the time they occur. At least for some kinds of production, Post-Fordist approaches are thought to be more effective (Kaplinsky 1995).

Does Post-Fordism have anything to say about more effective learning and teaching in general, and in science and technology in particular? Post-Fordism can be characterised by five dimensions (Figure 1). How might these be translated into educational developments?

Figure 1 Learning and Post Fordism

Fordist	Post Fordist
Standardised products	**Differentiated Products**
Production "pushed"	**Demand "pulled"**
Labour contribution minimised	**Learner contribution maximised**
Individual and sporadic innovation	**Collective, continuous improvement**
Quality control at output	**Quality control at input**

First, to what extent does science and technology education (STE) allow differentiated products? The complexity and rates of change of labour markets suggest that a "one size fits all" policy on STE is undesirable. Many different needs can be envisaged for different groups. Graduate engineers need different STE to those who work at the technician level. General scientific literacy needs different approaches to those for future specialists.

Second, is production *pushed* by supply or *pulled* by demand? The educational planning question is to what extent is the curriculum, and policy on streaming and tracking, responsive to changing patterns of demand from students and employers? Arguably, much STE curriculum development has been *pushed* rather than *pulled* and there has been very limited contextualised analysis of what might constitute useful knowledge and skills for school leavers. Perhaps there should be a different balance.

Third, does STE minimise contributions from students or involve them in improving their own learning? Many conventional STE programmes put students in the role of learner and assume that they have not much to contribute to the learning process. Active involvement of students, through invitations to suggest better ways of understanding science and technology, and more "constructivist" use of students' perspectives, might pay dividends in motivation and in relevance.

Fourth, are students encouraged to acquire skills related to continuous improvement and co-operative rather than competitive problem solving? For much STE this is not obviously so. STE systems are often characterised more by competition for grades, than by co-operation in the solution of collectively owned problems.

Fifth, how is quality control achieved? In much STE quality assurance remains summative and takes the form of external examinations. STE students rarely evaluate their own work and that of peers. Such forms of quality control seem more likely to encourage conformity rather than creativity, and devalue the development of internal standards.

Science educators will recognise some of these hypothetical alternatives in the rhetoric of science curriculum development in developing countries. But not in much of the empirical evidence on the realities (e.g. Lewin and Dunne (2000a), Caillods,

Gottelman-Duret and Lewin 1997, Lewin 1992, Postlethwaite and Wiley 1992, Ware 1992, Walberg 1991).

What then might be some concrete strategies to develop and implement such curricula[53]? First there is a need to strike a balance between the needs of those who specialise in science and technology and those who do not. At some level this implies selection, concentration of investment, and differentiated curricula. It may also invoke needs to manage participation to increase numbers from especially disadvantage groups. Second, wherever there is a choice, content and skills should be identified that relate to common occupations and livelihoods. Technologised science education, which relates science concepts to application, is attractive. Pedagogy that complements application with a complementary emphasis on underlying theoretical knowledge and the development of scientific thinking skills is desirable. Third, the contribution STE can make to informal sector livelihoods and to poverty alleviation should be valued. "Street science" can benefit scientific literacy; STE can and should help reduce the incidence of malnutrition and disease based on ignorance. Fourth, assessment methods should reward conceptualization, analysis and application, not emphasise the recall of disconnected facts, and the decontextualised application of concepts.

Concluding Remarks

The ideas that shape commentaries on globalisation are predominantly drawn from economics. These use globalisation mostly in the transitive sense of something that is being made to happen with intent, and which is a result of a concious policy to change in certain ways e.g. to adopt best practice and remain competitive in a global economy. Cultural analyses of globalisation tend to focus more on effects, and approach globalisation in an intransitive[54] way as something which is happening to societies and individuals, like it or not, and which requires a response. Those who work on education often fall into the latter category. They do not have to.

It is important to remember that education systems differ in many important respects from globalised production systems. Their purposes embrace many non-economic goals. The acquisition of knowledge and skill, which is at the heart of development, have little purpose if disembodied from the motivations, aspirations, and values that allow choices to be made that lead to diverse ways of making the world a better place.

Finally, we should remember that globalisation can look very different from alternative perspectives. The Department of Trade and Industry regards international educational services as a fifteen billion pound industry, not a programme of global enlightenment. Looked at from a poor country perspective this may look much less like globalisation, and more like internationalisation. It can look like Anglicisation or Americanisation, or even neo-colonialisation. And this is what it may be. Paradoxically, the best defence may indeed be more education, knowledge and skill, albeit of an enlightened kind!

I hope I have persuaded you of several things.

First, that knowledge does matter for development. It is at the core of the process in all but the short term. Investment in education is both a means to promote development, and part of its definition.

Second, that sustainable development requires growth. Knowledge and skills related to science and technology play a special role in development. We should maintain our confidence that this is so, and encourage development agencies and governments in developing countries to share this view.

Third, that globalisation is changing what people do, where they do it, and how wealth is generated. This, and the diffusion of new information and communication technologies, creates opportunities and risks for development. What these are, and how people choose to respond, will depend in part on how knowledge and skills are distributed across a divided world. Ignorance is not bliss, but a guarantee of marginalisation.

Lastly, what is learned, and how it is taught, remains at the heart of the educational enterprise. The task for educators is to translate knowledge and skill that matter, into new forms of learning and teaching which can lead *to Wealth from Knowledge*[55]. Our aspiration should be that as many children as possible and grasp their futures with the benefit of the intellectual tools that those in rich countries so easily take for granted.

End Notes

[1] Most simply indicated by the size of Gross National Product (GNP) per capita.

[2] By comparison the UK GNP per Capita is US$ 21,500, and the USA US$29,000.

[3] In addition 1.3 billion people do not have access to clean water; over 800 million are malnourished, and 1.3 billion live on less than US$1 per day (UNDP 1999:28).

[4] That at least is what many governments and development agencies seem have concluded as a rationale for promoting investment in education and training designed to support capacity building, skills for development, and good government.

[5] The Pacific rim countries include the "Tiger" economies of Korea, Taiwan, Singapore and Hong Kong, and the second wave of rapidly developing countries like Malaysia, Thailand, and the Philippines.

[6] Eagleton's attempt to define post modernism's stance towards cultural tradition as one of "irreverent pastiche and contrived depthlessness (which) undermines all metaphysical solemnities" speaks for itself (Eagleton 1987 quoted in Harvey 1995).

[7] Seers and Joy 1971 Development in a Divided World, Penguin.

[8] I use developing countries to refer broadly to those countries classified by the World Bank as low and low middle income countries. This groups includes countries with GNP per capita below about US$3000. They are very diverse and any thorough understanding of their developmental status has to recognise differences in history, culture and economic base.

[9] Much has been written on the meaning of development since Seers was writing at the Institute of Development Studies at Sussex (Seers 1969,1977) and many fundamental disagreements remain. One which is no longer in much doubt is that

"education is both a present benefit and an investment in future skills" (Jolly 1971:207)[9].

[10] The HDI in essence aggregates measures of life expectancy, literacy, combined enrolment rates and GNP per capita (PPP) to arrive at a proxy measure of developmental status which is argued to be more meaningful than GNP per capita alone (UNDP 1999:127). All these parameters are widely associated with higher levels of education in a positive direction.

[11] The long sweep of history intrigues with many unresolved debates about the relationships between technology and development. The motives for technological development may well have been mixed. Some may be explained as enlightened attempts to improve the living conditions of individuals and communities. Others were more obviously related to the imperatives of war and conquest.

[12] This is one way of describing the events that followed what Europeans call the "voyages of discovery",

[13] Astronomy and time were alternative ways of providing the answer. The former required difficult observation of astronical objects from a moving ship and careful calculation. The latter was essentially a practical problem of developing very accurate time measurement.

[14] Amazing though his achievements are, a quartz clock would have baffled him. He could neither have built it, or reverse engineered it, to understand how it worked. For that he would have needed more education and tools he did not possess.

[15] Moveable type was used in Korea and China at least 600 years before Guttenburg printed his bible. It failed to result in a flood of printed material because other innovations (e.g. in metallurgy, ink, and paper) appear to have been absent, and because alphabetic writing has a small number of letters, unlike Korean and Chinese.

[16] These long waves are sometimes called Kondratiev cycles (Freeman and Perez 1988, Dicken 1998:148)

[17] GNP per capita in Hong Kong is US$24,000, in Singapore US$30,000.

[18] The currency crisis of the late 1990s temporarily stalled growth in these countries. Already Malaysia is recovering with projected growth of more than 7% in 2000.

[19] Flows of foreign investment, strong state intervention in industrial development policy, periods of protection from world market forces, patterns of family investment and control

[20] Visitors to these countries can be in no doubt that science and technology are seen as being at the core of development – Singapore's public promotion of science centres - even in the airport - and Malaysia's confident investment in "smart" schools are indicative.

[21] See Schultz (1961), Denison (1964), Becker (1964), Blaug (1970), Psacharopoulos (1975), Lewin (1994).

[22] See also Layard and Psacharopoulos 1974, Stiglitz 1975,

[23] Thus some studies suggested that schools might well be more important than social background in many developing countries where schools were the only modern institution that most children experienced (e.g. Heyneman and Loxley 1983, Fuller 1987)

[24] Developing from Gerschenkron's ideas on late development.

[25] The role of investment at secondary level and above now seems to me to be critical. Our earlier work related to the World Conference on Education for All at Jomtien stressed the importance of universalising access to primary school in those countries that had not achieved this (Colclough with Lewin 1993). Ten years on all countries that have committed themselves to this goal have access to considerable external assistance to support the achievement of this outcome. Once they do, the sustainability of the achievement will depend on growth. This is most likely to be catalysed by those with education beyond primary level.

[26] More people live longer and healthier lives with higher real incomes than three decades ago. Some have been less fortunate, especially in Africa. But in most countries in most regions of the world real growth has occurred, and has been reflected in improving indicators of developmental status.

[27] All enrolment rates referred to are Gross Enrolment Rates i.e. the number enrolled over the number in the appropriate age group. These rates can be over 100% as a result of over age enrolment and repetition.

[28] It also suggests that where secondary enrolment rates are high the particiaption of females is likely to be greater than that of males. This is confirmed in a more systematic analysis of the data (Lewin and Caillods 2000). Males outnumber females in 90% of very low secondary enrolment countries, whereas females equal or outnumber males in 70% of all other countries.

[29] The number of hours taught to science students also varies widely from 150 to 450 hours a year at lower secondary, and up to 600 hours at upper secondary for these countries

[30] E.g (Hong Kong, Taiwan, Singapore, Korea)

[31] E.g. India, China, Bangladesh, and Indonesia have population growth rates below 2%.

[32] Some data from a recent study in South Africa is salutary. Coombe (2000) quotes infection rates in the population rising to over 20%, new cases exceeding half a million a year, the number of orphans exceeding 2 million, and life expectancy falling dramatically from over 50 to below 40 years. In KwaZulu it is estimated that this year 7% of children are already orphans; on current projections as many as 25% will be by 2015. About 12% of teachers are HIV positive. Projections suggest that as many as 25% of educators will die over the next decade on current trends (UNDP). This is consistent with trends in other similarly affected countries (Barnett and Whiteside 1999).

[33] Life expectancy appears to be increasing in Uganda for this reason.

[34] Our work in Malawi (Kunje and Lewin 2000) suggests that teacher attrition may already be in excess of 10% per annum, raising questions about the kind of training it is appropriate to provide to teachers who have shorter careers than might otherwise be the case. Bennell, Hyde and Swainson are completing a study based in the Centre for International Education exploring the impact of HIV/AIDS on education systems in Africa.

[35] A well known example is Sri Lanka which has a GNP per capita of about US$800, but has had universal primary enrolment since the 1970s and most pupils remain enrolled up to grade 11 (Lewin

and Mallawarachchi, 2000). Asian systems typically have lower salary costs as a proportion of GNP per capita than African systems.

[36] In contrast Malaysia, a much richer country, allocated 5.2% of GNP in 1996 (US$4.7 billion) to educate about 2.6 million primary students, 1.5 million secondary, and over 200,000 in higher education.

[37] At university level African countries average about US$1000 per student compared to US$7000 or more in rich countries.

[38] Glyn and Sutcliffe (1992) fall into the category of conservatives, as does Gray (1998). In contrast Reich (1993) and Ohmae (1990, 1996) are radicals in the sense that they see globalisation as rapidly creating borderless worlds where nation states have little independent existence, and individuals are more and more living within the boundaries of a normative global culture. Drucker (1986) and Dicken (1998) both detail real changes in how production is organised, where it takes place and who plays which role in the process. But they stop short of seeing this as leading to the kind of convergence in economic and social organisation that radicals envision. Lewin, Little and Evans (2000) review the positions of different authors.

[39] Only 25 countries have access to the private market in bonds and equity, the rest have to borrow from the World Bank.

[40] It could be argued that some of their distant forerunners e.g. the British or Dutch East India Companies, were really national monopolies supported by colonialism in rather different ways than modern multi nationals.

[41] It may be true that Manchester United has more supporters in Malaysia than in England. Its high price franchised shops for strip and memorabilia do good business throughout the world.

[42] e.g. the Universities of Nottingham and Monash both have Malaysian campuses where students study for foreign degrees without leaving their own countries.

[43] Reich was writing from his perspective as Labour Secretary to President Clinton

[44] In-person service providers migrate. Filipina maids are a well known example. They provide in-person services competitively in East Asia, North America and Europe and are often well educated.

[45] E.g. effective management, quality assurance, good communications, political and institutional stablity)

[46] The company has a putative market valuation of as much as £350 million for those brave enough to buy.

[47] Producers in those countries may of course seek to increase their competitive advantage in various legal and illegal ways – importing low cost labour from adjacent countries, using child labour etc.

[48] This begs the difficult question of how those who start later overcome the advantages of those who started earlier – back to "late development" effects.

[49] Thus UNICEF explicitly targets the "use of information technology to reduce disparities in (educational) access and quality (UNICEF 2000:48 UNICEF). The Imfundo initiative launched by Tony Blair is specifically designed to "consider how information technology can be used to support education, particularly teacher training, in developing countries.." through "well designed software programmes..ICT based distance learning….internet connectivity…and wireless technologies (DFID 2000:32).

[50] The internet requires literacy in an international language; English which accounts for 80% of current traffic. Though this may be changing, it is not changing in ways which will open access to speakers of non-international languages. Voice and images may complement text based communication; it is difficult to imagine them displacing it. These also come with the costs of broad band access.

[51] The high rates of change in the ICT industry is itself a generator of marginalisation. Three year old technology becomes obsolescent, yesterdays devices need constant up grading, entry level costs do not fall as fast as those of component parts as more services and complexity are offered.

[52] But note that connectivity does not guarantee use. Perraton (2000:145) notes that only half of the Masters in Distance Education students at the Open University take part in on-line conferences designed for the course!

[53] Further developed in Lewin (2000b)

[54] A similar distinction was made by Dore 30 years ago in his critique of dependency theorists.

[55] Langrish J, Gibbons M, Evans W, Jevons F (1972) Wealth from Knowledge: A Study of Innovation in Industry. MacMillan – another book that set me on this journey.

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