The knowledge economy – fact or faction[1]

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The phrase 'knowledge economy' has acquired currency as powerful as the adjective 'modern' once had. This paper explores the meaning of knowledged-based economy from the perspective of the South and traces the rise of the information sciences and the interplay between information technology and the present globalisation. Particular consideration is given to who is included and who is excluded in this new world order. Being involved in education, the authors are concerned to examine the track record of computer-based applications to education and the prospects for these to achieve the much elusive productivity gains in this field. The paper concludes with an outline of possible directions for the local information technology industry in relation to education.

The notion of a 'knowledge economy' is regarded by some as little more than a clever play on words – a grand oxymoron – not to be taken seriously by either corporate capital or the academics of learning.

Knowledge, in the traditional sense, is the quaint and noble preoccupation of men, and women, of letters –

> Old money and patronage sustain it.
>
> It is modestly subsidized by governments and progressive corporations.
>
> It is a somewhat puzzling source of power, perhaps, or influence.
>
> But for true believers, this is a trifle embarrassing, far too utilitarian a construct for intellectual comfort.

Not that this tradition fails to respect the virtues of the market place. Knowledge, and economic intercourse, occupy two distinct spheres – it is regarded as a category mistake to collapse them into the same conceptual pudding. Much of the world is still structured this way. And perhaps, so it should be.

Our schools and universities depend on people who measure success by the steady passage of understanding through the minds of their students, not the trajectory of their share portfolios.

And most people's jobs depend on the daily repetition of ordinary commerce and trade: the exercise of tried and tested manual skills, the combination of simple elements in well-known engineering designs.

The orderly cycle of production on the land, the ruthless hammering at the rocks upon which so much of our country's haphazard wealth rests, the vast and intricate networks of transactions that make up the fabric of our delicate market-based economy – these organic impulses are of course knowledge-based in a deep historical and institutional sense. But this is not what the notion of a 'knowledge economy' attempts to capture.

Let us try to tease out what this juxtaposition of ideas is really about.

These days, a great deal of money is being made by smart people who are a little ahead of the rest of us in electronic or wireless communication skill, or financial derivatives trading, for example. Some of the wealth that has been generated by 'new economy stocks' is no doubt spurious, not unlike the flotation of fictitious highveld mineral claims on the London stock exchange in the late nineteenth century – promises of gold nuggets on the empty expanse of scrubland. But there is also a great deal of money being made through genuine advances in networking technology, wireless protocols, intelligent software applications and a host of biological, chemical, telecommunications, financial or other advances.

The electronic and communications revolution is real enough. We should avoid claiming too much for this brave new world, and be prepared to learn something about the trajectory of this economic transition by reflecting on historical trends.

In the early stages of technological change, the rewards of industrial leadership are very great. As new techniques become better understood and more accessible, the generation of new wealth becomes less spectacular and the tools of progress more ordinary. In the early stages of commercial rivalry, exuberance elbows prudence aside and fortunes are made and lost sometimes on the most anecdotal of industrial evidence. This may well be a 'knowledge revolution', but the inescapable limitation of the knowledge that underlies stock market valuations, namely that future returns on investments cannot be known in advance, remains as much a feature of today's world as it was of the 1870s or 1930s.

There are also important lessons about how new knowledge is disseminated, adapted and institutionalised. Formal institutions of learning are not at the dramatic forefront of industrial innovation today, nor have they, some notable exceptions[2] aside, been so in the past. But they have played an immeasurably great role in the accumulation of understanding and stimulation of intellectual curiosity that is the fertile breeding ground of new ideas. And they will play an immeasurably great role in digesting, simplifying, popularising and extending knowledge that may presently be the preserve of a few, so that its benefits may be broadly enjoyed.

This is the role of our universities, technikons and colleges, and indeed of the whole education system, that deserves more respect and more aggressive reinforcement. The legacy we leave our children will depend far more on how we extend

technical progress through our institutions of learning, how we build bridges between innovative business enterprises and our colleges and academics, than on the particular success of our 'new economy' stocks.

We may aver that there are considerable external economies associated with extending access to new knowledge. The promise of the information technology age cannot fully be realised unless we support broad-based access to the opportunities it raises. This is clearly the domain of public policy. We channel public resources into an education system, into faculties of learning at our universities and technikons, into our research organisations, in order to ensure that the social infrastructure is in place to encourage and accelerate the adoption of new skills, new techniques and improved technical understanding.

What does the future hold? Is it a scenario like this ... In the State of the Nation Address of the year 2014, the President noted the tremendous progress achieved by the Ministry of Education and Knowledge Transfer. The 'NetCast' message included live coverage of college students. They were seen engaging in a team project using South Africa's own 'telebook' technology. At one point in the address the President was able to engage directly with one of the learners. The presidential staff, working from four different sites, assembled the address a mere hour before transmission. The Minister had watched the transmission on a telebook while visiting a rural school in the far North of the country.

This is perhaps an optimistic glimpse into the future. How probable is this picture? Technologically possible, yes. Socially desirable, maybe. Would it presage the potential for centralised control that would make the Big Brother created by George Orwell happy? How far will and should the web of information penetrate into daily life? Do we desire a situation where information travels freely, where everything is tagged and tracked, your car, your dog, you? Indeed what is the interplay of social, economic and political forces in the supposed Knowledge Economy, or as some style it, the Knowledge Society? Who participates, and who is excluded? Is participation a fact for some, and an illusion for others? These are some of the key questions.

Government recently completed the first phase of its Research and Technology Foresight study (DACST, 2000), a process that set out

> '... to capture the dynamics of change by placing today's reality within the context of tomorrow's possibilities'.

We are not alone in conducting this type of work. Numerous governments and multinationals around the world have effected such studies, all attempting to deal with future uncertainties.

A scenario that Shell (1992) developed in the early 90s as part of its planning for European Union integration is particularly relevant to this discussion. The scenario was styled 'Layers and Pockets'. In this scenario of the new Europe, what emerges is a highly mobile group of professionals, the 'layer' who are able to work and play anywhere, anytime. Members of the 'layer' have a common language and are able to slot into work wherever the demand arises. A kind of global hot seating, if you like. The 'pockets' on the other hand represent those parts of society that are unable to participate in the visible economy. These include impoverished inner city communities and migrants who have lost the jobs that attracted them to their new host countries in the first place. It is a polarised society where the 'layer' has the world at its feet and the marginalised 'pockets' are simply bypassed, if not actually trodden upon.

This was a scenario that considered a future Europe, and was developed before the Internet revolution began apace.

Some might say that this scenario has already become reality. The further alienation of societies through a growing 'digital divide' between rich and poor, urban and rural, and dominant *versus* marginalised demographic groups is a growing reality in the United States. This is reflected in access to computers and the Internet and is especially acute for African Americans in rural areas. Concerned at this further exclusion, the White House has committed additional budget to bridging the divide through a mix of tax incentives, teacher education programmes, the establishment of technology centres in low-income and rural communities, and the general improvement of access to careers in information technology.

In gazing into the future no one possesses perfect foresight. The history of technology abounds with examples of predictions that have rapidly turned out to be woefully inaccurate. Heavier-than-air flight, atomic energy, and controlled thermonuclear power are three examples of the first half of the twentieth century where scientists were proven wrong. In the latter half of that century we have the hapless case of the President of Digital Equipment Corporation on record in 1978 as having declared that there was no reason for any individual to have a computer in their home. And Bill Gates himself was almost wrong-footed by the rapid growth of the Internet. By a strange quirk of fate it was the vigour with which Microsoft embraced the Internet that led to the 3rd April ruling that his company had breached United States anti-trust legislation. The shock waves of this decision will be felt for some time to come.

Economic historians characterise humankind as having passed from the agrarian revolution when we first settled down, domesticated animals and began to raise crops, to the industrial revolution that began in England in the 17th century with the application of water power to textile production. These epochs of course overlap, with the industrial revolution still unfolding, albeit at a slower pace. One might argue that the information revolution began in the late 19th century when Herman Hollerith automated the data processing for the United States Census. The company that he founded, Tabulating Machine Company, later became IBM.

In the twentieth century our ability to process large volumes of data into useful information grew exponentially as the mechanical devices of Hollerith were replaced by successive generations of electronic devices. The invention of the valve amplifier was basic to the computers that assisted the design of the atom bomb. The transistor appeared in 1948 and became an essential tool in the lunatic arms race of the Cold War. A hint of the huge power that would become easily available to manipulate data came with the production of the first silicon chips a mere thirty years ago. This was followed by the personal computer, mobile communications, the Internet and now electronic commerce.

Somewhere in the late fifties and early sixties the service industries shifted to prominence in the United States economy and today so-called knowledge workers are the dominant group in the economies of the countries that belong to the OECD. I share this thumbnail sketch of technological progress with you for two specific reasons.

First that we take note of the fact of polarisation of the world into the generally rich North, and generally less developed South. Over the last few decades the gaps between these two have widened, not lessened. Such gaps are evident within our own country, with its unacceptable social and economic disparities. The question is – what do new work and production practices imply for these inequalities? A threat of further divergence? Opportunity to bridge the gap? Is the layer and pockets scenario inevitable? What promise for convergence does the new technology hold, indeed can technology alone ever hold such promise?

Though we are living the information revolution, the bio-information revolution is already upon us. With the new power to manipulate genes, the blind pursuit of technology while ignoring ethical and moral values becomes untenable. Genetic engineering may have acquired a bad press, tapping into deep-seated fears of the consequences of eating 'Frankenfoods'. Mary Shelley's *Frankenstein – the modern Prometheus* of 1816 warned of the dangers that unfettered applications of science and technology would have. The problem has not abated. We face stark decisions on our future. Do we yet possess the wisdom to develop a society at peace with itself and the environment?

While the global marketplace may offer untold delights to the consumers of the North, for whom it is a 'fact on the wire', who are the participants and beneficiaries in the South? Seen from the perspective of the South, the 'Knowledge Economy' may be little more than fiction. So the World Development Report notes that:

> 'Knowledge is like light, weightless and intangible, it can easily travel the world, enlightening the lives of people everywhere. Yet billions of people still live in the darkness of poverty, unnecessarily' (World Bank, 1999).

Indeed. The word 'enlightenment' reminds one that it was during the very Age of Enlightenment that the enslavement of what is now the 3rd World accelerated. The poverty of today has long and deep roots, and there are many reasons for it, the destruction of social fabric, untold violations of human rights, economic exploitation, and unfair terms of trade, among them.

The European Renaissance was propelled through the information technology revolution of that time. This was the innovation of Johann Gutenberg's movable type printing press that first copied, then extended Korean and Chinese technology. Suddenly the printed word became available outside monastic circles. It is worth noting that this is the six hundredth anniversary of the birth of Gutenberg. How strange that China from which came the technologies of printing, paper, gunpowder, pasta and ice-cream is now subject to the charge of violating intellectual property rights!

The African Renaissance, now in its infancy, may yet be enabled through the possibilities offered by the second information technology revolution.

But the African Renaissance is about more than property rights, it concerns our soul.

According to some knowledge workers, the passage toward the information-driven economy is profound enough for it to be characterised as a Kuhnian paradigm change (Mansell & Wehn, 1998). The new techno-economic paradigm entails the shift from production line 'Fordism' to information-intensive processes. This new paradigm is part of the emerging globalization, and is both a shaper of, and shaped by these forces. The fierce competition for markets, the demands for total quality management, the need for environmental sustainability, and the desire to minimise the costs of labour, are elements of this shift. Production runs are shorter and customised to requirements. All the inputs are assembled 'just in time', be these plastics, professionals or product technicians. The demand is for flexibility of labour. '7 times 24' operations using part-time and home-based workers is becoming the norm in some industries. One life, many careers, is the trend. Except it seems for the child workers who produce sports gear in the sweatshops of the East.

In this new environment national borders become porous to the flow of information, tax collection takes on a global reach, and the expectations of government and governance change.

For the 'layer' group in the Shell scenario we are approaching a global village; for the 'pocket' it may be village life as usual, where massive unemployment, crime and grime constitute life at the margins.

This new paradigm has vast implications for how we live, play, and educate. The information and communication technologies (or ICTs as they are now known) enable and underpin this new economy that sees the world as its supplier and market. Established companies crumble, while erstwhile competitors engage in new partnerships. Previously distinct technologies converge, such as is happening in the media and telecommunications industries. There is a tussle for dominance between what is being called the 'new' economy and the 'old', where start-up (or is it upstart?) information technology companies have paper values that defy logic. Apparently tried and trusted investment theories have been found wanting and the likes of companies such as Robertson's Tiger Fund and Buffet's Berkshire Hathaway have been decimated.

For many years industry spending on computers did not appear to provide the expected gains in profit. This phenomenon became styled as the 'productivity paradox'; the fixing of which became a reliable source of revenue for the droves of consultants employed to sort out the problem. And now research (Whelan, 2000) of the Federal Reserve indicates with some confidence that the strong productivity gains of the last five years in the United States economy are directly attributable to the use and production of computers. The 'productivity paradox' has finally been slain, or so it seems. With this kind of endorsement we may reasonably expect the computer revolution to move ahead.

For the less developed countries of the South it is evident that information and communication systems are essential for managing and growing their economies. Fortunately the new technologies do for once convey some advantage on the late starters. To establish a telecommunication system it is no longer necessary to string kilometres of copper cables on

posts across the landscape. Wireless technologies may be quickly installed and allow for fast and reliable voice and data transmission. So the Treasury of the United Republic of Tanzania boasts a wireless-based financial management system that connects all ministries and regional authorities. This system was put in place in less than two years, giving support to the assertion that developing countries may use the new technologies in 'leapfrog' fashion. And cellular telephone networks are being rolled out in many developing countries. In South Africa there are now close to a half million dial-up Internet users, along with four million mobile telephone clients. Indeed the mobiles have now exceeded fixed line users. Street vendors using cell phones are able to order supplies through their own version of 'just in time'.

Another advantage is that there is a low cost of entry to the software industries. A well-educated population is a prerequisite; vast industrialisation is not. Witness India, whose software engineers are world class and have been for the best part of a decade. In our country we see the emergence of information technology companies with global reach and financial relations.

But there is something hidden behind this facade of the electronic shopping mall, on-line banking, and perverse digitised images of humans. Someone, somewhere is carrying out the labour to produce the commodity, to transport it, stack it and pack it. Some human is being degraded by the digital body parts industries. Our environment continues to be mined and contaminated. Manual workers sweat, while knowledge workers suffer from repetitive strain injury.

Great vigilance is needed to understand the interplay between these new technologies, society and morality. Strange that sand, silicon, the second most abundant element in the earth's crust, should provide us with the means to know so much about so many things. But it is our intelligence that lets us down when we care too little.

What then the implications for formal education, this vast social movement that now consumes so much of all countries' wealth? Mass education, the three R's of reading, writing and 'rithmetic' began in parallel to industrialisation. There was a need for the acquisition of new skills and knowledge. It was necessary to compensate for the changes in family life that the new technology of industrial production and subsequent urbanisation brought about. Sociologist Jacques Ellul regards education and other social sciences as forms of technology. In this definition, technology is understood to be the act of organising and structuring people or objects in order to solve a problem. Hence education is a technology. So for that matter, was *apartheid*.

The numbers speak: at least one in four South Africans is in formal education; a further half million adults teach or support this effort, absorbing more than a fifth of the national budget. All this in the expectation that future prosperity and social cohesion will be promoted. Such huge investment of time, people and money must operate effectively. Currently it does not. One may talk glibly of the power of the Internet. In reality many learners sit in classrooms without electric light, few textbooks and no other educational materials.

The basic elements of formal education have changed but little over two centuries. Its format is that of the teacher facing a group of learners. The teacher's voice may be amplified, and her image transmitted afar, but fundamentally the technological arrangement has not changed. One teacher, twenty, thirty or sixty faces. Teacher talk, learner listen. Teacher write wrong. Learner write wrong too. While the efficiency of industrial production has risen over time, that of education has stood still. There has been no technological breakthrough. B.F. Skinner, the behavioural psychologist, did propose the construction of a teaching machine that was based on the mainframe computers of the 60s but this 'drill and practice' approach failed to acquire many adherents. Programmed learning and instruction simply did not catch on. Some progress has been made in understanding how we learn, but this has not been easy to incorporate into computer-based education.

The lack of change within the formal education system is most acutely felt within schooling. Dooley (1999) notes that for schools restructuring

> 'involves deep and profound changes in the ways schools function. Restructuring defines what goes on within classrooms – rethinking the way teachers teach, the way students learn, and the way we asses them'.

Restructuring changes the roles of teachers, administrators, parents and learners. Such changes will be needed if education is to fulfil its expected role in building our economy.

The development and deployment of the personal computer that started in the late 70s might have been expected to lead to widespread applications in education, but it was the office and home environments that boosted the extraordinary growth of this industry. Arcade game technology also became a major driver for faster and larger memory devices. But education as a consumer remained at the margins.

From the point of view of education one may assume that the ICT revolution will continue to take drive change, Microsoft's setback notwithstanding. In July 1999 the Ministry published our Call to Action that sought to mobilize our people to build an education and training system for the 21st century. Recall too the question then posed by President Mbeki: 'Is our education system on the road to the 21st century?' The response provided was that in crucial aspects the system was not ready for the 21st century, since there was a crisis at each level of the education system. To be precise, there was rampant inequality, low teacher morale, failures of governance and management, and poor quality of learning. This is the education system that sees half of the senior certificate class fail. And this is the education system that produces young Delisile Mdleleni, the fifteen-year-old matriculant from the Orange Farm informal settlement near Johannesburg. Delisile is now reading for a B.Sc. in information technology at the University of the Western Cape. This is the education system that produces heart surgeons and software developers such as new billionaire Mark Shuttleworth.

South Africa is on a quest for education quality. The outcomes-based curriculum is intended to provide a quality educative experience that allows for proper monitoring and accountability to be effected. The Report of the Review Committee (Department of Education, 2000) reviewing the nature and pace of implementation of Curriculum 2005, in no way reflects a deviation from the commitment to outcomes-based education.

The emerging National Qualifications Framework with its associated Standards Generating Bodies, and the provision of funds through the Skills Development Levy are policy instruments intended to ensure active participation social and economic life.

Each country, each school is unique. But one may learn from experience elsewhere. The Republic of Korea began serious investment in education in the 30s; the Republic of Ireland pushed resources into education in the 70s and 80s. Today Ireland boasts its own 'silicon glen', and Korea is the world's leading chip designer and producer. What these examples imply is that one needs to take a long view, while striving for short-term gains.

A short-term goal is to achieve a 5% increase in the senior certificate pass rate, an increase to be achieved without any skulduggery. The next goal will be significantly to increase the number of students who achieve higher grade passes in the gateway subjects of mathematics and physical science prior to the replacement in 2005 of the Senior Certificate by the new Further Education and Training Certificate. One needs to understand how gains may be made at the school level, and if possible build on the experience.

The report of the Council for Higher Education investigation on the future size and shape of the universities and technikons was tabled in mid July. In parallel to this study, policy is being made on the ground in that student enrolment has plummeted at some major historically disadvantaged institutions, coupled with a complementary soaring in black student numbers at the old racially exclusive technikons and universities. These changes are dramatic enough for the phenomenon to have been described as a 'skewed revolution' (Cooper, 2000). The size and shape study is the timelier in another respect.

For the best part of four decades it has been dictum among economists that developing countries should target national investment at the basic education level since this offered the highest social returns. The orthodoxy has been eloquently challenged in a recent study (World Bank, 2000) that argues for new investment in higher education. This asserts that participation in the global economy requires the abilities constantly to renew economic and social systems, to extend knowledge and specialist skills, and effectively to engage in knowledge production and transfer. To engage with this reality, and avoid relegation to the subservient role of 'data gatherers', a vibrant higher education system, socially responsive, in close contact with industry, and able to produce top quality graduates is essential. This we shall strive to attain. While we shall act responsibly in creating an environment where our higher education institutions may flourish, only the institutions themselves can guard against the loss of their students to virtual institutions offering degrees over the Internet.

The speed with which the new media have penetrated is staggering: it took 38 years for radio to reach 50 million listeners; 13 years for television to reach 50 million viewers; 4 years for the Internet to attract 50 million surfers. Estimates suggest that by 2005 there will be two billion people using it regularly.

The technologies will become cheaper to install, and easier to access. Voice recognition and language translation is becoming increasingly viable and will further empower our people once they are deployed.

The Ministry of Education is also involved in other processes to modernise the education and training system. The proposal to establish an educational network that connects all universities, colleges and other learning institutions will enable such entities to interact with one another, share information, and grow together.

Earlier we claimed that the technology of education has remained fairly static. In the main, from the perspective of schooling, this is so. However, even in low-income countries informal and casual education has been strongly driven through the mass media, notably television. In better-endowed communities school and home computers provide a launch pad for minds as young as two or three, where small fingers are able to manipulate a touch-pad.

The Internet, acting as a portal to the libraries and encyclopedias of the world, has deepened this school and home learning experience. The adherents of home learning have grown in number and the Internet enables this. Parental choice in education is a constitutional right. There is however concern that children may be isolated, even indoctrinated by cult-like movements that insist on the withdrawal of children from formal schooling.

What then is the potential for the provision of a quality, affordable public education system? Its attainment demands utilization of the most appropriate technologies, be these electronic information systems, networking our schools, or simply better organisational workflow. In particular, excellent information systems will be needed to reap maximum benefit of outcomes-based education. How else to document and monitor learner profiles, assure quality and maintain integrity?

As an example, November 1999 was the first time that compiled examination results along with the individual candidates' attainment were published. This publicly available document could in the future be available as a download off the Internet. The next step is the improvement in the education management information system, the database that must track and guide the operations of what is arguably the largest enterprise in the country. This should be followed by the inclusion of procurement administration, human resources management, curriculum development, examination management, and school governance and asset management.

Information and communications technologies have a direct role in the classroom. There is now widespread evidence (Cox, 2000) from industrialised countries that the use of ICTs does promote the development of skills that are valued in the workplace and society generally: inquiry, comparison, search, sorting, testing, all the components of 'what if?' Furthermore, studies attest to the positive impact on learners' subject interest, motivation and commitment to learning. Perhaps the most obvious statement is to observe that if ICTs are a dominant influence and instrument outside school they ought to be as powerful in schooling.

In the United Kingdom (BECTA, 1999) an independent Government-funded evaluation, found improved subject learning and vocational training across a broad range of subjects and the full age range, from infants to adults. There was a shift towards project work and a more integrated curriculum, the development of the capacity to use electronic networks to access and create resources, and to communicate with others.

Motivation and self-esteem improved, particularly for pupils with special educational needs, who gained proportionately more than others from the increased social interaction through means such as e-mail, fax and video conferencing.

Perhaps it is the opening of communication channels that holds most promise to isolated individuals or school communities. The concept of extra-mural activity is being replaced by trans-mural activities. The wall has crumbled. Locally, SchoolNet has been a pioneer in extending and supporting connectivity among the schools. Out on the Cape Flats some schools have raised their own funds to set up computer facilities and are making strides in opening up new possibilities to their learners.

A further role of these technologies is their impact on teachers. While their use for record keeping is obvious, it is the use in classroom practice that holds most promise. And there is the prospect of teachers promoting their own professional development through formal in-service training over the web, as well as through informal contacts.

In order to participate in this rapidly changing environment one requires skills to work across disciplines, across borders, in teams. The goal of lifelong learning is enabled by the new technologies in profound ways as learners access and process information more readily.

It appears however that there is insufficient local research and development in educational technology to support education and training. This despite the fact that the country has a hundred-year history of being an early adopter of new technologies. It did so through the colonial era and the *apartheid* years, and retains the capability. Over the last few years the financial services sector of the economy has shown the largest growth rate. It is an avid user and developer of the new technologies. How then to bring these talents and those of the information technology sector to bear upon the education enterprise?

An obvious mechanism is through public-private partnerships that shift the preparation for our use of ICTs to higher gear. One would wish to see that all teacher education programmes confer information technology literacy on their graduates, and that within the next three years all further education and training, teacher support and education sites are Internet enabled. The are a number of alternative technologies that may be deployed for this purpose. It is unacceptable that the process of curriculum development is retarded by lack of connectivity. We have e-fail. We require e-mail.

This implies investment in the development of information technology professionals who can work alongside educators and graphic designers to produce world-class education software. The South African Information Technology Industry Strategy project (IDRC, 2000) has predicted an ongoing shortage of IT professionals. This implies that in the interim we may have to rely on imports of educational software. Naturally we would not wish to reinvent what already exists abroad. However we do know that curriculum material is frequently not transportable. In this lies a challenge for our local developers.

Finally to return to the matter of values. Education is concerned with the transmission of values, socialisation, and preparation for the future. Our curriculum seeks to achieve that: to develop critical, aware, self-motivated learners, able to work alone or in teams, and able to sift and select the information on which to base life choices. The values include the promotion of democracy, non-racism and non-sexism, environmental sustainability, and a respect for diversity.

These values are embodied in the desired outcomes of education. These are central to the act of teaching and teacher education. Open access to information will enhance these outcomes, and that is why full engagement with the imperatives of an open economy, whether styled as a Knowledge Economy or not, is required. Our vision is to ensure that these values remain in the foreground and that the huge 'pockets' in our society are freed of their constraints.

References

BECTA. 1999. *Connecting schools, networking People 2000.* London: British Educational and Technology Agency.

Cooper, D. 2000. The skewed revolution. Seminar paper for the Centre for African Studies. Cape Town: University of Cape Town.

Cox, M. 2000. Information and communication technologies: their value for science education. In Monk, M. & Osborne, J. Eds. *Good practice in science teaching.* Buckingham: Open University Press.

DACST. 2000. *Dawn of the African century. National Research and Technology Foresight Project.* Pretoria: Government Printer.

Department of Education. 2000. *Report of the Review Committee on Curriculum 2005.* Pretoria: Department of Education

Dooley, K.E. 1999. Towards a holistic model for the diffusion of educational technologies: an integrative review of educational innovation studies. *Educational Technology and Society,* 2(4).

IDRC. 2000. *SAITIS Baseline Studies* (mimeo). Johannesburg: IDRC.

Mansell, R. & Wehn, U. Eds. 1998. *Knowledge societies: information technology for sustainable development.* Oxford: Oxford University Press.

Shell. 1992. *Management matters* (Mimeo). London: Shell (UK) Ltd.

Whelan, K. 2000. *Computers, obsolescence and productivity.* Federal Reserve Working Paper, Washington D.C.

World Bank. 1999. *World Development Report.* Washington: World Bank.

World Bank. 2000. *Higher education in developing countries.* Washington: World Bank.