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NATIONAL POLICIES THAT CONNECT ICT-BASED EDUCATION REFORM TO ECONOMIC AND SOCIAL DEVELOPMENT

Robert B. Kozma
Center for Technology in Learning
SRI International, USA

Abstract: *Information and communication technology (ICT) is a principal driver of economic development and social change, worldwide. In many countries, the need for economic and social development is used to justify investments in educational reform and in educational ICT. Yet the connections between national development goals and ICT-based education reform are often more rhetorical than programmatic. This paper identifies the factors that influence economic growth and shows how they supported economic and social development in three national case studies: Singapore, Finland, and Egypt. It describes a systemic framework of growth factors and types of development that can be used to analyze national policies and connect ICT-based education reform to national economic and social development goals. And it discusses how the coordination of policies within and across ministries can support a nation's efforts to improve economic and social conditions. The paper highlights special concerns and challenges of developing countries.*

Keywords: *educational information and communication technology (ICT), public policy, education reform, economic development, social development.*

INTRODUCTION

Over the past several decades, the development of new information and communications technologies (ICTs) has resulted in significant changes in the global economy and the way people, companies, and countries interact and do business (Bhagwati, 2004; Sachs, 2005; Soros, 2002; Stiglitz, 2002). The reduced costs of communication and transportation have lowered barriers to the flows between countries of goods, services, capital, knowledge, and, to a lesser extent, people. Increased global trade is associated with significant economic growth. This growth has, in turn, corresponded to an increased standard of living for millions of people across the globe, although the benefits of this growth have not been uniformly distributed across and within countries (Sachs, 2005; World Bank, 2002b).

Beyond the increased flow of goods, economists acknowledge that globalization has corresponded to a profound shift in the role that knowledge creation and innovation play in driving productivity and global economic growth (OECD, 1996, 1999; 2004b; Romer, 1993;

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Stiglitz, 1999; World Bank, 2003), a phenomenon referred to as the "knowledge economy." Knowledge—unlike commodities—can be used multiple times and by more than one person without losing value, and it has marginal distribution costs. These facts open the possibility of an economic production factor with compounding rather than diminishing returns. The production, distribution, and use of new knowledge and technological innovations have been major contributors to increased productivity, the upgrade of physical capital, and the creation of new, high-value-added jobs. Increases in human, institutional, and technological capabilities are, in turn, major sources of new knowledge and innovation which then feed economic growth. From this perspective, technological innovation and new knowledge are both the engine and the product of economic growth. Consequently, investments in research and development and technological innovation can create new knowledge that spawns a virtuous cycle of growth.

A third, parallel and related development—sometimes referred to as the "information society" (European Commission, 2000)—is the set of broader social changes resulting from the convergence of computers and communication technologies, their assimilation throughout society and their use for communication, collaboration, and the sharing of knowledge. As ICTs—including laptops wirelessly connected to the Internet, personal digital assistants, low-cost video cameras, and cell phones—become more accessible and embedded in society they offer the potential to restructure organizations, promote collaboration, increase democratic participation of citizens, improve the transparency and responsiveness of governmental agencies, make education and health care more widely available, foster cultural creativity, and enhance the social integration of individuals with different abilities and groups of different cultural backgrounds.

National policymakers struggle, on the one hand, to create conditions that support these developments in their countries and, on the other, to craft policies and programs that cope with them and harness their effects to support economic growth and the public good. Education is among the public sectors that most effects—and is most affected by—these developments. The improvement of educational systems and increased educational attainment are seen as primary ways that countries can prepare for these global, technology-based changes (OECD, 1999, 2001a, 2004b; World Bank, 2002b, 2003). And within education, ICT is seen as a way to promote educational change, improve the skills of learners, and prepare them for the global economy and the information society (Haddad & Draxler, 2002; Kozma & Wagner, in press; McNamara, 2003; UNESCO, 2002; Wagner & Kozma, 2005).

Consequently, the desire to be globally competitive, grow the economy, and improve social conditions is often used to justify significant public sector investments in educational improvement and the application of ICT in schools. For example, in promoting the use of educational ICT to support the reform program of the current administration, the U.S. National Education Technology Plan (Department of Education, 2004) stated that the country "will face ever increasing competition in the global economy" (p. 6). Correspondingly, the U.S. Government budgeted over US$690 million on educational technology through block grants to its states in 2004. Similarly, Singapore, a country of 4 million people, budgeted over US$1 billion during the 5-year period of its first information technology master plan to install computers, network schools, and train teachers. In announcing its second master plan, the Senior Minister for Trade, Industry, and Education said, "Our most important priority as a nation is to gear up to this future of frequent and unpredictable change, and innovation-driven

growth" (Shanmugaratnam, 2002). The economic argument for investment in educational ICT is used even in developing countries. In a policy paper on the topic, Egypt's ruling National Democratic Party stated, "integrating modern technology into education has astounding positive influence on nations' educational development, economical progress and global position" (NDP, 2003, p. 3).

While the economic rationale is frequently used to justify ICT investments, and the investments in educational ICT have been substantial, national plans have often lacked explicit causal connections between these investments and the desired economic and social impact stated in national goals. This is an important missing link in the structure of ICT-based educational reform policies and programs. ICT-based innovation can and does occur in classrooms without there being a close linkage to national policy (Jones, 2003; Kozma, 2003a). However, without explicating the relationship between ICT-based education reform and the desired social and economic outcomes and building these outcomes into policies and programs, it is less likely that these classroom innovations will add to overall national economic and social efforts and have the ultimate intended effects. The connection between these educational investments and their economic and social returns is a concern for all countries but they are nowhere more important than in developing countries, where the resources are few and both the costs and stakes are high.

In this paper, I review the literature in economic development, education reform, and educational technology to identify growth factors that influence and are influenced by economic and social development and ICT-based education reform. I formulate a framework that can be used to analyze these factors, devise policies, and coordinate strategies. Throughout the paper, I illustrate these factors and their related issues through case studies of three countries: Singapore, Finland, and Egypt. I feature Finland and Singapore because of their significant success in both economic progress and educational attainment and because they represent alternative, policy-based approaches that support these developments. I pick Egypt because it is a less developed country that is in the midst of reform and currently in the process of formulating significant economic and educational policies to promote its development. I draw on the reviewed material, the framework, and the case studies to make recommendations for the development of ICT-based educational reform policies and programs that can strengthen the connection between public sector investments and economic and social transformation. In doing this, I emphasize the particular concerns and challenges of developing countries.

DEVELOPMENT AND PUBLIC POLICY

National policymakers have an extremely difficult job. They are confronted by tremendous global trends over which they have little or no control. They have to manage complex systems of interconnected departments within the context of an even more complex system of government, non-governmental, and private entities. They have to make high-risk, high-stakes decisions about public sector policies and programs. And they work with limited, sometimes extremely limited, resources. Policymakers must often accommodate the interests of other countries, multilateral institutions, and transnational corporations, while considering the needs and welfare of their citizens and the development of their national economy. They are challenged to provide the institutional environment within which the economy can function

effectively, craft regulations that moderate market failures, set monetary policies that balance unemployment and inflation, build infrastructure and supply essential public services that address the social and economic needs of the country, consider the impact of government spending on economic growth, and provide leadership that can nurture and facilitate economic and social development.

Within this highly constrained policy space, how can policymakers balance global trends and national needs and set policies that foster economic growth and social development? What are the key factors that are most likely to make a difference when making policy decisions and public investments? What roles do technology and education play in this mix? While the answers to these questions challenge the brightest economists and most dedicated policymakers, they are, for this article, the context in which I explore the connections between ICT-based education reform and development policy.

The Role of Government Policy in Development

Despite these challenges for policymakers, economists have not always ascribed a central role to government policy in economic development (Chang, 2003). Classic economic theory describes the function of the free market and ignores that of government. Governments have not always reciprocated and the twentieth century was filled with a range of grand experiments in which governments directed, regulated, or otherwise intervened in their economies. However, from the 1980s to the mid-1990s, there was a general consensus (referred to as the "Washington Consensus"), expressed in the policies of international financial institutions and adopted by many governments, that economic growth depended on macroeconomic stability and market liberalization, rather than state interventions (Williamson, 1990, 2000). The International Monetary Fund, the World Bank, and donor nations emphasized the need for countries to avoid large national deficits, reform taxes, shift public expenditure patterns, privatize state-owned enterprises, and deregulate financial markets. According to the consensus, or at least one interpretation of it, the role of national policy intervention in economic development was limited. The argument postulated that by stepping back and selling off state enterprises; by allowing the free exchange of currencies; by easing barriers to trade and capital flow; and by reducing taxes, public expenditures, tariffs, and deficits; governments would activate the private sector, attract foreign investment, and stimulate natural market forces to achieve subsequent growth in gross domestic product (GDP). Public policy and public investment were to be redirected away from industry, trade, and the financial sectors.

However, after a series of economic crises in Latin America, Southeast Asia, and Eastern Europe in the late '90s, this consensus unraveled (Bird, 2001; Lall, 2004; Ranis, 2004; Rodrik, 1996; Stiglitz, 1998, 2002; Williamson, 1990, 2000). However, a few areas of agreement remain. Development economists generally continue to believe that price stability is important to investment and that large government deficits are problematic to economic growth. They believe that open trade and perhaps even privatization contribute to growth, although this position is now qualified by the need for legal and financial institutions and regulations that provide the necessary preconditions for liberalization.

But with the failure of the Washington Consensus, there has been a reassertion of the importance of government policy and intervention. This reassertion emerged in large part as a result of an analysis of the role of state policy in the development and endurance of the "East

Asian Miracle" (Jomo, 2001; Stiglitz & Yusuf, 2001). The "Miracle" refers to 5 years of significant annual economic growth in the early '90s of eight Asian countries: Japan, Korea, Singapore, Taiwan, Hong Kong, Thailand, Malaysia and Indonesia (Yusuf, 2001). Four of these countries (Singapore, Hong Kong, Korea, and Thailand) had an annual per capita GDP above 5% between 1973 and 1996. An analysis of the causes of this growth, particularly in light of the 1997 crisis and the subsequent rebound, found that government policy played a strong role in creating the conditions for it (Stiglitz, 2001). While these Southeast Asian countries varied in their specific approaches to policy, Stiglitz found that among the policies that contributed to the rapid and robust growth were those that promoted education, facilitated the production and dissemination of knowledge and technologies, encouraged a high rate of savings, supported cooperation between government and business, and advanced industrial development.

Alternative Approaches to Development Policy

Economists (Sachs, 2005; Stiglitz, 2001) point out that there is no one development approach that fits all countries and circumstances. Each country must craft it own policies and strategies based on sound macroeconomic principles; its history, culture, and geography; its unique competitive advantages; and its development goals. But what are the factors that are going to most influence growth and development? Singapore, Finland, and Egypt illustrate alternative approaches that governments can take to answering this question.

Economic Growth and the Case of Singapore

The case study of Singapore illustrates one approach to state-supported economic growth (this case report is based on analyses by Anwar & Zheng, 2004; Blomström, Kokko, & Sjöholm, 2002; Castells & Himanen, 2002; Economic Review Committee, 2003; Hernandez, 2004; Rajan, 2003; Wilson, 2000). Singapore is an island city-state of 4.2 million people with an ethnic mix of approximately 77% Chinese, 14% Malay, and 8% Indian.1 It had an annual population growth rate from 1975-2003 of 2.2%. It is a parliamentary republic which the People's Action Party has controlled since the separation of Singapore from Malaysia in 1965. Historically, political stability has been maintained at the expense of public participation and dissent. There is limited freedom of the press, with Singapore scoring 147th out of 167 countries on the Worldwide Press Freedom Index of the group Reporters Without Borders (2005).

Yet Singapore has come to have a highly developed and successful free market economy that has experienced significant growth over the past several decades. Despite its very small population and landmass, Singapore ranks as the world's 41st largest economy, according to the Economist (2003), with a gross domestic product in 2003 of US$91.3 billion (UNDP, 2005). Signapore has a high standard of living with an adjusted per capita GDP of US$24,481. However, Singapore has a high income disparity, with the ratio of the income of the top 10% to that of the bottom 10% being 17.7. It was ranked as the world's seventh most competitive economy by the World Economic Forum in 2004 and second most competitive by the Institute for Management Development in 2004. These indices attempt to measure a country's macroeconomic environment and the quality of public institutions and infrastructure. On the UNDP (2001) Technology Achievement Index that measures access, technology creation, and education, Singapore was ranked 10th internationally, with a score of

.585. The World Bank (2005) reports that that Singapore had 622 PCs per 1000 people in 2003 and the UNDP (2005) reports that there were 509 Internet users per 1000 people in that year.

Since starting out as a developing country with its separation from Malaysia in 1965, Singapore's economic growth has been closely linked to the emergence and evolution of state policies. The government's initial strategy was to focus on the development of physical and labor capital. They instituted policies to develop a labor-intensive, export-driven industrial economy by building a private savings-financed infrastructure and attracting foreign direct investment (FDI) from transnational corporations. Singapore had few competitive advantages. It has essentially no agriculture or natural resources and a small domestic market. But it has a deep-water port and a strategic location in the shipping corridors of Southeast Asia. Through the 1960s and 1970s, Singapore was considered to be a reservoir of cheap labor as a result of the government's wage controls and restrictions on labor unions. The particular combination of constraints and competitive advantages supported the strategy of promoting a labor intensive, low value-added, entrepot economy. Low tariffs allowed inexpensive imported parts to enter the country for assembly by low-wage laborers and the export of finished goods. The government created a forced retirement savings program to which both employees and employers contributed at a very high level, up to 40%, and used this to finance the development of a re-export-friendly infrastructure (such as port facilities, airport, roads, and telecommunications infrastructure), without recourse to high taxes, deficit financing, foreign commercial debt, or foreign aid that would otherwise put a drag on the economy. Human capital development was an important part of this strategy and Singapore built up a strong education system to supply a literate labor force with a reasonable knowledge in basic numeracy. The government coordinated these investments around the development of strategically selected industrial clusters—the geographical concentration of firms and ancillary units engaged in the same sector. The government courted transnational corporations in industries such as consumer electronics and computer peripherals by providing them with incentives for locating production facilities in their country and thus tapping into global value chains of these industries.

Foreign businesses benefited from low import tariffs and implicit subsidization from ready-made factory sites, technical education and training, and education delivered in the English language. Because government investments were strongly complementary to the private sector, there was a large degree of "crowding in" of private investment and Singapore became a leading destination for FDI. Singapore in turn benefited from the importation of technology that came along with these investments. The government used the stability of its extended tenure to refine its strategy and develop it over time, leveraging initial gains in the economy to pursue a growth trajectory that moved from low value-added export to high value-added manufacturing and services. As a result of this strategy, Singapore's GDP grew at an impressive average annual rate of about 4.9%, during the period 1975-2003 and 3.5% from 1990-2003 (UNDP, 2005). This compares to at rate of 2.0% and 2.1%, respectively, in the US during these periods.

However, in the mid-1990s, economists noted that much of Singapore's economic growth was due only to the accumulation of its input factors—growth of its labor force and foreign capital—rather than growth in total factor productivity (Krugman, 1994; Young, 1995). Total factor productivity is the amount of growth in the economy beyond that attributed to growth in labor or physical capital. While growth in labor or capital has diminishing returns, growth in total factor productivity—which is often attributed to technological innovation—is

associated with compounded economic growth and sustainable development. In effect, Singapore was able to grow its work force, its physical capital, and its economy by tapping into the global market, bringing in transnational corporations, and with them imported technology developed elsewhere. However, Singapore did not develop its indigenous technological innovativeness; investment in local research and development was substantially lower than other newly industrialized countries in Asia. Furthermore, locally owned companies did not participate in economic growth, so economic development was not widespread. Consequently, analysts felt that Singapore's initial growth was subject to diminishing returns and would run its course and flatten out. According to analysts, in order to continue its growth, Singapore would have to increase its research and development (R&D) and technological innovativeness, enhance the creativity of its labor force, and foster local entrepreneurship and widespread participation in the economy.

In the late 1990s, the government acknowledged this problem and has subsequently shifted its policies to address it. In 2003, the cross-ministerial Economic Review Committee (2003) issued a report that recommended a number of measures to promote more sustainable economic growth. In addition to recommending upgrades in the existing industrial clusters of electronics, chemicals, biomedical sciences, and engineering, it promoted the development of new clusters, such as micro-electromechanical systems and nanotechnology, and new exportable services in areas like health care, education, and creative industries. Significantly, the government also recognized a third factor needed to sustain its economic growth—knowledge creation and technological innovativeness.

Social Development and the Case of Finland

The relatively narrow focus of Singapore's early industrial policy of economic growth based on factor accumulation can be contrasted with the approach taken by Finland, which was more focused on social change and mobilizing widespread participation in development. Some development economists (Bourguignon, 2004; Sachs, 2004, 2005; Stiglitz, 1998) take the position that sustainable development policies must go beyond economic growth to include social development. The goal is to not only to minimize market distortions, develop physical infrastructure and human capital, and support economic growth but also to minimize distributional inequities, increase the standard of living, preserve natural resources, and develop society's capacity to create, absorb, and adapt to new knowledge. In brief, the goal is the systemic transformation of society. The approach is systemic in that all levels of society are included in the development strategy: the private sector, the public sector, the community, the family, and the individual. It is transformational in that all of these levels are working together to move toward a shared vision and bring about fundamental change in society. The case study of Finland provides an example of this broad-based, systemic approach to development (Blomström, Kokko, & Sjöholm, 2002; Castells & Himanen, 2002; OECD, 2004a; Stevenson & Lundström, 2001). Finland achieved this transformation not by top-down command but by creating a policy environment that nurtured and built upon consensus about socially valued goals. These policies facilitated widespread, cross-sector organizational networking and supported the creation of new knowledge and technological innovation that compounded economic growth.

Finland is a country of 5.2 million people, 93% of whom are ethnic Finns. The population in Finland is aging with an annual population growth rate between 1975 and 2003 was only

.4%. It has significant natural resources in timber, iron ore, copper, lead, zinc, and other metals and the extraction and use of these resources is the traditional base of the Finnish economy. Finland is a parliamentary republic with a strong multiparty system. It is a member of the European Union (EU) and the Organization for Economic Co-operation and Development (OECD). There is extensive participation in the political process and the country has a vibrant free press, scoring at the top of the 2004 Worldwide Press Freedom Index (Reporters Without Borders, 2004). Finland has maintained its commitment to the Nordic form of welfare state despite occasional declines in the economy and shifts between left and center governments over the past two decades. This commitment includes free high quality schooling from kindergarten through university and universal health care.

Finland has a highly industrialized, largely free-market economy. The country ranks as the 31st largest economy according to the Economist (2003), with a GDP in 2003 of US$162 billion (UNDP, 2005). It has a high standard of living with an adjusted per capita GDP in 2003 of US$27,619. It was ranked as the world's sixth most competitive economy in 2005 by the Institute for Management Development and as the world's most competitive economy by the World Economic Forum in 2004. It ranked first in the UNDP (2001) Technology Achievement Index, with a score of .744 and it had a reported 441 PCs (World Bank, 2005) and 508 Internet users (UNDP, 2005) per 1,000 people.

Between 1990 and 2000, there was a fundamental structural transformation of Finland's economy, as it moved from a raw materials-based manufacturing economy to one with a high concentration in high-tech products, particularly in the area of telecommunications. During this period, unemployment was halved from 20% to 9% and the balance of trade moved from a large deficit to a significant surplus. The value of Helsinki's stock market rose well over 200%, with 70% of its shares held by foreign investors. The country's average annual per capita growth rate was 2.0% between 1975 and 2002. Between 1990 and 2002, the economy grew at an annual rate of 2.5%, despite a significant economic downturn early in that period. The US grew at a rate of 2.0% during this entire period. Most notably, Finland has among the lowest income disparities in the world, with the ratio of the income of the top 10% to that of the bottom 10% being 5.6 (UNDP, 2005). This compares to 17.7 for Singapore and 15.9 for the US. This dramatic economic transformation relied on two important interrelated developments: change in government policy and innovation in the private sector.

In the early 1990s there was a significant recession throughout the Finnish economy with an average annual GDP growth rate of -3.5%. Despite the recession, the government continued its commitment to the educational, health, and social service components of the Finnish welfare state and this commitment was integrated into new policies that promoted economic growth and social development. In response to this crisis, the Government of Finland instituted a series of policy changes that shifted resources from the subsidization of large but uncompetitive industries to investments in infrastructure, education, and research and development. Public R&D investments grew rapidly in the '90s, funded by revenue from the privatization of state-owned enterprises. These public investments were structured to encourage cross-sector, private-public collaborations in research and innovation. In parallel, private R&D investments grew at an even faster pace, the result being that the nation's total R&D funding grew from 1.9% of GDP in 1990 to 3.4% in 2000, compared to 2.1% in 2000 for Singapore and 2.8% for the US. The use of this new knowledge was across sectors in Finland, with 40% of all innovative firms reporting that they cooperated with universities or public research institutes. The government encouraged entrepreneurial activity and the

development of small and medium enterprises (SMEs) by supporting incubators for start-ups, promoting capital investments, and fostering cooperation between SMEs and large businesses.

The result was broad-based growth. In 2000, there were approximately 200,000 SMEs in Finland employing about 60% of private sector work force. Policies shifted from direct support of specific industrial clusters to horizontal policy measures that supported cluster development, such as the improving cluster-specific skills and encouraging networking within clusters. Networking and improved knowledge flows increased the productive interactions among firms and organizations within clusters. There was also a shift from policy vision for how all sectors of society would benefit economic growth and the social condition in Finland. In the early ’90s, the Ministry of Finance appointed a broad-based board to draft a national information society strategy and articulate a vision for what Finland would be like as a country enriched by ICT. The board reported that, independence within government ministries to policy interdependency across ministries and sectors.

The impact of these decentralized activities was focused and coordinated by a common vision for how all sectors of society would benefit economic growth and the social condition in Finland. In the early ’90s, the Ministry of Finance appointed a broad-based board to draft a national information society strategy and articulate a vision for what Finland would be like as a country enriched by ICT. The board reported that,

> The Finnish society will develop and apply the possibilities of the information society in an exemplary, diversified and sustainable manner in order to improve the quality of life, skills, and international competitiveness and interaction. . . . Finland will be developed into an information society, in which knowledge and expertise form part of the culture and also the key factor in production (Information Society Advisory Board, 2000, p. 5).

The Information Society Program is now managed by the Information Society Council of ministers from Transport and Communications, Defense, Finance, Education, and representatives of the National Technology Agency, businesses, civic organizations, educational organizations, regional organizations, health care organizations, and unions. It is chaired by the Prime Minister. The Council periodically reviews issues and progress toward achieving the country’s development goals.

These changes in government policies paralleled change in the private sector. The growth of the Finnish economy is probably most often associated with the dramatic transformation of one particular company: Nokia. Nokia started as a wood pulp and paper mill company but over time it added other ventures in rubber and cable works to develop into a large, hierarchically structured conglomerate. In the 1980s and early ’90s, Nokia experienced a significant financial crisis and their workforce was cut in half from 44,000 to 22,000 (Castells & Himanen, 2002). In response, Nokia appointed a new CEO who was the head of the company’s then-small mobile phones division, and a new, like-minded board. They transformed the company by divesting it of all businesses except telecommunications and focusing on the global market. The company shifted the funding of its growth from bank financing to portfolio investment that attracted both domestic and foreign investors and a

significant portion of this capital was put into R&D. The company also changed its organizational structure and culture, moving from a hierarchically managed conglomerate to a distributed network of subcontractors and clients. Interactions within this network were facilitated by the transparent sharing of information, more and more of which was done via electronic networks. The rapid sharing of information about consumer needs was quickly reflected in the development of new products and their production by the company and its suppliers. By 2000, Nokia employed about 60,000 workers, with 25,000 in Finland—about 1% of total employment in the country. Nokia's suppliers and partners accounted for another 20,000 employees. Together, they accounted for about 70% of Finland's information technology exports, nearly 25% of its total exports, and over a third of Finland's GDP growth (Castells & Himanen, 2002).

Special Concerns of Developing Countries and the Case of Egypt

While the success of Singapore and Finland are inspiring, most countries are faced with a different set of current realities. For many countries, achieving economic growth and social development is a work in progress. Egypt is one such country. In the earlier stages of economic development, government policymakers are faced with making decisions and allocating limited resources in ways that are most likely to launch a virtuous cycle of compounding growth. This task is most challenging for those countries that have the smallest economic base to begin with and the fewest resources to invest. Governments in least developed countries are faced with the additional challenge of planning for future growth when they lack sufficient resources to address the most immediate, often dire, needs of their citizens—such as imminent epidemics, hunger, and extreme poverty. Within this context, policymakers must make the difficult decisions of addressing immediate concerns while selecting those few development goals, policies, and programs that are most likely to create additional resources and lay the foundation for further development.

The World Bank and the United Nations are among the post-World War II Bretton Woods organizations set up to assist less developed countries in setting policies and creating resources. The World Bank (Wolfensohn, 1999; World Bank Institute, 2002, 2003, 2004) and the UN (2000) have worked together over the past several years to build a global consensus on a comprehensive approach to development and poverty reduction. The United Nations established the Millennium Development Goals to reduce poverty, educate children, improve health, and protect the environment in developing countries by 2015. Through a series of meetings in Monterrey, Johannesburg, and Shanghai, the UN and the World Bank worked together to tie economic growth to human development and the reduction of poverty.

The United Nations Industrial Development Organization (UNIDO) recently issued a series of reports commensurate with the Millennium Development Goals (UNIDO, 2003a, 2003b, 2004a, 2004b) in which they describe how industrial development policies can spur economic growth, support human development, and reduce poverty. Confronted with intense global competitive pressures, developing countries may be tempted to take the "low road" to development by reducing wages, devaluating exchange rates, and disregarding labor or environmental regulations. UNIDO described an alternative "high road" approach to economic development in which less developed countries use competitive advantages, create a stable macroeconomic structure, liberalize trade, and attract transnational corporations, FDI, and imported technology. The approach builds on competitive advantages and sound policies

and investments to deepen capital, foster local R&D and enterprises, build technological innovativeness, and move up the value chain to initiate a virtuous cycle of development and transformation. This was the approach taken by Singapore to launch its development.

Although attractive, this strategy itself presents a challenge for those countries that are coming to it late, most of which are less developed countries. Relying only on low-cost labor is no longer a sufficient initial buy-in strategy, as many transnational corporations already have established production facilities in low-wage countries, currently China. The development of clusters must be more strategic. In this regard, it can be useful to narrow the focus of the development strategy from the whole economy to the development of particular clusters—certain industries (e.g., agriculture, tourism, textiles) and locations (e.g., cities, rural areas, geographical regions) that have the potential for contributing to global value chains. By carefully considering geography and competitive advantages, a government can either directly support (a la Singapore) or foster (a la Finland) the development of a target cluster around which infrastructure can be developed, enterprises can be agglomerated, private investment can be accumulated, and competition can be encouraged. For many countries, the development of a cluster in the ICT sector is tempting because it most directly taps into the high-road growth path and connects to the high-value global knowledge economy. But the conditions must be right for this strategy to work (Chang, 2001; Lall, 2003; Navaretti & Tarr, 2000). A large-scale investment in technology and technological infrastructure will not be sufficient by itself. Beyond the availability of necessary infrastructure, both the work force and enterprises must have the capacity to absorb new technologies and apply them innovatively to some aspect of the value chain. This often requires significant public and private investments in human capital development that, along with supportive economic policies, a dynamic information infrastructure, and an innovation system of firms, universities, and R&D centers support the development of a knowledge economy (World Bank, 2003).

The case of Egypt typifies the concerns and challenges facing many countries, particularly developing countries. (This case is based on Aubert & Reiffers, 2003; International Monetary Fund, 2004; Kozma, 2004; UNDP, 2004; World Bank, 2002a). Egypt is a country with a population of 73.4 million, a current annual growth rate of 1.9%, and an ethnic mix of 99% Egyptians, Bedouins, or Berbers, and 1% Nubians or Europeans. Egypt has a republican form of government in which the National Democratic Party (NDP) has controlled the People's Assembly since 1977 and its leader, President Mubarak, has been the Head of State for 24 years. During this time the country has been under a continuous state of emergency. Consequently, the country has limited public participation in politics and limited freedom of the press, scoring 128th out 167 countries on the Worldwide Press Freedom Index (Reporters Without Borders, (2005).

Although not among the world's poorest countries, Egypt is considered by the World Bank to be a lower middle-income country. Egypt ranks as the world's 39th largest economy (Economist, 2003), with a gross domestic product in 2003 of US$82 billion. In that year, it had an adjusted per capita GDP of US$3,950. The ratio of the income of the top 10% to that of the bottom 10% is 8.0. It was ranked as 62nd out of 104 countries in the World Economic Forum's (2004) competitive index. Egypt has experienced a hardy economic growth over the years, with an average annual growth rate of 2.7% during the years 1975-2003 and 2.5% from 1990 to 2000. This compares with the U.S. growth rate for these periods of 2.0% and 2.1% respectively. While economic growth in Egypt has been encouraging, the high poverty rate impedes the country's economic progress. The UNDP (2005) cites a figure of 44% of the

population living under the poverty level of US$2 a day. Almost 900,000 people join the labor force in Egypt each year and the economy absorbs just under 60% of this supply (Radwan, 2002). The UNDP (2005) credits Egypt with only a 55.6% adult literacy rate and literacy is particularly low among women (43.6% compared to 67.2% for men). These conditions, among others, currently constrain the type and amount of economic growth that Egypt can expect in the near future.

In response to the global trends mentioned above, Egypt is in the process of social and economic reform. The government recently instituted modest electoral reform that allowed citizens to vote directly for president for the first time in the fall of 2005, although opposition candidates faced significant qualification hurdles and constrains on press and speech freedoms. The country is also transitioning from a heavily state-directed economy to a less regulated, more open economy. There has also been some limited progress in privatizing state enterprises and state banks. The government has recently taken steps to bring some tariffs into World Trade Organization compliance but overall protection remains high. And while the rate of reform has been slow, the Prime Minister and Cabinet have taken macroeconomic measures to increase growth, including tariff reduction and tax reforms ("Mubarak fully supports…," September 30, 2004). But the country is burdened by a top-down organizational structure and entrenched bureaucracy associated with a command economy and these conditions inhibit reform.

In August of 2004, the new Prime Minister presented an economic development strategy intended to turn Egypt's ICT sector into a major engine for economic development. Entitled Egypt's "Information Society Initiative," the initiative offers a vision of providing equal access for all to information technology, nurturing human capital, improving government service, providing companies with new ways to do business, improving health services, promoting Egyptian culture, and developing an ICT export industry (Ministry of Communication, Information, and Technology, 2005). However, as common among latecomers to this sector, the development of Egypt's ICT cluster is not straightforward. For example, Egypt spent a mere .02% of its GDP on research between 1997 and 2002, according to the UNDP (2005), compared to 2.2% for Singapore and 3.5% for Finland. And while a recent study by the International Telecommunications Union (2001) recognized that Egypt has one of the largest ICT sectors and among the highest levels of computer and Internet use in North African and Middle Eastern countries, the ICT penetration in Egypt is quite low as compared to countries that have grown their economy through the ICT sector. For example, there are only 22 PCs per 1000 people in Egypt, according to the World Bank 2005 World Development Indicators, and only 4% of Egypt's population is connected to the Internet (UNDP, 2005). This compares to 53% of the population for Finland, and 51% of the population for Singapore. The UNDP (2001) rates Egypt as 57th on its Technology Achievement Index, with a score of .236. The low penetration rate of technology interacts with the country's geography and poverty. Most of the infrastructure is concentrated in the Cairo area. Most of the country's poor are concentrated in Upper Egypt and Lower Rural Egypt (El-Laithy & Lokshin, 2003) and they are least serviced by the current ICT infrastructure, according to the International Telecommunications Union (2001). Consequently, there is concern that ICT-based developments might exacerbate the situation for the poor in Egypt by creating a two-tiered information society that increases inequity in the country (Wheeler, 2003).

This case highlights some of the issues for developing countries as they consider strategic options for economic growth, particularly the development of an ICT cluster to tap into the global value chain and support a knowledge economy. The World Bank (2003) identifies four pillars of the knowledge economy: supportive macroeconomic policies and institutions, an educated and skilled population, a dynamic information infrastructure, and an innovation system of firms, universities, and R&D centers. Egypt lacks many of these conditions, as do many other less developed countries. Egypt is still emerging from a highly state-controlled economy, a large bureaucratic infrastructure, and, as we will see in the next section, an education system that is focused on rote memorization. Egypt has a constrained political process with limited public participation and a controlled press. These conditions reduce the capacity for technology absorption and innovation and this, in turn, limits the potential economic growth. Yet the experience in Singapore and Finland suggests that if sustainable growth is to occur in Egypt, public policy must support the development of physical capital, raise the quality of the workforce, and promote knowledge creation and sharing. If social transformation is to occur, these changes must be focused on reducing inequities, improving the standard of living, and increasing civic and political participation. But everything does not, nor cannot, change at once, particularly with limited resources. Faced with this dilemma, the task of Egyptian policymakers is to find the key pressure points and strategic levers that, if applied, will make the system dynamic and launch a virtuous cycle of sustained growth within the economic and social systems.

Summary of Development Issues

What have we learned so far about the factors that influence economic and social development? From the Singapore case, we learned about the important role that the deepening of physical and human capital can play in economic growth. Government policies can support dramatic economic growth even when starting with a low-wage labor base by developing a business-friendly infrastructure, investing in education, liberalizing trade, and encouraging foreign direct investment. However, the importation of foreign technology may have only a limited effect on a nation's technological innovativeness and indigenous industrial base and a narrow focus on economic development may create social inequities and limit long-term growth.

We learned from the case of Finland that knowledge creation, technological innovativeness, organizational networking, and knowledge sharing can support both sustained economic growth and social development. Government policies and programs can build infrastructure, nurture the development of small- and medium-sized enterprises, encourage both competitiveness and collaboration, and spur widespread participation and broad-based economic and social transformation. A cross-ministerial, cross-sector vision can serve to coordinate widespread participation and focus the impact of these distributed endeavors.

The key lessons from Singapore and Finland for Egypt and other countries are that well-crafted government policies can make a difference in a country's economic and social development. But we learned from the case of Egypt that crafting the right public policy can be a huge challenge, particularly for a developing country. The strategic development of industrial clusters can offer less developed countries a viable way to tap into the global value chain in support of capital deepening. The development of the ICT sector presents a unique opportunity to build technological innovativeness. But it presents significant challenges as

well. This approach requires a sound technological infrastructure, a highly skilled workforce, economic openness, and broad social participation. With limited resources, developing countries have to find the key pressure points and strategic levers within the system that can be used to initiate change and launch a virtuous cycle of sustained economic and social transformation.

We also learned from Singapore and Finland that investment in education can be an important component of a government's strategy to support economic and social development. With this in mind, let us explore how education can serve as a lever to initiate change and launch transformation.

EDUCATION AND DEVELOPMENT

The economic and development policy literature ascribes a very important role to education in economic development (OECD, 2001b, 2002; 2004b; Stiglitz, 1998; Temple, 2001; UNIDO, 2003a, 2003b; Wolfensohn, 1999; World Bank, 2003). In the narrowest sense, education increases the productive skills of laborers and these skills increase the productivity of the economy and increase the earning power of the individuals. In a broader sense, education has an impact on a person's sense of well-being, job satisfaction, and capacity to absorb new ideas and technologies, as well as an impact on increased community participation, improved health, reduced crime, and so on. Because of the economic and social benefits of education, the United Nations launched its Education for All initiative in 1997 and subsequently connected this effort to the Millennium Development Goals and the Literacy Decade initiative (UN, 1997, 2000, 2002a, 2002b). These efforts commit developed and less developed countries to work together to provide universal primary education, increase adult literacy, eliminate gender disparities in education, provide youth with life skills, and improve the quality of education.

Studies of the Economic and Social Impact of Education

Empirical studies confirm that education can make an important economic contribution. This is found in both microeconomic and macroeconomic analyses. Microeconomic studies have found that a person's investment of time and money in additional education returns a higher income. For example, in an examination of microeconomic studies from 42 countries, Psacharopoulos and Patrinos (2002) found that an average rate of return for an additional year of schooling was a 9.7 percent increase in personal income. People in low- and middle-income countries benefited relatively more from additional education than those in high-income countries. People in Latin American and Sub-Saharan African countries benefited more than those in other regions. The returns were positive but lower for non-OECD European, Middle Eastern, and North African countries. Across all countries, the highest returns were for additional years of primary school, while people in low-income countries benefited most from additional years of higher education. Women received higher returns to their investments than men at the secondary level but men had higher rates at the primary level.

While microeconomic studies look at the impact at the individual level, macroeconomic studies look at the benefit of educational investment to the economy as a whole. In a cross-country examination of the relationship between education and economic growth, Barro (2000) found that in the sample of males aged 25 or older, there was an additional .44%

growth in a country's per capita GDP for each additional average year of attained schooling, a return on investment of 7%. A review by Sianesi and Van Reenen (2002) found a return of 3 to 6% and a review by Stevens and Weale (2003) found returns that ranged from 6 to 12%. Sianesi and Van Reenen (2002) found that primary and secondary education had the largest return for less developed countries, while tertiary education had the largest returns for OECD countries. They also found indirect economic effects of increased education, such as associated increases in investment and the uptake of technology. Most importantly, Barro (2000) found that measures of the quality of education had a stronger relationship to growth than mere levels of attainment. That is, the amount learned was more important than the number of years of schooling. Using international comparative test data, Barro found that scores in science and math, particularly science, were highly correlated with economic growth. A one standard deviation higher in test scores equated to 1% growth in per capita GDP.

Beyond impact on personal income and economic growth, investment in education has social returns, and secondary economic effects. For example, studies in the United States (Coley, 1995; Kaestle, et al., 2001; National Center for Educational Statistics, 2002; Rumberger, 1987; Schwartz, 1995) indicate that high school graduates are less likely to be unemployed than those who drop out of high school and they are less likely to go on public assistance. High school completers are also less likely to have health problems, to engage in criminal activities, and to become dependent on government programs than are high school dropouts (Rumberger, 1987). Dropouts comprise nearly half of the heads of households on welfare, and a similar percentage of the prison population. Dropouts are more likely to be to have babies and/or to be married by the age of 18. Unsurprisingly, the highest rate of adult illiteracy is for those who have dropped out of high school, and dropouts are the least likely to engage in literacy activities (Kaestle, et al., 2001). Further, United States employers reported that they had to provide approximately 7% of their employees with training in basic skills, such as reading, writing, arithmetic, and English language skills (Bureau of Labor Statistics, United States, 1996).

Alternative Approaches to Education and Development

However, the problem with microeconomic or macroeconomic studies of the return of educational investment is that both treat the educational system as a black box. There is no causal connection made between what goes on in school and how that may lead to economic and social development. There is no accounting for the effects of curriculum, pedagogy, teacher quality, or the use of ICT that might actually influence what it is that students know and are able to do as a result of their educational experience. And there is no connection between these components of the education system and the factors that influence economic growth and social development. Yet the details of these connections are very important to the educational policymakers who are charged with trying to prepare a workforce that is globally competitive and citizens who can participate in the knowledge economy and information society.

Education and the development of human capital have been central to the development strategies of each of our case study countries. An examination of the way each country addressed the various components of the education system as a part of their development effort can help identify the specific connections between education and development policies.

So informed, we can then explore how ICT-based education reform might be used as a lever to initiate economic growth and social development.

Economic-Based Education Reform in Singapore

An examination of the case of Singapore illustrates one way a country can make significant educational investments that pay off economically. In Singapore, education decision making is centralized at the Ministry of Education. The high quality of Singapore's education system is evidenced by the fact that their students scored at the top of all countries in both mathematics and science in both the 4th and 8th grades in the 2003 Trends in International Mathematics and Science Study, or "TIMSS", an international assessment of student achievement (Mullis, et al., 2004a, 2004b), as they have performed consistently well in mathematics over the past decade. UNDP (2005) figures indicate that the adult literacy rate is 96.6% for males and 88.6% for females.

Singapore's education policy is strongly linked to the development of human capital (Ashton, Green, Sung, & James, 2002). Officials from the Ministry of Trade and Industry chair the Economic Development Board, a cross-ministry agency that sets directions for policies in other relevant ministries, including education. From the beginning of Singapore's modern economic development, the government tasked the education system to supply targeted clusters with skills necessary for their labor force. Anticipated skill needs were translated into production goals for secondary, polytechnic, and university institutions. As the initial, low-wage, export-based strategy achieved full employment and the development policy shifted toward high-value-added production, the government upgraded its education requirements. Secondary schools were to produce higher levels of skills in science, mathematics, and language; tertiary institutions were to produce more engineers and scientists. High-stakes tests were used to assure that the most able students had access to the higher levels of education. To upgrade the current labor force, a tax was imposed on low-wage jobs; the resulting funds were put into skill upgrading, and these funds could be returned to those corporations that participated in training programs. Unions also participated in the skills upgrading effort. The most recent shift to a knowledge economy development strategy has resulted in yet another set of economic development-driven changes in Singapore's education system. Indeed, part of the current economic plan includes the development of Singapore as a regional educational hub that would contribute directly to economic growth.

In coordination with shifts in the economic development plan toward a knowledge-based economy, the Education Ministry instituted a number of reforms under the title "Learning to Think, Thinking to Learn: Towards Thinking Schools, Learning Nation" (Ministry of Education, Singapore, 2000). An important component of the reform was to create a better balance in the curriculum between the acquisition of factual knowledge and the mastery and applications of concepts, and the development of individual curiosity, creativity, and enterprise. Thus the curriculum was broadened beyond a set of cores skills and values to include information skills, thinking skills and creativity, communication skills, knowledge application skills, self-management skills, and character development. To develop these skills and attitudes, cross-discipline project work was introduced into the classrooms. Assessment was revised to measure students' skills in analyzing and applying information, thinking, and communicating. The plan also strengthened the connections between the school, the home,

and the community, as part of a larger social development plan that encouraged a more active participation of citizens in community life.

ICT has been an important component of Singapore's education reform. In 1997, Singapore initiated a 5-year ICT plan, called "Master Plan for IT in Education," to incorporate technology into the school system (Mui, Kan, & Chun, 2004). This $US1.2 billion project provided a national blueprint for the use of ICT in all schools and aimed to create an ICT-enriched school environment for every child. This first master plan focused primarily on installing computers and high bandwidth Internet access in schools and classrooms and training teachers on the use of computers. In 2002 the Ministry launched its Master Plan 2, in coordination with "Thinking Schools: Learning Nation" reforms. The new master plan adopted a more systemic, holistic approach in which all the key components of the system—ICT, curriculum, assessment, instruction, professional development, and school culture—were integrated. Changes in one area were to be matched to changes in others within the Education Ministry. For example, the curriculum was reduced by 10 to 30% to allow for the integration of technology in the subject areas and university admission required the submission of an electronic portfolio of student work, in addition to exam scores.

Societal Transformation and Education Reform in Finland

The case of Finland provides a contrasting approach to the use of education in support of development, one focused on broad-based, decentralized decision making and collaborative knowledge creation. Finland has approximately 65,000 teachers and 900,000 primary and secondary students (UNESCO, 2004). According to UNDP (2005) figures, the government spends 6.4% of its GDP on education, about 12.7% of all government expenditures. Finnish students scored second to (but not statistically different from) students in Hong Kong, among 40 countries participating in the mathematics portion of the Program for International Student Assessment, or PISA (OECD, 2004c). (Singapore did not participate in the recent PISA nor did Finland participate in the recent TIMSS.) The country scored first among nations on the science and reading portions of this test of 15-year-olds. Finland also scored first in a special assessment of students' problem solving skills that measured students' ability to analyze problem situations, apply knowledge to solve problems, and evaluate, justify and communicate results (OECD, 2004d).

The Government of Finland places a very high importance on education, viewing it and research and development as the foundation for economic growth and maintenance of the welfare society (Ministry of Education, 1999, 2004). In contrast with Singapore's centralized structure, the school system in Finland is highly decentralized and decision-making is distributed across sectors. Each school writes its own curriculum based on very general guidelines from the National Board of Education and developed through discussions among teachers and parents. As a result, school curricula may be quite diverse across the country. Schools and teachers are also given the authority to select teaching materials that correspond to the curriculum. Businesses work closely with schools. Nearly one third of secondary students are enrolled in vocational education. Vocational education is conducted in collaboration with local businesses through apprenticeships and on-the-job training and with business leaders who participate in school decision making. Students in the general upper-secondary program can also choose to participate in work-related study. The purpose of Finnish higher education is to support research and development. And the aging of the

Finnish population has increased the importance of adult education and lifelong learning is a priority in education policies and action plans.

The Ministry attributes the country's excellent performance on PISA to free, high quality education across the country, high quality teachers with a high degree of autonomy, development-oriented assessment that gives students feedback on their progress, and a socio-constructivist approach to learning that treats students as autonomous learners who are guided to develop their study skills and plan their life career. The Ministry conceptualizes learning as an individual and community process of knowledge creation, a skills- and goal-oriented process that includes independent and collective problem solving.

The education policy is coordinated with the national vision of an information society. As part of this the Finnish Information Society Program, the Ministry of Education developed the Information Strategy for Research and Education (Ministry of Education, Finland, 1995, 1999, 2004; Kankaanranta & Linnakylä, 2004). Like Singapore's master plan, Finland's Information Strategy also integrates ICT with other components of the system but the focus is much more on supporting knowledge production and use. Among the goals of this policy are the following:

- Assuring the development of information products and services;
- Assuring that all students have information society skills and are able to access, use, and provide information society services;
- Developing learning-centered instructional approaches that focus on collaboration, individual styles of learning, learning difficulties, alternative ways of learning, and multidisciplinary approaches to learning;
- Moving from "once-and-for-all" training to lifelong learning;
- Ensuring that teachers achieve a high level of professional skills;
- Building education and research networks into an open, global network;
- Increasing Finnish language content on the Web.

The Information Society Program has helped schools purchase computers, link them to the Internet, promote the introduction of ICT as a tool for teaching and learning, and carry out in-service training for teachers. The program's aim is for all schools to be connected to networks and for all teachers to use ICT-based tools in their teaching. The purpose of the in-service training program is to provide teachers with the knowledge and skills needed to reform the pedagogical practices in their schools, especially with regard to collaborative teaching and learning, networking, and teamwork. The program also encourages the production of Finnish language instructional materials on the Web and this is now one of the industrial clusters that the Government is developing in the country.

Issues of Development and Education Reform in Egypt

Egypt has also targeted the education system as an important component of its development strategy and this case highlights the issues and constraints that many countries—particularly less developed countries—face as they consider education reform in the context of economic and social development. Egypt has approximately 16.5 million students at the primary and secondary levels taught by approximately 850,000 teachers (UNESCO, 2004). There are over 2.5 million students in institutions of higher education. The education system is currently very centralized, with a curriculum that is uniform in content and a schedule

that is determined by the Ministry of Education. According to UNDP (2005) figures, the Government of Egypt makes a significant financial commitment to education, spending 3.9% of its GDP on education (compared to 3.1% in Singapore). However, the quality of its educational system is rather low, at least as measured by international assessments. Egypt recently participated in the TIMSS (Mullis, et al., 2004a, 2004b) and scored well below international averages in assessments of students' knowledge of both science and mathematics in grade 8. The adult literacy rate is 67.2% for men and 43.6% for women.

There are several interlocking factors within Egypt's educational system that work against reform (El-Tawila, Lloyd, Mensch, Wassef, & Gamal, 2000; Kozma, 2004). The pedagogy, curriculum, and textbooks emphasize the memorization of subject matter facts and principles. Student examinations also emphasize memorization. These are high-stakes tests that determine their educational (and consequently, their economic) future. Teachers are paid very poorly and this, along with the emphasis on high-stakes examinations, has created a huge private tutoring business for teachers that is valued, by some estimates, at half the size of government expenditures on public education. The use of ICT in schools reinforces the curricular and pedagogical emphasis on rote learning.

Recently, the government introduced educational reforms to prepare students for a modern future in which Egyptians are open to cultures of other peoples and school learning becomes integrated into that of the outside world ("[An] Egyptian reform pledge…, " September 1, 2004). At its 2002 congress, the ruling National Democratic Party (2003) identified three pillars of their education reform policy: decentralization and increased community participation in decision making, improvement and monitoring of the quality of education, and development of the human and physical infrastructure in the education system, including the building of more schools, an improvement of the quality of administrators and teachers, a revision of the national exam, a reduction in illiteracy, and the improvement of higher education. In a major pilot reform project, communities in the Governorate of Alexandria were given authority to develop local school improvement plans they would use to guide their development and monitor their success. A board of trustees was established in each community to increase community involvement and input into the project. And teachers were trained in new teaching methods that encourage student-centered learning and high-level problem solving. Recently, this project was extended to 6 more of the country's 26 governorates.

As part of the education reform effort, the Party has advanced a plan that would integrate technology into the education system to both improve education and benefit the economy through the export of knowledge-based services and software production. The plan includes programs to increase the computer skills of pre-university students, increase the efficiency of learning across subject areas, improve the curriculum to match the capabilities of ICT, and upgrade vocational education. At the university level, the plan proposes the use of ICT to improve the quality of education and advance research. A number of resources have been dedicated to the effort, including a state-of-the-art technology facility that trains teachers in the use of computers and develops software on various topics in the curriculum. However, the Party's plan does not coordinate ICT strategies with specific reform efforts and, in any case, the plan has not yet been incorporated into the education system. Several national and international donors, non-governmental organizations, and transnational corporations have launched a variety of ICT-based educational programs in support of this effort, although they are typically not coordinated with each other or the nation reform effort.

Summary of Education and Development Approaches

Again, Singapore and Finland provide interesting contrasts in their approaches to using education to advance development. Both approaches focused on developing an education system of very high quality. Singapore focused its education system narrowly on the development of human capital through tight coordination within and across ministries that subordinated education policy to economic interests of targeted industrial clusters. Curriculum standards and assessments were coordinated with skills needed for a productive workforce and the numbers of students at each level were adjusted to match shifts in Singapore's development trajectory. The move from a strong basic education to a curriculum that emphasized mathematics, science, and technology was matched to the shift from a low-wage, low-value-added economy to a high-wage, high-value-added one. In a subsequent move, the curriculum, pedagogy, assessment, and educational ICT all emphasized the development of creativity, innovation, and entrepreneurship that is needed by a workforce prepared for the newly targeted knowledge-economy industrial clusters.

Finland's equally successful approach is far more decentralized and broad-based, linking the educational system to the civic and business communities. Decisions on curriculum and instruction are made by local schools and teachers. This distributed effort is coordinated by a vision of a Finnish information society in which technology and information sharing support economic growth and social development. The role of the government in Finland is to foster innovativeness, knowledge creation, and knowledge sharing. Policies and programs support this vision through the development of knowledge-building skills among teachers and students and through the use of student-centered and collaborative approaches to learning.

Egypt faces significant challenges in harnessing its education system in service of its development plans. The government has articulated a vision of an information society in which widespread access to technology can nurture human capital, improve government services, promote Egyptian culture, and support economic growth. They have targeted the ICT sector as a vehicle for this economic growth and social development. Yet a number of barriers reduce the prospects for success: Illiteracy is high, the current technological infrastructure does not allow widespread use, and civil participation and freedoms of press and speech are limited. Education could contribute to the development of Egypt's information society by improving the quality of its human capital, increasing knowledge creation and innovativeness, and fostering knowledge sharing. A reform effort has been initiated and technology has been identified as an important component of this effort. But there are major systemic barriers to change within the education system itself. Most significantly, the country's curriculum and assessment systems emphasize the memorization of facts and this works against innovative thinking and knowledge creation in schools. To succeed with the information society, Egypt will need to align curriculum, pedagogy, assessment, and the use of technology with its vision of the future.

Education Reform and Development

The thread that ties the Egyptian, Finnish, and Singaporean experiences together is the need to coordinate the education system with development goals. To date, most countries—even OECD countries—have merely aimed at improving their education systems at the margin (OECD, 2004b). Singapore and Finland are two countries that have invested significantly in

education reform and have developed education systems that are among the best in the world. Their education systems have contributed significantly to their national development goals. These two countries represent alternative models for how educational investment can offer returns for development. In the case of Singapore, increased educational investments lead to a higher quality workforce. Within this model, investments are directed toward increased efficiencies and effectiveness in the education system and toward students that are better prepared for the work world. A higher quality, more skilled workforce increases the capacity of labor to absorb new physical capital and this deepening of capital increases output per worker, productivity, and significant economic growth. This approach to education change could be called the capacity development approach to education reform.

However, OECD concedes that most countries have not yet tried to harness their education systems as a means of transforming the economy and society. An alternative approach to education change, represented by Finland, is what could be called the knowledge creation approach. With this approach, educational investment is used to change not only how well students perform but what it is that they do within schools and outside of them. It also changes what teachers do and how schools function. The focus of this change is on developing the capacity of students, teachers, schools, and communities to create, share, and use new knowledge, such that individual and organizational knowledge creation, learning, and improvement become continuous, self-sustaining activities. These capacities support a qualitative change in the economy. The capability of the workers individually and society collectively to think creatively and innovatively and to continuously create, share, and use new knowledge leads not only to better ways of doing old things but also new ways of doing entirely new things, thus resulting in economic transformation and sustained growth. This development approach includes social transformation to the extent that gains in the economy are funneled into achieving socially valued goals, such as improved health care and access to it, a cleaner environment, increased democratic participation, and enhanced human services, including improved education which creates, in turn, a more prosperous society and a more productive economy. Thus economic and social change feeds on itself, resulting in a virtuous cycle of sustained development in which economic growth funds the improvements in the social condition and improvements in the social condition supports compounding economic growth.

What implications do these approaches have for reform in classrooms and schools? How can reform of specific components of the system, such as changes in curriculum, pedagogy, and assessment, interact with the productivity factors that lead to sustained economic growth and social development? In the following sections, I examine implications of the capacity development and knowledge creation approaches for changes in these components.

Curriculum Reform

Curricula have traditionally focused on the scope and sequence of subject matter topics that are to be covered within an educational program. These are codified as facts, concepts, principles, and procedures related to mathematics, biology, history, language, and so on. Too often, curricula are focused more at the lower-end, easier-to-teach-and-test range of this skill continuum. Too often understanding key ideas is sacrificed to breadth of topics, as “coverage” trumps depth. Too often schools stress the memorization of specific facts and procedures outside of the context of their use in the real world and apart from the experiences that students may bring with them to the classroom and the needs of communities to which they return.

Students that go through such a curriculum are poorly prepared to participate in the modern labor force and address contemporary social problems. This is certainly the case for Egypt.

The capacity development approach to reform can revise the curriculum to better prepare students for the world of work by moving the curriculum to the higher end of the skills continuum and setting high expectations for student achievement (Tucker, 1996). Beyond memorization of facts, the learning of complex concepts, principles, and procedures leads to a higher quality, better prepared workforce that has the skills needed for higher value jobs. Students are more likely to have a deeper understanding of the curriculum when it focuses on a smaller number of concepts, principles, and procedures that are at the core of a subject area than when students and teachers spend their time superficially "covering" a large number of topics (Bransford, Brown, & Cocking, 2000). Students learn better when curriculum goals are built on their own interests and everyday experiences and they are better prepared for the world outside of school when these goals are connected to community conditions and needs. This entails that districts, schools, and even teachers have a certain amount of flexibility within the curriculum framework to adjust instructional goals to the interests of particular groups or individual students and to community goals and the requirements of local enterprises. As a consequence, the curriculum goals related to mathematics, science, social studies, and literature may be somewhat different for rural students than urban students and for students of different cultural backgrounds, based on the social and economic needs of their local communities.

But what of the knowledge creation approach to education reform? Is there a way that changes in the curriculum can support fundamental economic and social transformation? Economists contend that transformations of this sort require new kinds of skills, capabilities, and attitudes, and these need to be incorporated into the curriculum (OECD, 2001a). If students are to participate in an economy and society in which the creation, sharing, and use of new knowledge are the basis for sustained development, their preparation must go beyond the learning of established knowledge. Beyond the learning of key concepts and principles in the subject areas, students must be able to engage in the sustained, collaborative process of building on current knowledge to create new knowledge (Bereiter, 2002). These become new goals of the curriculum. Knowledge creation skills and habits include information management, communication, working in teams, entrepreneurialism, global awareness, civic engagement, problem solving, using technology, and designing systems (Lall, 2000; Partnership for the 21st Century, 2003, 2005; Resnick & Wirt, 1996). But paramount among the knowledge creation skills are those that allow students to continue their learning throughout their lifetimes what are sometimes called metacognitive skills (Bransford, Brown, & Cocking, 2000): students' ability to set their own goals, determine what they already know, assess their strengths and weaknesses, design a learning plan, stay on task, track their own progress, and build on successes and adjust to failures. This set of skills among all others will enable students to sustain their own personal development and contribute to that of the economy and society.

Pedagogical Reform

With traditional instructional approaches, teachers are the ultimate sources of knowledge, which they then transmit to students who passively receive and record this knowledge in memory. Research evidence suggests that this approach is not very effective. The sciences of

learning (Bransford et al., 2000) specify a number of pedagogical reforms that help students acquire more skills and develop their capacity to live and work productively outside of school. The focus of these reforms is on the understanding of key concepts, principles, and procedures. Factual knowledge is organized around important concepts and introduced as students need it and within the context of solving problems. Rather than being passive listeners, students are actively engaged in applying their new knowledge to the solution of complex tasks. Teachers support student learning by individualizing instruction to the needs of students, addressing misconceptions they may have, and providing the time that students need to learn. This model also stresses the usefulness of school knowledge for the real world. The transfer of school learning is facilitated by relating concepts, principles, and procedures to a wide variety of appropriate, real world examples and situations.

However, moving the education system beyond knowledge acquisition to knowledge creation involves a more profound participation of students in their own learning. Learning how to learn is both a goal and a central classroom practice. Students identify problems or goals of shared value and produce plans and products that will accomplish these goals or solve the problems (Blumenfeld et al., 1991). In helping students create and share new knowledge, teachers design tasks and activities that engage students in these knowledge-building processes. To support student learning, teachers explicitly model cognitive and social processes of knowledge building and they prompt students to take up these practices for themselves (Brown & Palinscar, 1989). For example, in science classes, teachers structure student investigations in which they pose scientific questions, plan and design experimental procedures, construct apparatus, carry out experiments, interpret data, draw conclusions, and present their findings (Krajcik et al., 1998). But knowledge creation is not restricted to science. Teachers have developed knowledge-building communities in mathematics, social studies, and literature in which students are engaged in sustained investigations whereby students generate new ideas by building on and extending the ideas of others. Within these communities, students support each other's learning and develop a shared value for this ongoing process (Brown & Campione, 1994; Scardamalia & Bereiter, 1994).

Assessment Reform

Traditionally, educational assessment has been used as a way of periodically arraying students along a continuum of ability or school knowledge and selecting those who are most fit for the next level of study. In some countries, high-stakes tests of students are used to identify under-performing schools. Such assessments serve to select students who are most capable for high-level positions or identify schools that have large numbers of high-performing students but they do little to lift the overall quality of the student learning or the performance of schools (Amrein & Berliner, 2002). Because assessments often serve to organize the work of schools, teachers, and students, reform of assessment practices may be the single change that, if coordinated with an overarching plan or vision, can most influence all other changes in the education system.

Assessment reform can support the general upgrade in the capacity of the workforce by improving the learning of all students. Assessments can support the deepening of learning when they are integrated into regular, ongoing instructional activity and when they provide teachers and students with periodic feedback on learning progress (Bransford et al., 2000; Pellegrino, Chudowsky, & Glaser, 2001). Since some students take longer to achieve

curricular goals or have different instructional problems than other students, detailed information on what it is that specific students know and how they think can be particularly useful to teachers as they customize lessons. Assessment reform can also improve the quality of student learning by upgrading the complexity of tasks. While traditional assessments rely on multiple-choice or fill-in-the-blank responses that favor lower levels of knowledge, performance assessments and projects provide students with tasks that examine higher levels of knowledge and are more similar to the types of tasks that students will encounter in the real world (Shavelson, Baxter, & Pine, 1992). Performance tasks are particularly useful in displaying both students' knowledge and their cognitive and social processes, and this information can aid teachers in planning subsequent instructional interventions.

Changes in assessment can be crucial in the knowledge creation approach by supporting the continuous improvement of students, teachers, and schools. Self-assessment and peer assessment can be particularly important in supporting the development of metacognitive skills and continuous improvement (Bransford et al., 2000; Shepard, Hammerness, Darling-Hammond, & Rust, 2005). With the guidance of teachers, students use self- and peer assessments to develop abilities to monitor their own progress, distinguish between high-quality and low-quality products, and provide others with useful feedback and support. The discourse among students elevates what students expect of themselves and fosters a share value of learning. These skills, practices, and values sustain high quality efforts outside of school and over a lifetime. Similarly, when teachers share their instructional goals and plans, observe each other's practice, and support each other's professional development efforts, they create an expectation of high-quality teaching and it becomes a core value of the school. Used in this way, assessment reforms improve both teacher performance and student learning.

Teacher Professional Development

As with the development of human capital in business, the productivity of education can be significantly improved by upgrading the skills and knowledge of teachers and their ability to apply these in the classroom. Educational researchers have identified two kinds of teacher knowledge that can significantly improve their practice: their understanding of their subject matter and the pedagogical knowledge about how students learn the subject and how it is best taught (Darling-Hammond, 1997; Shulman, 1986). Teachers must understand their subject thoroughly enough to organize it so that students can understand underlying concepts, procedures, and principles. Teachers must also know what students know and what they believe about their subject, what students typically misunderstand, and how students learn. Teacher professional development in these areas that are connected to classroom practice could improve the effectiveness of instruction.

Beyond improvements in teacher knowledge, the transformation of education into a source of sustained knowledge creation and innovation requires teachers likewise to engage in sustained learning, knowledge creation, innovation, and knowledge sharing. In this regard, researchers advocate an approach to teacher professional development that builds a community of practice focused on continuous improvement (Bransford, Darling-Hammond, & LePage, 2005; McLaughlin & Talbert 2001). With this approach, teachers work together, within subject areas and across schools, to identify problems of practice, collaboratively generate and try out solutions, share resources and best practices, and build a body of

professional knowledge that influences classroom instruction (Little, 1993; Talbert & McLaughlin, 1993).

School Organization

Traditional schools are hierarchical structures with teachers' classroom practice tightly controlled by curriculum inspectors and principals. In some countries, teachers are often held accountable for teaching a specific lesson in a specific way on a particular day. Significant resources are expended on managing the organization. However, to develop students' capacity and the quality of their learning, schools need to be structured around student understanding, rather the management of teaching (Darling-Hammond, 1997). In schools restructured for understanding, students work together on engaged extended projects and teachers work with students and their colleagues on designing an environment that supports learning. These practices are facilitated by structural changes in the school, such as allowing for flexible student grouping or altering the school schedule to allow more time for student projects and more time for teacher planning and collaboration.

On the other hand, schools can be restructured to continuously engage in ongoing innovation—a capacity that, in effect, creates a learning organization (Elmore, 2004; Fullan, 2001a, 2001b; Senge et al., 2000). Within such organizations, teachers have significant autonomy to modifying the curriculum and create the learning environment in their classes. They also have control over the discretionary resources—such as funds for materials and supplies—that are needed to carry out their plans. At the same time, teachers take responsibility for contributing to shared goals and moving toward the shared vision. These teachers' efforts are coordinated by shared goals for and a local vision of what the school should become. Consensus on the school's goals and vision is fostered by cooperative decision making among teachers, administrators, parents, and community members. School principals or headmasters play an important role by developing this consensus and structuring the school environment to support learning and the creation of knowledge. With these shared goals in mind, community members, teachers, and students spend their time moving the school forward rather than trying to figure out what policymakers want them to do and then doing it—or not. The impact of this innovativeness, autonomy, and accountability at the local level is compounded throughout the education system by what might be called "coordinated decentralization": local decisions and actions that are guided by higher level goals and visions.

Systemic Reform and Educational Transformation

A prominent feature of the education systems in both Singapore and Finland is that all of the components are coordinated around goals and visions. Individually, any of the above reform efforts can improve education. But to get the kind of results achieved in these two countries, education reform needs to be systemic. Policies and programs need to be targeting all of the components of the system in a coordinated and coherent way so that reform-based changes, in turn, become mutually reinforcing and promote continuous improvement (Cohen & Hill, 2001; Elmore, 1995; Vinovskis, 1996). Changes in curriculum have to be coordinated with changes in pedagogy and assessment. Changes in curriculum, pedagogy, and assessment entail new capabilities for teachers. To maximize impact and be sustained, school change must be coordinated with the community and with the larger system (Sergiovanni, 1994;

Talbert & McLaughlin, 1993). In systemic reform, this internal consistency is complemented by vertical consistency between different levels of the system (Pal, 2001). Provincial, district, and school-level policies and programs must be in sync, coordinated by an overarching set of goals or vision. Finally, the vertical consistency is complemented across different policy areas, integrating educational goals with economic and other social goals. These multiple levels of coordination assure maximum impact on development, as they did in Singapore and Finland.

The Role of ICT-Based Education Reform in Development

Technology and technological innovativeness—the ability to apply knowledge and technology in new ways—have been the sources of significant economic growth. How can ICT be applied to support education change? And how can its application in education in turn support sustained economic development and social transformation? In general, there are four types of applications. With the first approach, ICT is used to improve the delivery of and access to education. This approach can improve education on the margin by increasing the efficiency by which instruction is distributed but it need not involve fundamental change. In the second approach, ICT is the focus of learning. By learning ICT skills, students become better prepared for work that increasingly involves the use of ICT. The remaining two approaches parallel the capacity development and knowledge creation approaches discussed in the last section. ICT can be used to improve student understanding, increase the quality of education, and thereby increase the impact of education on the economy. With the fourth approach, knowledge creation, technology, technological innovativeness, and knowledge sharing can contribute to the transformation of the education system and to sustained economic growth and social development.

ICT in Support of Delivery and Access

Researcher Richard Clark (1983) contends that technology can be used to improve the way that instructional methods are delivered by making instruction more efficient, less expensive, or more accessible. These can be important contributions, particularly in rural areas and for less developed countries where access to education is often limited. For example, with the UNESCO-UNICEF Gobi Desert Project in Mongolia, 15,000 nomadic women used radio to receive an education in literacy skills, livestock rearing techniques, family care, and basic business skills (Perraton & Creed, 2002). *Telesecundaria*, a secondary-level education television series in Mexico, served over 800,000 students during the 1997-98 school year (Wolf, Castro, Navarro, & Garcia, 2002). China, India, Indonesia, Iran, the Islamic Republic of Pakistan, the Republic of Korea, Sri Lanka, Thailand and Turkey have all used broadcast media to set up national open universities. Most of these institutions serve more than 100,000 students, and China Radio and TV University serves 400,000 (Perraton & Creed, 2002).

Computers, particularly those connected to the Internet, are being used to provide students with access to a vast array of multimedia resources, related to current events, science, social studies, and culture. The Internet also provides teachers with access to curricular materials and other resources. These uses are widespread in developed countries (Eurydice, 2004). Recently, less developed countries have begun to use computers to increase educational access (Wagner & Kozma, 2005). For example, in Chile computers now serve over 90% of the school population and 80% of the teachers have been trained in their use

(Hepp, Hinostroza, Laval, & Rebein, 2004). The Ministry of Education provides an Internet portal through which students and teachers have access to a wide variety of digital materials. One of the most ambitious efforts in Africa is the African Virtual University, which has established 31 learning centers at 17 African universities that are working with partner universities in developed countries to provide over 3,000 hours of instructional programs to more than 23,000 students.

ICT as the Goal

The development of technological skill improves students' capacity to absorb technology when they move to the workforce (OECD, 1999). This is illustrated in an international study involving 23 countries and 174 case studies of ICT-supported innovative classrooms (Kozma, 2003c). This study identified a number of interesting patterns in the ways that teachers and students were using ICT to change the curriculum and pedagogy (Kozma, 2003b; Kozma & McGhee, 2003). In one pattern, called tool use, students used e-mail and productivity tools such as word processors, spreadsheets, and presentation software, to communicate, search for information, and create products. For example, a secondary school in England offered a 2-year online course leading to formal accreditation in ICT. In these classrooms, students acquire the technical skills that they will be able to use in the workplace.

ICT in Support of Student Understanding

ICT can support students' deep understanding of subjects as teams of students engage in solving complex, real world problems that cross disciplinary boundaries (Kozma & Schank, 1998; Means & Olson, 1995; Means, Penuel, & Padilla, 2001; Roschelle, Pea, Hoadley, Gordin, & Means, 2000; Sandholtz, Ringstaff, & Dwyer, 1997; Schofield & Davidson, 2002). Students and teachers use a variety of multimedia, e-mail, and web design tools, simulations, and course management tools to support deep understanding, collaboration, and project planning. This is illustrated in another pattern found in the international case study of classroom innovations (Kozma, 2003b; Kozma & McGhee, 2003), called the Student Collaborative Research Cluster. An example is an Australian primary school where students participated in an international project of Internet-based science explorations in which student teams used the Web to follow research scientists as they explored the geology and biology of a group of isolated islands in Hawaii. These students used various software and multimedia tools to conduct their own research, plan their projects, and design their classroom presentations.

ICT in Support of Knowledge Creation

Technology can be used, along with pedagogical, curricular, and assessment reforms, to support the process of knowledge creation in which students and teachers set their own goals, plan their learning activities, build on each other's ideas to create new knowledge, and monitor their current levels of understanding in preparation for lifelong learning and participation in the information society (Brown & Campione, 1994; Scardamalia & Bereiter, 1994).

This is illustrated by several patterns in the case studies of innovative classrooms (Kozma, 2003b; Kozma & McGhee, 2003). In the Information Management Cluster, teachers

designed materials and students searched for information, solved problems, published their results, and assessed themselves and each other. ICT was used to support the search for information, the creation of products, and the monitoring of students and of the planning process. For example in the US, the "Future High School" was redesigned as a high-tech start-up business in which students developed real world projects consisting of complex tasks with long-range due dates for which they had individual and shared responsibility. Students used computers on a daily basis for everything from research on the Internet to multimedia projects that combined social studies, math, science, economics, government, and literature. And they maintained on-line portfolios that were assessed by staff and community members. In the Teacher Collaboration Cluster, teachers collaborated with students, their colleagues in the school, and others outside the school. In an upper secondary school in the Slovak Republic, two informatics teachers trained students to create hypermedia materials and work with teachers in other areas such as mathematics, physics, the Slovak language, and history to design educational materials for their courses. In the Outside Collaboration Cluster, teachers and students worked on projects with others outside the school. For example, teachers in a set of primary schools in rural Catalonia, Spain worked together to have teams of their students create reports about their small villages: their history, monuments, community traditions, and so on. Students took digital photos, recorded interviews of their grandparents, and published their reports in the Catalan language on the Web. Some of the Catalan songs and folk tales that they captured were quite old and in danger of being lost within their culture.

These classroom practices support the development of skills needed by a society focused on sustained economic development and social transformation: information management skills, communication and collaboration skills, interpersonal and self-directional skills, and ability to create and innovatively apply new knowledge to solve complex problems (Lall, 2000; Partnership for the 21st Century, 2003, 2005; Resnick & Wirt, 1996), skills that are often difficult to measure with traditional assessments. Novel ICT-based assessments are beginning to provide complex performance tasks with which students can use a various ICT tools and collaborative environments to find or create the appropriate knowledge and apply it to solve the problem (Educational Testing Service, 2002; International Society for Technology in Education, 1998; OECD & Statistics Canada, 2000; Quellmalz & Kozma, 2003).

A FRAMEWORK FOR ICT-BASED EDUCATIONAL, ECONOMIC, AND SOCIAL DEVELOPMENT

How can policymakers coordinate economic, social, and educational development? Policymakers are often confronted by a system of mutually reinforcing economic, social, and educational components that work against change. Within this context, they must decide which factors, enriched by which public investments, will interact with private efforts to support sustained change. They must find the pressure points and levers within government structures that can be applied to make the system dynamic. The appropriate policies, strategies, trajectory, and pace of change would vary from country to country based on unique strengths and competitive advantages. In one country, a strategic economic change, such as supportive macroeconomic policies, may be the appropriate way to launch change within the economic system, which then ripples into the social and educational systems. In other countries, it may be changes within the social or educational systems that ultimately affect

economic growth. The selection of levers for change within government systems would be opportunistic. Policymakers in more developed countries may have the luxury of changing several components at the same time in a coordinated way. Policymakers in less developed countries are likely to be limited to finding the one or two levers that, strategically applied, can launch a compounding, virtuous cycle of change and transformation.

In this section, I draw on the reviewed literature and the case studies to provide policymakers with a framework to help them with these decisions (Table 1). The framework itself does not supply answers to the challenges of development. But I believe it can help policymakers analyze their national context, set goals, identify pressure points and levers, and coordinate policies and programs for systemic change across sectors. Along the vertical axis of the table are the factors that support growth: the deepening of physical capital, the improvement of human capital, the increase of technological innovativeness and knowledge creation, and the networking of organizations to improve knowledge flow. To this list is added an evaluation and monitoring component that serves to chart progress and modify strategies over time. On the top of the horizontal axis of the matrix are the types of development or development sectors: Economic and social, with education being highlighted as a special case of social development for the purpose of this article, and educational ICT being a highlighted component of the education system. For other purposes, the columns could be modified to highlight different components of the economic or social system.

The Framework in Action

Analyses appearing in each of the cells would be a consideration of policy goals and strategies that would relate one of the growth factors to one or more system components within one of the development categories. While the cells in Table 1 are filled in, normally they would be blank. Policymakers can use the exercise of filling in cells to either analyze the current state of affairs or the desired government policies and activities of the private sector. Not all the cells need to be filled in and the framework can be used to consider even modest changes in one sector or another. But filling in the matrix completely will aid systemic change by coordinating growth strategies within and across sectors.

In Table 1, I draw on the findings from the economic, social, and educational development literature, along with insights from the case studies—to provide the hypothetical results of such a matrix-filling exercise. Let us say, for example, that a lower middle-income country pulled together a high-level cross-ministry, cross-sector commission to review the current economic and social situation and to devise a 15-year development plan for the future. In their analysis they identified specific strengths, problems, and trends. They were encouraged by the modest but steady economic growth over the past 10 years, supported primarily by an eco-tourism industry and by a growing light manufacturing industry that provides consumer goods and small appliances to a modest but expanding middle class. The country also has a significant, although traditional, film industry and a vibrant entertainment industry that is supported by regional market demand, based on linguistic and cultural commonalities. Their growing light manufacturing industry compensates somewhat for a significant decline in the state-subsidized heavy manufacturing industry. Most of these economic assets are located in the country's two major cities. Eco-tourism is located in remote areas but their corporate offices are in the urban centers. There are significant inequities in the distribution of income and social condition because of a large,

Table 1. Examples of the relationships between Growth Factors and Types of Development.

Development Framework				
Growth Factors	**Types of Development**			
	Economic Development	**Social Development**	**Educational Development**	**Educational ICT**
Deepening of Physical Capital	Target tourism, light industry, entertainment, and agriculture. Extend ICT infrastructure and support the deepening of private capital.	Target rural areas; build community technology centers; support private acquisition of ICT; facilitate Internet cafes.	Build and modernize school facilities, particularly in rural areas. Community technology centers in rural areas.	Invest broadly in school ICT equipment and networking but particularly at the secondary level and in rural areas.
Improvement of Human Capital	Upgrade labor; develop technology use, application, and production skills.	Strengthen education and social services, particularly employment transition and community development in rural areas.	Focus curriculum and pedagogy on understanding, real world problem solving and creativity. Include technology skills. Upgrade teachers' content, pedagogical, and technological knowledge.	Develop students' skills in using ICT to solve real world problems. Develop teachers' ability to integrate ICT into the curriculum.
Knowledge Creation and Technological Innovation	Strengthen intellectual property laws. Support of invention of new products and services in targeted clusters; research in agriculture.	Increase knowledge and best practices information on education, adult literacy, and modern farming practices.	Increase pedagogical knowledge and best practices on teaching for understanding and problem solving and on technology use.	Collect best practices on the application of ICT for understanding, complex problem solving, and the production of creative products.
Organizational Networking and Knowledge Sharing	Develop participation of SMEs in light industry, tourism, entertainment, and agriculture. Support networking between urban, rural, and regional resources and markets. Expand agricultural extension services.	Develop community knowledge sharing and collaboration; open government and education organizations to community and parent participation.	Decentralize decision making; foster teacher professional development communities and knowledge sharing, particularly between urban and rural schools.	Use of ICT to support communication, collaboration and knowledge sharing by students and teachers. Assess impact of ICT on learning.
Monitoring and Evaluation	Monitor effectiveness of government policies on key economic indicators.	Monitor effectiveness of government policies on social equity indicators; obtain community feedback.	Monitor indicators of high-level student learning; assess application of knowledge to solve problems.	Use ICT to support school effectiveness and efficiency; use ICT in assessment.

generally illiterate, population that relies on traditional and inefficient farming methods. Based this analysis, the commission came to consensus on a vision for the future of the country in which the deepening of physical and human capital would support sustained economic growth and a reduction in social inequities. The filled-in matrix in Table 1 represents the product of their analysis and strategizing.

The table shows that our hypothetical commission decided to focus on the development of three industrial clusters and the modernization of its agriculture. The plan would implement policies that support the deepening of physical and human capital, particularly in the areas of tourism, light industry, entertainment, and agriculture. Significant public investments would be made in education, innovation capacity, and rural development. Shorter term investments would be made in training and unemployment compensation for displaced workers in heavy industry that would help them transition to targeted industries. Related to physical capital, policies would encourage public and private investment in the ICT infrastructure. Public investments in the development plan would be funded by privatization of telecommunications and a reduction in government subsidies to the increasingly uncompetitive heavy industry.

Privatization of telecommunications would launch the development of infrastructure in urban areas but it would be coupled to the required private subsidy of Internet services to schools and the extension of telecommunications infrastructure to rural areas. Improved infrastructure and human capital would increase the capacity of targeted clusters and society more generally to absorb ICTs. These new technologies would support the global Web-based marketing of eco-tourism and the connection of rural tour locations with urban corporate offices and other resources. Along with strengthened intellectual property laws, technology development would support the modernization of the film industry, the creation of digital entertainment content, and a broadening of the regional and international market for these companies. Technology deepening and the establishment of an invention incubation center would also support innovativeness and further development of small- and medium-sized light manufacturing companies by connecting them to suppliers and to a broader regional market.

Social inequities in rural areas would be addressed by making public investments in agricultural research on locally optimized, high-yield hybrid seeds and through expanded agricultural extension services to modernize farm practices. These efforts would be complemented by other rural development programs and social services, particularly those that fostered rural community development and increased adult literacy. These programs would be supported by extending the ICT infrastructure out to rural areas and making it accessible through public investment in community technology centers. The commission identifies key economic and social indicators and set stepped goals that could be used to measure progress on their plan.

Where does ICT-based education reform come into the plan? First of all, the commission felt that education is central to the development of human capital and, in turn, the absorption of new technologies and technological innovation in the economy. The commission also felt that a significant investment in education would respond to pressures for better schools from the country's growing middle class. It would also play an important role in addressing social inequities. Consequently, a cross-department education subcommittee, chaired by the minister of education, conducted an analysis of the current education system and identified key strengths that would allow education to promote the overall development strategy. The analysis also identified some significant problems and the subcommittee developed a master plan recommending changes that would reinforce the overall strategy of upgrading human capital and addressing social inequities.

In our hypothetical country, it turns out that there has been a strong tradition of hands-on pedagogy in the schools, although this has been used more as a set of classroom activities than a foundation for deep understanding. Also, several multinational ICT companies had initiated pilot projects that put networked computers into schools, primarily in urban areas, and trained teachers on the use of technology. The subcommittee's plan applied the growth factors in the framework to the education system in support of the national development plan. The primary emphasis of the plan was also on the development of human capacity of the students and the teachers. It focused on improving student learning by shifting teachers' hands-on instructional practices to project-based learning focused on student understanding, problem solving, and creative thinking in math, sciences, and the creative arts. The application of project-based learning would be stressed at the secondary level with the goal of producing better prepared graduates and thus providing the most immediate payoff for the economy. ICT would be used to develop students' technology skills and to support project-based learning through the use of the Internet and various productivity and creativity tools. The ministry would phase in national assessments that reduce the recall of factual knowledge and include real world problem solving tasks. These changes would better prepare students for participation in manufacturing and entertainment industries that would become increasingly innovative.

These shifts would require a significant program of teacher professional development. This too would be supported by ICT that enabled teachers to develop and share resources and best practices within disciplines across schools. ICT-based education would be used to address social inequities by extending the ICT infrastructure to rural schools and community technology centers. The Internet would allow for the inexpensive distribution of resources to remote areas, and rural teachers would have access to materials, other teachers, and curriculum experts in other locations. Emphasis would be given to a deeper understanding of science and the development of technological skills. Equipped with these skills and knowledge, rural students would be better prepared to use modern agricultural practices or to work in the nearby eco-tourism industry. Remote access to experts would support adult literacy programs, given that there are few teachers experienced in adult learning in rural locations. The community technology centers would house resources to support education reform, adult literacy, and agricultural extension services and this colocation would allow for the coordination of these services and their impacts. The subcommittee set measurable goals for examining the impact of education reform and the use of ICT on student learning.

This hypothetical example illustrates how the development framework and a systemic approach to policy formulation can align economic, social, and educational strategies to leverage strengths, coordinate investments, consolidate gains, and advance national development goals and visions. The resulting strategies would differ from country to country. In some cases, economic change may lead social and educational development. In other cases, ICT-based education reform may make a significant contribution to the launch of social and economic development. But regardless of the starting point and subsequent trajectory, the intent is that by aligning policies and programs across factors and sectors, application of the framework supports educational, social, and economic transformation.

Implications for National Policies and Programs

The specific policy implications for this framework would emerge from its application in each national context. However, there are some general policy considerations that can guide policy makers applying it to analyze current situations and crafting development strategies.

Create a Vision

Policy leadership will be the key to any successfully development strategy, particularly if these efforts are to contribute to economic and social transformation. Successful development in Finland was guided by a clear vision of how the availability of new technologies could increase economic productivity, improve the quality of life, and enrich the culture. This vision was founded on broad-based consensus among public and private stakeholders and, as a result, it coordinated distributed efforts across sectors to accomplished shared goals. Investment of time and effort to create such a vision at the national or ministerial level will have huge operational paybacks.

Develop a Plan

Singapore, on the other hand, had a detailed plan for developing the economy and this guided their long-term efforts. Many countries, including both Singapore and Finland, have national plans for implementing ICT in education. These master plans describe how ICT can contribute to education reform and improvement and tie it into economic and social development. Typically the plan describes the hardware, software, and networking that will be implemented in schools, as well as the technical support and technical training for teachers. The national plan should specify measurable goals, authorize and fund specific programs, and projects to advance this vision and provide the resources needed to implement them. To reinforce broader education reform, the technology plan should also describe how technology will be coordinated with changes in curriculum, pedagogy, assessment, teacher professional development, and school restructuring.

Align Policies

To realize the full impact of ICT-based education reform, educational policies and programs need to be coordinated with those in other ministries, such as economic development, human resource development, telecommunications, agriculture, and rural and urban development. A national, cross-ministerial ICT coordinating agency or council can facilitate this policy and programmatic harmonization as well as promote the sharing of knowledge and resources. The committee should include participants from outside the government, such as business people, unions, university faculty, members of scientific organizations, and so on, as was the case in both Singapore and Finland.

Monitor and Evaluate Outcomes

Significant public investments demand a significant return in terms of educational, social, and economic benefits. National development plans should specify a stepped trajectory of expected outcomes. Measures of both the implementation process and the outcome should be used to continuously monitor the progress of programs toward goals and provide information to policymakers that can be used to refine policies and programs and adjust trajectories. In this way, initial policies and programs can be shaped to assure on-going coordination and foster fundamental changes in education, society, and the economy.

ICT and Extreme Poverty

Applications of the above principles to policy formulation aided development in Singapore and Finland. They can also aid development in countries like Egypt. ICT and ICT-based education reform can play an important part in these developments. However, there are many countries, primarily those in sub-Saharan Africa, that are much worse off than Egypt and other lower middle-income countries. Because of unfavorable geography, disease, physical isolation, climate stress, environmental degradation, and lack of capital, these countries are not in a position to move out of poverty—they are trapped (Sachs, 2005). It is clear that education is an important part of the formula for breaking out of the trap. It is yet unclear if and how ICT might also be a part of that formula. For the same lack of capital investment, there are yet few models of ICT applications in extremely poor countries. The poor would benefit from research and new knowledge that applies these important growth factors to address their needs.

ENDNOTE

1. Country ethnicity statistics are taken from the *World Factbook*, U.S. Central Intelligence Agency (2005), as is information on form of government. All other demographic and economic statistics are taken from the 2005 *Human Development Report, UNDP* unless otherwise noted.

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All correspondence should be addressed to:
Robert Kozma
2151 Filbert St.
San Francisco, California USA
robert.kozma@sri.com