White Paper
April 2008

ICT, Education Reform, and Economic Growth: The Role of the Intel® Education Initiative

Robert B. Kozma, Ph.D.
San Francisco
robert@robertkozma.com

Contents

Executive Summary

The 21st century presents tremendous challenges and significant opportunities to national policy makers as they formulate economic and social policies and programs. The Intel® Education Initiative can help national policy makers and thought leaders connect education reform and the use of ICT resources to policies and programs that advance their economic and social development goals. This second paper of a two-part set, reviews the various programs in the Intel Education Initiative. Through program analysis and case studies, draws on a conceptual framework that connects ICT-based education reform to economic and social development to show how the Intel Education Initiative helps educational policy makers and thought leaders create an education system that prepares teachers and students for the challenges and opportunities of the 21st century and contributes to national economic and social goals.

Dr. Robert Kozma is an independent consultant in San Francisco, California. During his 35-year career, he has been director and principal scientist at the Center for Technology in Learning at SRI International, a professor and research scientist at the University of Michigan, and a primary school teacher with Detroit Public Schools. He has directed more than 25 projects and authored more than 75 articles, chapters, and books. He has consulted with Ministries of Education in Egypt, Jordan, Singapore, Thailand, Norway, and Chile, as well as with Intel Corporation, the World Bank, OECD, UNESCO, and the Ford Foundation on the use of technology to improve educational systems and connect to development goals.

Introduction

Economists attribute much of the dramatic growth in the world's economy over the past several decades to the role that knowledge and technological innovation have played in driving economic productivity. The production, distribution, and use of new information and technological innovations have been major contributors to increased productivity, the upgrade of physical and human capital, increased democratic participation of citizens, a flowering of cultural creativity, and the construction of new knowledge that has spawned a virtuous cycle of economic and social development—sometimes referred to as the knowledge economy or the information society.

But along with this worldwide economic growth has come considerable social turmoil and dislocation. Not all citizens are prepared to participate in the knowledge economy or benefit from its products; indeed, some lose their jobs or vital social services as industries and governments adjust to these developments. Not all countries are prepared for the global competition that comes with open markets, increased trade, and the reduced costs of communication and transportation; some fall further behind and become less competitive.

These worldwide economic and social changes have significant implications for human capital development and education policy. The challenge is for national policy makers to rethink their education systems in order to prepare students for the global economy, to maintain economic and social progress, and to assure that their citizens will benefit equitably from this growth. To participate in the knowledge economy and the information society, students need to leave school with a deeper understanding of school subjects– particularly science, mathematics, and technology. They will need skills necessary to respond to opportunity and uncertainty—to think critically, collaborate, communicate, solve problems, create, and continue to learn.

Intel Corporation is dedicated to helping countries move toward this vision of the 21st century. The mission of the Intel Education Initiative is to accelerate 21st century education for the knowledge economy as a trusted partner to governments and educators. To achieve this goal, Intel seeks to improve teaching and learning through the effective use of technology, advance math, science, and engineering education and research, and to advocate for educational excellence through collaborations with multilateral organizations. Intel carries out these objectives through a portfolio of programs.

This paper draws on the conceptual framework summarized in Appendix 1 and presented in the first of this two-papers set to analyze the various programs in the Intel Education Initiative and, through case studies in many countries, shows how these programs are helping countries achieve their economic and social development goals.

Moving from Knowledge Acquisition to Knowledge Creation with the Intel Education Initiative

The Intel Education Initiative is designed to help policy makers connect education reform to economic growth and social development. The initiative consists of a portfolio of programs that improve teaching and learning, both within and outside the formal education system, and that advance understanding of science and mathematics (see Figure 1). Through these programs, Intel helps governments rethink the various components of the education system: policies, professional development, pedagogy, curriculum, assessment, ICT use, and school organization. The Intel Education Initiative helps governments move from an educational approach that emphasizes the acquisition of knowledge to one that emphasizes the deep understanding and application of this understanding to real-world situations. Its education approach emphasizes the creation of knowledge and the development of higher-order thinking skills that are needed to thrive in the knowledge-based economy and participate in the information society. The programs provide teachers with the skills and tools they need to support student learning, community education, and, at the higher education level, the development of technical curricula, entrepreneurship, and research programs.

Figure 1: The Intel Education Initiative Portfolio

Program	Focus	Description
Intel® Teach Program	Formal education: K–12	**Skills for Success Course**: Training for ICT instructors on a student curriculum that develops digital literacy, critical thinking, problem solving, and collaboration skills
		Getting Started Course: An introduction to classroom software productivity tools and student-centered approaches to learning
		Essentials Course: Face-to-face training on how to integrate technology into existing classroom curricula to promote student learning
		Essentials Online Course: Training on the same skills as the Essentials Course through a blend of face-to-face and online training
		Thinking with Technology Course: Training on effective technology integration skills using online thinking tools to enhance students' higher-order thinking
		Advanced Online Course: Training that enables teachers to build communities to advance the integration of technology and 21st century learning through a blend of face-to-face and online training
		Leadership Forum: Interactive forum focused on leadership in promoting, supporting, and implementing effective technology integration in schools
Intel® Learn Program	Information education	A 60-hour, hands-on, after-school curriculum built around two core modules. The Learn Program taps into children's interest in their own communities while developing their skills and nourishing their curiosity with creative, technology-driven projects
Intel® Computer Clubhouse Network	Information education	An after-school, community-based technology learning program in which participants are given the support and freedom to pursue their own ideas
Intel International Science and Engineering Fair	Formal education: Secondary-level science, math, and technology	The world's largest pre-collegiate science fair which brings together more than 1,500 young scientists from 51 countries, regions, and territories to compete for more than USD 4 million in scholarships and awards
Intel® Higher Education Program	Formal education: Tertiary-level science, math, technology, and engineering	A worldwide collaboration between Intel and 150 universities in 34 countries that brings cutting-edge technology expertise to universities through research grants, technology entrepreneurship forums, and mentoring by Intel technologists

Improving Teaching and Learning

Intel® Teach Program Description

Intel realizes that teaching for the 21st century is very different than traditional teaching. Teachers and students play different roles than in earlier eras. The teacher is no longer the dispenser of information; the student no longer the mere recipient. The student is now the active agent, continually striving to understand the world, apply what is learned, and break new ground. Teachers need new skills and students need new resources for these new roles. The key to changing what is taught and learned in the classroom is professional development.

The Intel Teach Program is designed to help bring schools into the 21st century by providing teachers and administrators with the skills and resources they need to bring about change. Since the program's inception nearly a decade ago, the program has trained more than 5 million teachers in more than 40 countries worldwide with a commitment to reaching 13 million teachers by 2011. The case study from Jordan illustrates how the Intel Teach Program can support education reform (see box and case study in the appendix).

The Intel Teach Program is a customizable set of offerings that range from basic ICT literacy skills to training on tools that support students' development of 21st century skills. It also includes the training of school administrators on effective ICT implementation. The program is composed of seven courses: *Skills for Success Course, Getting Started Course, Essentials Course, Essentials Online Course, Thinking with Technology Course, Advanced Online Course* and the *Leadership Forum*. Intel collaborates with Ministries of Education or other government entities to adapt the curriculum for each location.

Skills for Success Course

The Skills for Success Course is designed to allow ICT teachers to deliver an engaging student curriculum that develops students' 21st century skills with a focus on technology literacy, critical thinking, problem solving, and collaboration. Through a formal curriculum, teachers learn to deliver a prepared curriculum incorporating student-centered activities and projects exploring practical technology tools. These projects utilize technology tools such as word processors, multimedia, and spreadsheets to address issues and challenges relevant to the local community.

Intel Teach in Jordan

As part of Jordan's program of Education Reform for the Knowledge Economy, Intel provided 40 master teachers with 80 hours of training in the spring of 2003. By the end of the year, 700 master trainers and 5,000 participating teachers were trained. Jordan has since added a new module that fits the need of Jordan education reform and a second 40-hour module on using the learning management system of the ministry. To date, over 50,000 Jordanian teachers have participated in the Intel Teach program.

Getting Started Course

The Getting Started Course is typically a series of 12 two-hour modules that can be expanded to 32 hours of face-to-face instruction, individual work, hands-on activities, discussion, and teamwork. The course introduces software productivity tools and student-centered learning approaches to teachers with little or no technology experience. Teachers develop an awareness of practical applications of technology for hands-on, collaborative learning. This introduction to 21st century skills prepares teachers for the Essentials Course.

Essentials Course

The Essentials Course is typically a 10-module, 40-hour, face-to-face professional development course intended to provide teachers with the pedagogical and technical skills needed to integrate technology into their classroom teaching. The Essentials Online version is a more flexible hybrid of face-to-face and online training. Advanced Online and Collaborative is a follow-on resource that allows teachers to engage in ongoing learning and continue their collaborations online.

External Evaluations

Intel contracts with independent, prominent research and development institutions to evaluate their education programs. These evaluations use state-of-the art methodologies to examine the implementation, satisfaction, and impact of the program on target audiences. For example, in a survey conducted by EDC's Center for Children & Technology of over 12,000 teachers in 17 countries who participated in the Essentials Course, 75 percent reported that they used their unit plan at least once, and 48 percent reported using it multiple times. In addition, 75 percent reported integrating ICT into their courses in new ways, and 61 percent reported increasing their use of project-based teaching.[2] This report and others are publicly available on Intel's Web site: http://www.intel.com/education/EvidenceOfImpact/Index.htm

The premise of the Essentials Course is that students learn best when they are answering essential content questions or engaged in understanding core concepts in a subject and applying them to solve complex problems. With a curriculum aligned with the International Society for Technology in Education (ISTE) standards for teachers, Intel Teach participants leave the Essentials Course able to use technology and design learning environments that support students' deep understanding in their subject area. Teachers learn principles of this student-centered approach to teaching while they themselves are engaged in applying these key concepts to designing units they will use in their classes. The design process involves teachers in identifying the important ideas they want their students to understand, creating complex assessment tasks and rubrics that will assure them that students have learned what is intended, and designing technology-based activities that will engage students in understanding and applying these key ideas. The teachers use a variety of ICT tools to design their units, and they embed ICT in their students' activities and assessments. These tools include word processors, spreadsheets, graphic and multimedia tools, presentation and publication software, Internet browsers, CD-ROM resources, and Web collaboration tools. As part of the Essentials Course, teachers can access a set of online resources that include more than 60 unit plans developed by teachers who have participated in the program, and a collection of more than 350 stories of technology applications in school by grade level, subject area, or type of technology used.

Thinking with Technology Course

The Thinking with Technology Course is typically a 24- to 40-hour workshop that focuses on enhancing students' higher-order thinking skills using a set of free online *Thinking Tools*. During the workshop, teachers build on key concepts acquired in the Essentials Course to design unit plans that employ the *Thinking Tools* and are ready for implementation in their classes. The *Thinking Tools* can be used with any subject area and are designed to help students visually represent their understanding of complex interconnected ideas and issues. The intent is that students will think more deeply about key

2. D. Light, K. McMillen Culp, R. Menon, andS. Shulman, Intel Teach to the Future Essentials Course: Impact Survey Results for 2005,http://download.intel.com/education/EvidenceOfImpact/EssentialsImpact2005.pdf (2006).

ideas and be able to reflect on their own thinking and learning over time. The tools also make the students' thinking visible to other students and the teacher so that thinking and learning processes can be discussed and critiqued as part of the ongoing classroom discourse. The *Thinking Tools* that are currently available include:

- Visual Ranking Tool, which helps students establish criteria to evaluate and prioritize information, view issues from multiple perspectives, and make decisions by seeking consensus and negotiating new options with fellow students
- Seeing Reason Tool, which helps students understand complex problems or systems that involve cause-and-effect relationships, create idea maps that display the connections among ideas, and discuss and defend their understanding
- Showing Evidence Tool, which helps students develop effective evidence-based argumentation skills and skills needed to analyze and evaluate criteria for their decisions

An independent evaluation of the Thinking with Technology course was conducted in the U.S. by EDC's Center for Children and Technology.[3] Study data included surveys of both master teachers and participant teachers, analyses of unit plans constructed during the workshop, and observations of classes taught by participants. Participant teachers taught at all levels—from early elementary to high school—and specialized in a range of subjects, including computer science and vocational education, science, mathematics, social studies, and English and language arts. The study found that 70 percent or more of the teachers completed the workshop with an understanding of the operation of the Thinking Tools, and student thought processes, skills for integrating the tools into student projects, and new assessment skills. Data also indicated that most teachers were successful in creating unit plans that integrated *Thinking Tools,* and that they used these tools to make students' thinking visible and support classroom discussion and analysis of their ideas.

Leadership Forum

The Leadership Forum is a four-hour session that provides school principals or headmasters, district administrators, and curriculum directors with background they can use to promote the effective use of technology in their classrooms. Aligned with the ISTE standards for administrators, the forum supports school leaders in creating an innovative and effective school environment in which technology is used to support teaching and learning. In the forum, participants engage with their peers to examine the critical role that leaders play in the effective integration of technology into the classroom, apply their knowledge to create a prioritized list of leadership behaviors that impact the integration of technology, and develop a personalized action plan to implement in their school or district. In addition to the discussion session, participants are provided with a CD-ROM containing relevant research, case studies, and other resources to help them implement their action plan; resources that will help to promote technology integration and improve teacher effectiveness; and a networking opportunity with peers.

Analysis

The goals of the Intel Education Initiative and the Intel Teach Program, more specifically, can be analyzed in terms of their relationship to educational policies and programs that connect the use of ICT to education reform and to national goals for economic and social development. Some national reform policies focus on improving economic productivity by increasing student enrollments, improving their ICT skills, and raising their scores on standardized tests. This could be called the *knowledge-acquisition* approach to

3. K. McMillan Culp, S. Pasnik, D. Wexler, and T. Meade, Formative Evaluation of the Intel Teach to the Future Workshop on Teaching Thinking with Technology (U.S.): 2005 Report, http://download.intel.com/education/EvidenceOfImpact/EssentialsImpact2005.pdf (2005).

reform (see the companion paper[4] and Appendix 1). Other nations aim to advance economic and social development goals by deepening students' understanding of subject matter—particularly science, mathematics, and technology—and improving their ability to use this knowledge to solve complex real-world problems—in what could be called the *knowledge-deepening* approach. Yet others may promote their economic and social goals by moving the education system toward *knowledge creation*—policies focused on the research, development, generation, and sharing of new knowledge and the capability of citizens to learn continuously throughout their lives. The Intel Education Initiative was designed to help countries move from *knowledge acquisition* to *knowledge creation* and prepare students for the challenges and opportunities of the 21st century.

The Intel Teach Program accomplishes this movement through its various component courses. The *Skills for Success Course* helps ICT teachers engage students in knowledge creation by helping students to identify real world problems and needs in their community and use technology to analyze these problems and create solutions. Teachers encourage students to make choices and develop their own ideas. Students work collaboratively to create plans, implement them, and review and share the results of their work. At the same time, students develop higher order thinking skills, such as the ability to access and manage information, pose and solve problems, and analyze and interpret evidence.

With the *Essentials Course* teachers use curriculum framing questions to guide students' deepening knowledge of school subjects that they can apply to improve their everyday lives and to become highly productive workers. This is achieved by providing teachers with knowledge about students' understanding and learning processes and providing them with the skills they need to design collaborative, project-based learning experiences. As a result, students identify core ideas in the subject area and are engaged in key inquiries that use these core ideas along with technology productivity tools to solve complex problems. Student knowledge is assessed in the context of their project work. Teachers' use multiple modes to measure students' ability to apply knowledge to problems, draw conclusions, and analyze relationships. The roles of teachers and learners change as they collaborate on class projects such that students become actively engaged in searching for, analyzing, and creating new knowledge to solve complex and important, real world problems. At the same time, teachers use knowledge creation skills to develop innovative lessons and environments that support students' deep knowledge of school subjects.

When teachers use *Thinking Tools* they engage students in knowledge creation by making their knowledge visible and helping students reflect on their own thinking and learning processes. This provides students with skills that they will need for a lifetime of continuous learning and construction of their own knowledge. The Advanced Online Course enables teachers to build online communities that share the knowledge and resources they create.

Finally by explicitly addressing the social infrastructure of the school, the Leadership Forum provides administrators with new skills that they can use to begin to transform the social infrastructure of the school and support ongoing innovation and build knowledge communities. The intended result is the creation of an innovative, continuously improving educational system that produces creative citizens and highly-productive workers who can contribute to and benefit from the knowledge economy and information society.

Intel® Learn Program and Intel® Computer Clubhouse Network

Not all learning occurs in school. Ironically, it is sometimes difficult to fit something as novel as knowledge creation into the discipline-bound formal school curriculum. In some ways, it is easier to introduce the knowledge-creation approach outside the formal school setting. That is what Intel has done with the Intel Learn Program and

4. Kozma, ICT, Education Reform, and Economic Growth.

the Intel Computer Clubhouse Network. These programs use the *knowledge-creation* approach to foster continuous learning and create ongoing learning communities.

Intel Learn Program Description

The Intel Learn Program is a 60-hour, hands-on, after-school project-based curriculum built around two core modules for learners from communities that have no access to technology. It taps into children's interest in their own communities while developing their skills and nourishing their curiosity with creative, technology-driven projects. Intel has collaborated with governments, NGOs, and local community technology centers to implement the Intel Learn Program in nine countries, including Egypt, Israel, Russia, Turkey, China, India, Brazil, and Mexico. The case study from India illustrates how Intel Learn can be implemented in communities (see box and case study in the appendix). To date, Intel Learn has helped more than 662,000 students, ages 8–16 years old, acquire crucial 21st century skills. Specifically, the program promotes the learning of:

- computer skills such as using the Internet, word processing, multimedia, graphics, and spreadsheets
- collaboration skills by working together on projects, sharing ideas, and solving community problems
- critical-thinking and problem-solving skills by building projects that contribute to their community

In the *Technology and Community* module, students are asked to identify a key problem or issue in the community. Students work in groups and learn to apply basic technology tools—a word processor, graphics software, spreadsheet, multimedia software, and an Internet browser—and a "plan-it, do-it, review-it, share-it" approach to addressing the problem or issue. In the *Technology at Work* module, students learn how computers are used in a variety of jobs and careers. Working in teams, students use a variety of increasingly sophisticated software tools to create projects ranging from designing a survey that a healthcare worker might use to assess health needs, to developing a project management plan that a local engineer might create before starting a building project.

Intel Learn in India

Launched in India in November 2004, the Intel Learn Program focuses on building technology literacy and 21st Century skills for youth living in rural communities who have little or no access to technology. The initial program was piloted as part of the Akshaya project in rural Mallapuram district in collaboration with Kerala IT Mission and has been implemented through 100 community technology centers. The program has since expanded to other states and programs, and to date has affected more than 48,000 youth across 14 states and Union Territories in the country.

The program's impact is illustrated by a student project in the Akshaya center. Students used technology to gather and analyze information from their community and identified that the lack of playgrounds was a high-priority problem. Their analysis of the situation determined that renovation of existing playgrounds would be more cost efficient than building new ones. As part of their Intel Learn unit, students developed flyers using the technology and creative skills they had learned in the program and raised awareness of the problem in their community. After presenting their recommendations at a community meeting the village council took up the renovation plan.

An independent evaluation by SRI's Center for Technology in Learning[5] examined the Intel Learn Program in six countries (China, Egypt, India, Israel, Russia, and Turkey) and found that 98 percent of the youths who enrolled completed the after-school curriculum. In addition, staff members reported that as a result of the program, students made gains in their technical skills, critical-thinking skills, and collaboration skills. An analysis of student products concluded that more than 70 percent of the students met or exceeded the criteria for successfully demonstrating the expected skills.

Intel Computer Clubhouse Network Program Description

The Intel Computer Clubhouse Network is sponsored by the Intel Foundation. The Computer Clubhouse program was created in 1993 by the MIT Media Lab and the Computer Museum, now part of the Museum of Science, Boston. The difference between the two programs is that in Intel Learn, the learners follow a structured curriculum. In the Clubhouse program, some structured activities are available, but participants are encouraged and given the support to pursue projects of their own interest.

A clubhouse is not only a safe environment for youth, it is a creative place where young people, mentors, and staff use technology as a tool for learning and creative expression. In each clubhouse, students have access to high-end computers and a suite of professional software tools for illustration and animation, photographic and video editing, digital music creation and sound editing, robotics, programming, writing and publishing, and Web design. With these resources, young people can work as designers, inventors, and creators on projects of their own interest to produce computer simulations, electronic music compositions, computer games, computer-controlled devices, and Web sites. The Clubhouse program is also based on the premise that interpersonal relationships and community are important to the learning process, particularly for adolescents. *Clubhouse* members become part of a community that values and respects hard work and the ongoing pursuit and sharing of ideas and knowledge. Members not only forge continuing relationships within the Clubhouse environment, they exchange information, communicate through e-mail, collaborate on design activities, and share their creative products with Clubhouse members around the world.

An independent evaluation of the Clubhouse program in the U.S. by SRI's Center for Technology in Learning[6] surveyed more than 1,600 youths (807 girls and 889 boys) who participated in the program. A large majority of the respondents (87 percent of the girls and 85 percent of the boys) reported coming to the clubhouse at least once a week. Half of the participants (50 percent of the boys and 49 percent of the girls) reported coming daily, with many (36 percent of the boys and 29 percent of the girls) reporting that their typical session was three hours long. The survey data indicated that participants scored high on socio-emotional measures (positive relationships with adults, sense of belonging, sense of future, social competence, and collaboration) and academic engagement (school engagement, academic self-perception, problem-solving competence, and problem-solving planning). Generally, students scored higher on these scales the longer the session they typically spent at the clubhouse. Another study interviewed participants, observed them during their clubhouse sessions, and conducted an in-depth analysis of their final products. Researchers rated 9 of 22 participants' projects as "high" and 9 as "medium" using criteria that assessed the ability to express oneself with technology, the ability to collaborate and work in teams, the ability to solve complex problems, the ability to develop, plan, and execute complex projects, and the development of self-esteem and self-efficacy.

5. Center for Technology in Learning, Review of Evaluation Findings for the Intel Learn Program, http://download.intel.com/education/EvidenceOfImpact/Report-IntelLearn_April2006.pdf (2006).
6. L. Gallagher, Assessing Youth Impact of the Computer Clubhouse Network: 2005 Year-End Report, http://download.intel.com/education/EvidenceOfImpact/ICCN-SRI-2005-Report.pdf (2006).

ISEF in Pakistan

The Intel Science Olympiads in Pakistan have now been running for 3 consecutive years. Since 2004, the provincial and federal ministries of education have supported the program and in 2006, the Federal Ministry made a special project for the National Science Olympiad, committing $65,000 over 3 years for just this event. Workshops and Science Fairs across the country reach out to over 2,500 (grade 9 through 12) students and 500 science and math teachers, on an annual basis.

Fatima Shami is one of the ISEF winners from Pakistan. In 2005, Fatima was an international finalist with her project titled, "Effects of Reused Edible Oil on Human Health." At the time, she was 16 and living with her family in Islamabad. "No one had ever tested this oil for its harmful contents formed due to its reuse," said Fatima. "I tested samples of reused oil both from home and the market and found out there was 100 percent abuse of oil samples taken from the markets. I also found out the effects on oil caused by its reuse and about the different toxic chemicals formed and diseases caused by them."

As evidenced by Fatima's projects, ISEF encourages students to tackle challenging scientific questions through authentic research practices.

Analysis

The *Intel Learn Program* and the *Intel Computer Clubhouse Network* help countries move toward *knowledge deepening* and *knowledge creation* by helping students develop continuous learning skills and providing youths with the technical skills and creative capabilities they need to participate in the knowledge economy and information society. In the Intel Learn Program students use a variety of technology tools to access and manage information, pose and solve problems, and analyze and interpret evidence as they work collaboratively on high-priority problems of their community. Learning in both programs is very learner-centered, with participants selecting their projects, developing their plans, collaborating on their projects, and serving as peer reviewers. The learning process and knowledge products become an integral part of the ongoing knowledge community. The effect is to prepare students to work collaboratively in teams that generate new knowledge and new products and apply these skills to solve problems that have real value to their community and employer, client, or customer.

Advancing Science, Engineering, Math Education and Research

Any country that is using knowledge and technological innovation to drive economic productivity must be concerned about the promotion of science, engineering, and mathematics education—for these disciplines are the sources of many innovations and inventions. Intel is supporting this concern through two programs: the *Intel International Science and Engineering Fair* and the *Intel® Higher Education Program*.

Intel International Science and Engineering Fair Program Description

The Intel International Science and Engineering Fair (Intel ISEF) is the world's largest pre-college science competition. The fair has been administered for more than 50 years by Science Service, one of the most respected nonprofit organizations advancing the cause of science. Intel became the first title sponsor of the fair in 1996 as a way to recognize and reward excellence in science from the world's best young scientists, and to encourage more young people to explore science and technology in their higher education and career. As the title sponsor, Intel

Corporation has committed millions of dollars (U.S.) to developing and promoting this competition. Since assuming the sponsorship, Intel has focused on adding new awards (such as the Intel Foundation Young Scientists Scholarships, Best of Category, and awards to schools and fair directors) and on increasing international participation. The case study of Pakistan serves to illustrate how ISEF helps students and contributes to a country's development goals (see box and case study in Appendix).

Intel ISEF finalists are selected annually from over 550 ISEF-affiliated fairs around the world. More than 1,500 students from over 50 countries, regions, and territories win the chance to compete at the Intel ISEF for over USD 4 million in scholarships and prizes in 17 scientific categories and a team project category. More than 900 individual student and team awards are presented. Each of the top three finalists receives the Intel Foundation Young Scientist Scholarship of USD 50,000. Grand awards are given for the first-, second-, third-, and fourth-place projects in each category.

A related program—the Intel ISEF Educator Academy—brings together educators and government officials from Intel sites around the world to network and explore proven, innovative methods of engaging students in the study of science and math. During the five-day academy, outstanding educators present workshops on student research, project-based learning, and other ways to engage students in the study of science and mathematics. Also, experienced science fair organizers share resources and provide participants with valuable information about managing, organizing, and preparing students for science fairs.

Analysis

Intel ISEF supports education reform goals associated with the *knowledge deepening* approach by fostering a technologically and scientifically competent citizenry and highly productive workforce that can effectively compete in the global economy. But it goes further than this. By encouraging secondary students to engage in active research, it supports the goals of the *knowledge creation* approach, which is to create a workforce and citizenry that is continuously engaged in knowledge production and lifelong learning.

Intel® Higher Education Program Description

The Intel® Higher Education Program is a worldwide effort focused on advancing technology innovation and developing a diverse pipeline of technical talent. Through a sustained collaboration with governments and universities, Intel brings cutting-edge technology expertise to university campuses. This technology not only encourage students to pursue technical degrees, but also helps move technology out of classrooms and into local economies. Intel works closely with local governments and university faculty at more than 150 universities in 34 countries to accelerate curriculum development, engage in focused research, and encourage students to pursue a range of opportunities for technical study and research.

Technology Curriculum

Developing leading-edge curriculum to teach the engineers of tomorrow is a challenge faced by universities around the world. The Intel Higher Education Program works to accelerate this process by providing world-class curriculum modules developed by leading universities worldwide. These modules demonstrate how other universities have implemented technology curriculum. Departments or individual professors can utilize this model curriculum to review or expand their own offerings. The program supports universities in the development of new curricula for emerging technologies through sharing of information from other universities and from Intel. The modules are developed by leading universities worldwide and are offered for open review. All course content is developed by university faculty and is provided free of charge.

Research with Universities

Research is the key to developing next-generation technologies. Intel is working with universities worldwide to enable the advancement of technology through a variety of programs including regional academic forums, university research grants, and the funding of open and collaborative research labs. Intel's collaboration with Nizhni Novgorod State University in the Russian Federation is an example of this collaboration (see case study in the appendix).

Entrepreneurship

To encourage and prepare today's students to become tomorrow's technology entrepreneurs, the Intel Higher Education Program, through partnership with Lester Center for Entrepreneurship and Innovation at the Haas School of Business, offers a curriculum in entrepreneurship education. The program helps move technology out of research labs, and into local communities—where it can do the most good.

Student Programs

The program also encourages a pipeline of technology talent through grants and internship programs that help students gain advanced technical degrees. The technical areas include semiconductor technology, high-volume manufacturing, circuits, software, networking, and communications. Intel offers students opportunities to support their technical research and/or careers through Ph.D. and Master's fellowships, undergraduate scholarships, student research competitions, and a resource center for information on employment opportunities at Intel. These programs are tailored to the specific country or region in which they are located.

Analysis

Engineering, science, mathematics, and technology all play essential roles in economic development. Clearly, the Intel Higher Education Program emphasizes both the *knowledge deepening* and *knowledge creation* approaches by developing advanced engineering capacity in a nation's universities and helping students to acquire advanced technological and research skills. As a result, institutions and their students are in a position to both contribute to the development of new knowledge and advance economic development.

Getting There from Here

How should countries respond to the global trends that have taken us into the 21st century? How can policy makers turn the challenges of the decade into economic growth and social improvement? And how can policy makers and education leaders take advantage of the opportunities offered by the Intel Education Initiative?

In their details, each response will be unique and will depend on a nation's history, social priorities, resources, and political will. Schools in South Korea and Finland are different from each other and different still from schools in Egypt, Bolivia, or Kenya. But the framework provided in the companion paper and summarized in Appendix 1 gives policy makers three alternatives that allow them to craft educational reform policies and programs that connect with productivity-based economic growth and social development. Related to these options, the Intel Education Initiative can play a leadership role in helping a country reform its education system by leveraging strengths in the system to develop other components and move toward 21st century schools. Examples from South Korea and Egypt illustrate how the Intel Education Initiative can help countries move from *knowledge acquisition* to *knowledge creation*.

South Korea

South Korea has a population of 48 million and ranks as the world's 11th largest economy. The country has experienced strong economic growth over the past several decades, with an average annual growth rate of 5.8 percent from 1990 to 2000 and 4.7 percent from 2000 to 2004, according to the World Bank. Despite its strong international showing, South Korea continues to be concerned about its economic performance

and remains focused on advancing its competitiveness in the global knowledge economy.

South Korea's education system is an important part of the country's economic development plans. South Korea's students consistently score at the top on international assessments of problem solving, math, reading, and science. But as with its economy, South Korea strives to improve its education system, despite outstanding international performance. Over the past several years, the Korea Ministry of Education and Human Resource Development has implemented a series of nationwide master plans for the effective use of ICT in education. The initial plan equipped 100 percent of the nation's primary and secondary schools with computer labs and provided classrooms with broadband connections to the Internet. In the second phase, policies were developed to promote the effective use of the educational infrastructure, including the initial training of teachers and the development of digital content. The third phase is intended to make the educational use of ICT pervasive and foster lifelong learning.

Within this context of these reform efforts, the Ministry and Intel Korea Ltd. signed a memo of understanding (MOU) in 2005 for a joint partnership that would support the master plan. The objective of the MOU is to strengthen Korea's global competitiveness through innovation in primary, secondary, and higher education by enhancing students' 21st century skills. As the MOU states:

> *A well-educated workforce is fundamental for the success of a nation. Especially in the 21st century, where knowledge is the superior value, students need to be able to analyze problems, think at a high level, envision solutions, and collaborate with others. At the same time, they must know how to harness information and communications technologies not as an end itself but as a tool for solving complex problems and enhancing their productivities.*

With the MOU, the Ministry and Intel agreed to jointly train all of South Korea's 400,000 teachers using the localized version of the Intel Teach curriculum aligned to the country's education standards, and to train all 10,000 of South Korea's principals with the Leadership Forum curriculum. Both parties will also enhance the quality of local pre-college science and engineering fairs, jointly train 50 percent of the faculty at the nation's 11 education universities, and advance the curriculum and research capabilities of the nation's engineering universities.

South Korea is in an enviable position, with a strong economy, a top-rated education system, and world-class technological resources at their disposal. Yet to maintain and improve their position in the world economy, the government of South Korea is leveraging its resources to position the country as a major player in the global knowledge economy. Through policy leadership and coordination and the private-public partnership with the Intel Education Initiative, the government of South Korea is providing teachers and students with 21st century skills improving their science and technology capacity to create a workforce and citizenry that is continuously engaged in knowledge production and lifelong learning.

Egypt

Egypt has a population of 72 million and ranks as the world's 43rd largest economy, according to *The Economist*. Egypt has experienced solid economic growth over the years, with an average annual growth rate of 4.7 percent from 1990 to 2000 and 3.4 percent from 2000 to 2004, according to the World Bank. However, Egypt's per capita Gross Domestic Product (GDP) in 2003 was only USD 1,150 (compared to USD 12,690 for South Korea). And its economy is not growing fast enough to keep up with the population growth. In recent years, almost 900,000 people join the labor force in Egypt each year but only 60 percent of this number are absorbed into the economy.

In August 2004, Prime Minister Ahmed Mahmoud Nazif announced Egypt's "Information Society

Initiative," an economic development strategy intended to turn Egypt's ICT sector into a major engine for economic development. 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. Yet, unlike South Korea, Egypt currently has a low rate of computer penetration; there are only 32 PCs per 1,000 people in Egypt and only 5 percent of Egyptians were connected to the Internet in 2004, according to 2006 World Bank Development Indicators. This compares with 545 PCs per 1,000 and 66 percent of the population connected to the Internet in South Korea. Yet, as with South Korea, Egypt sees education reform as central to advancing its economic and social goals.

The education system in Egypt is currently very centralized, with a curriculum that is uniform in content and a schedule that is determined by the Ministry of Education. Egyptian students scored well below international averages on recent international assessments of both science and mathematics in grade 8. Currently, the pedagogy, curriculum, textbooks, and assessments in Egyptian schools all emphasize the memorization of subject matter facts and principles. As part of its reform efforts, the government launched the Egypt Education Initiative (EEI) in May 2006, in collaboration with the World Economic Forum. The Egyptian Education Initiative (EEI) aims to improve schooling in the country through the effective use of ICT.

In parallel with these developments, Intel launched the Intel Teach Program in Egypt in 2004 in close collaboration with the government. The goal was to train teachers to integrate ICT to improve their classroom teaching. To date, the program has successfully trained 150,000 teachers in Egypt. In 2005 Intel also launched its Intel Learn Program in Egypt to teach 8- to 16-year-old students the technological literacy, problem-solving, and collaboration skills they will need to succeed in Egypt's knowledge economy. In 2006, Intel aligned its educational efforts in support of the new EEI and announced that it will train 650,000 Egyptian teachers and student teachers through the Intel Teach Program over the next five years, effectively reaching 80 percent of all Egyptian teachers. As part of the program expansion, Intel implemented an online version of the core Intel Teach curriculum early in the 2006–07 school year, making Egypt the first developing nation to begin training teachers online through the program. Moreover, Intel has donated 5,250 of 8,000 PCs to Egypt for use in 350 model schools. Teachers in those schools will receive training, and the government will provide the necessary connectivity and technology infrastructure to ensure effective and sustainable use of the technology.

The challenges that Egypt faces are significant, as the economy and society move into the 21st century. But the government of Egypt has created a vision of how technology-based change can influence education and ultimately the Egyptian society and economy. It has leveraged this vision to coordinate policies and programs within and across agencies. And they have created a number of private-public partnerships to enlist resources they need to face the challenges ahead as they make significant changes in their education system. The programs of the Intel Education Initiative are a major part of this effort, as they provide teachers with the resources and skills they need to prepare students for the 21st century.

Conclusion

Responding to the challenges and opportunities of the 21st century will require policies and programs that connect education reform to national economic and social development goals. Sustained economic growth and social development will require an education system that generates a highly productive workforce and cultivates creative, thoughtful citizens who can contribute to and benefit from the knowledge economy and information society.

Within this policy context, the Intel Education Initiative can help countries move their education systems from a focus on *knowledge acquisition* to one on *knowledge deepening* and *knowledge creation*. The Intel Teach Program provides teachers with the knowledge and skills that they can use to create continuously innovative schools. In these schools teachers collaborate with each other and leverage outside resources to design learning environments in which students work in teams to apply key concepts and technology tools to solve important, complex problems. The Intel Learn Program and the Intel Computer Clubhouse Network engage students in using ICT tools to produce creative products that are important to the community, while acquiring 21st century skills of collaboration, critical thinking, problem solving, and continuous learning. The Intel ISEF and the Intel Higher Education Program foster a technologically and scientifically competent citizenry and highly productive workforce that can continuously engage in knowledge production and effectively compete in the global economy. Together, these programs provide a country with significant resources that can be used to help achieve its economic and social goals.

Appendix 1

Education Reform, ICT, and Economic and Social Development

Education Reform, ICT, and Economic and Social Development
Developing 21st Century Skills

	Knowledge Acquisition	Knowledge Deepening	Knowledge Creation
Policies	The policy goal is to prepare a workforce capable of taking up new technologies and contributing to economic productivity. Education policies focus on increasing students' enrollments, ICT skills, and scores on standardized tests, primarily in reading and math.	The policy goal is to upgrade the productivity of the workforce so that it can add value to economic output. Education policies focus on improving the understanding and problem-solving skills of students and connecting school learning to real-world problems and contexts.	The policy goal is to increase innovation and knowledge creation to drive the knowledge economy. Education policies are focused on the research, development, generation, and sharing of new knowledge, and on continuous learning. Schools, teachers, and students participate in these endeavors.
Professional Development	Teachers are expected to have a comprehensive knowledge of their field. Teacher training emphasizes the comprehensiveness and accuracy of teacher subject knowledge. Teachers may be tested on this as part of certification. Continuing professional development may not be required if mastery is achieved.	Teachers are expected to have a deep understanding of their field and principles of pedagogy. Professional development emphasizes both the deepening of teachers' subject knowledge as well as their understanding of student learning processes. This is done through a combination of continuing formal and informal experiences.	Teachers are model learners. As experienced professionals, they are primarily responsible for their own and each others' development as colleagues and mentors. They collaborate with each other and with outside experts to build a professional community. They are engaged in creating and sharing their own body of professional knowledge and best practices.
Pedagogy	Teaching is focused on information delivery. Lectures are common but information may be presented in a variety of forms. Alternatively, instruction can be individualized and self-paced.	Teaching is conducted in the context of complex, open-ended questions and problems, and it is anchored in real-world contexts. Classroom activities involve the application of key concepts and principles to analyze systems and solve problems across subjects. Internships and apprenticeships can be an important way to connect school learning to the real world.	Teaching consists of challenging students to build on their knowledge and explore new topics. Collaborative projects and investigations involve searching for information, collecting and analyzing data, generating knowledge products, and communicating with outside experts and audiences to share results.
Curriculum	The curriculum enumerates a large number of facts and concepts within school subjects and emphasizes their acquisition. ICT is included as a subject in the curriculum.	The curriculum identifies key interrelated concepts and principles that organize the subject area. It emphasizes deep understanding of these within and across subjects and their application to solve complex real-world problems. Curriculum implementation is responsive to local contexts.	The curriculum is flexible and responsive to student goals and local contexts. It emphasizes the development of collaboration, inquiry, information management, creativity, and critical-thinking skills. Learning how to learn is essential.
Assessment	Assessments are composed of a large number of brief tasks that require the recall of facts and the application of principles to solve simple, one-part problems. Accuracy is emphasized. Students are tested frequently and receive regular feedback on progress.	Assessments are composed of a few extended, open-ended, multipart problem-based projects that embed key concepts and principles and correspond to real-world situations. These tasks are integrated into the learning experience.	Assessment tasks consist of investigations, reports, presentations, creative works, and other knowledge products. These products are evaluated through self, peer, and public review, as well as expert review. Assessments also emphasize student goal setting and self-monitoring.
ICT Use	Technology is used primarily to deliver instruction and management. The ratio of students to computers may be low if used by teachers for delivery, or high if used by students for individualized instruction. Networking is used to support management and accountability.	Networks are used to support collaborative projects and connect students and teachers to outside contexts. Simulations and multimedia are used to support deep understanding of interrelated concepts, address misconceptions, explore systems, and solve problems.	Pervasive technology is used to support knowledge production, collaboration, and knowledge sharing by students and teachers. Networks are used to help teachers and students build knowledge communities.
School Organization	Schools are hierarchically structured with a high level of accountability and little autonomy or flexibility. Curriculum inspectors assure the curriculum is covered as prescribed. School and teacher performance are measured and rewarded by student test score gains.	Teachers have flexibility over implementing the curriculum and making it responsive to student interests, community needs, and contemporary issues. Structural flexibility allows teachers to adjust student groups or the class schedule to allow more time for projects, planning, and collaboration.	Schools are learning organizations and teachers are engaged in continuous innovation. Administrators, community members, teachers, and students create a shared vision and goals for their learning community. Within this vision, teachers have autonomy in implementing goals and accountability for results.

Appendix 2

Intel® Education Initiative Case Studies

Intel® Teach Program Case Study

Country: Jordan

Faced with persistently high unemployment and poverty, the government of Jordan created a program of economic and social transformation in 2001 to develop high value-added sectors and to establish a knowledge economy. The top priority in this program has been the development of the nation's human resources. The Educational Reform for the Knowledge Economy (ERfKE) was a program launched in 2003 in support of these human development priorities. The Intel Teach Program has become a major contributor to ERfKE.

Challenges

- Stagnant economy: Between 1975 and 2003, the average annual growth in per capita GDP in Jordan was .3 percent, according to the United Nations Development Program (UNDP).
- Underdeveloped infrastructure: In 1996, only 60 Jordanians per 1,000 had telephones, according to the UNDP; only 7 per 1,000 had computers.
- Education system incompatible with the knowledge economy: The curriculum and assessment emphasize memorization rather than 21st century skills.

Solutions

- Develop policies and programs that build a knowledge economy: The government crafted human resources policies to build a growth economy.
- Prepare students to work in the knowledge economy: ERfKE lays out a plan to transform education programs relevant to the knowledge economy.
- Revise the curriculum, train teachers, and upgrade the infrastructure: ERfKE provide the resources needed to transform the education system.

Details

The Jordanian National Economic and Social Development Plan for 2003–2006 sets an economic growth goal of 6 percent for the country. The plan sees the creation of a knowledge economy as the basis for sustained economic growth and an improved standard of living for the people of the country. The development of Jordan's human resources is central to achieving its goals. In the plan, it articulates a vision of Jordan's future in which a higher quality of education arms students with specialized skills and expertise in various fields of knowledge to fulfill the needs of society and contribute to sustainable economic and social development. An Education Reform for the Knowledge Economy (ERfKE) was established in 2003 to help make Jordan the hub of modern commerce by modernizing the economy and society through the application of information and communication technology in all areas of learning and work. The transformation of educational practices is intended to achieve learning outcomes that are relevant to the knowledge economy. This is to be accomplished by changes in curriculum and learning assessment, providing resources to support effective learning, and professional development and training of teachers. Teacher training includes the development of teachers' abilities to integrate ICT in the curriculum and pedagogical methodologies that support, facilitate, and encourage the learning of students.

Intel's collaboration with the government of Jordan began in 2002 with a meeting between King Abdallah II and Intel Corporation CEO Craig Barrett. The Intel Teach Program was launched later that year in Jordan with the development of materials and the training of 18 senior trainers. In the spring of 2003, 40 master teachers were given 80 hours of training, and by the end of the year 700 master trainers and 5,000 participating teachers were trained. Jordan has since added a new module that fits the need of Jordan's education reform and a second 40-hour module on using the learning management system of the ministry. To date, over 50,000 Jordanian teachers have participated in the Intel Teach program.

Dr. Majdi Al-Mashaleh is a teacher who participated in the Intel Teach program in Jordan. He has been a teacher in Jordan for 16 years and teaches Islamic science to upper secondary students. He was among the first teachers in Jordan to participate in the program, taking the Intel Teach Essentials course as a master trainer in 2003. He subsequently took all the other Intel Teach course offerings. As a master trainer he has trained nearly 80 participant teachers.

"In Intel Teach, I learned and gained knowledge and skills to effectively integrate technology in the classroom," Dr. Al-Mashaleh commented. "Most importantly, I learned what project-based learning is and how it is applied to the topic I teach, which is Islamic science. . . It changed my whole view of education, as I now see that education and technology should go side by side." His training included the Thinking with Technology Course. "Thinking with Technology provided us with deeper knowledge about higher order thinking skills. . . The tools are very simple, but the outcomes are beyond expectation," he said.

As part of his training, Dr. Al-Mashaleh collaborated with a biology teacher and an English teacher to develop a unit on the process of human creation, incorporating biology, physiology, and religion. The essential question for the unit was "Who am I?" "When I posed it in the class, different students understood it differently. Some took it from the ethical point of view, others took it from the biological point of view, others took it from the religious point of view, and others took it from a characteristic point of view. The essential question guided students' thinking and created lots of discussions among them, and each tried to bring the subject that interests him most. The essential question triggered other questions in the students' minds and made them more interested in the subject."

New assessment approaches were integrated into the unit. "As teachers, we used to assess the knowledge of the students only by doing tests and exams that do not go beyond the knowledge and memorizing of the information," Dr. Al-Mashaleh said. "Now different assessments are being used by teachers, like rubrics, which measure different skills of the students, such as technical skills and the effective use of technology and the authenticity of the information retrieved from the Internet, and the documentation of reference copyrights."

The exams were not checked by the teacher in the traditional manner but by peer review, where students used the rubrics to assess each others' answers and provide feedback.

Intel® Teach Program Case Study

Country: Colombia

(Based on reports written by Daniel Light of the Education Development Center)

The Colombian government has pursued a well-structured and coherent reform effort that is designed to transform its public education system. To meet its goals for its citizenry, the country is moving from a traditional model of education to a comprehensive 21st century educational paradigm, working to enhance quality, expand school enrollment and improve access to education, and increase administrative and financial efficiency. Colombia's reform strategies emphasize the use of information and communication technology (ICT). The government participates in the Intel Teach Program because it promotes teachers' and students' use of ICT and supports the government's new teaching paradigm. .

Challenges

- Colombia experienced difficult years of violence and social and economic turmoil in 1999 and 2001 that reduced its productive capacity.
- Education reform efforts of the 1990s focused on challenges of decentralization and institutional changes but did not change classroom practice and the learning environments so that schools still use traditional methods.
- The quality of education had suffered. In 1999, only 20 percent of the students in the fifth and ninth grades could read and understand texts at an acceptable level, and 11 percent could solve problems that required abstract and conceptual thinking.

Solutions

- Introduce a National Development Plan that build the nation's productive capacity.
- Institute a comprehensive Education Revolution to transform how and what students learn.
- Use ICT as a thread that connects all of the components of the reform effort.

Details

In response to Colombia's difficult years of violence and social and economic turmoil in 1999 and 2001, the country developed a Plan Nacional de Desarrollo (National Development Plan--PND). Drawing on the lessons learned from this period, the PND was formulated between 2002–2006. In developing the plan, the government recognized that political and social stability are necessary for the nation's improved productive capacity. This capacity is supported, in turn, by three factors: educational advances, enhanced abilities of the labor force, and technological development. Colombia's leaders believe that education is the key to addressing both the need for social peace, inclusion, and integration and the need for economic development in an era of competitiveness and globalization. They believe that a revitalized, 21st century education system is the pathway to a fair, tolerant, and stable society.

Colombia's educational vision and reforms initially grew out of a set of broad social dialogues in the 1990's that involved a diverse group of representatives from social, political, and economic arenas. For more than a decade, debates about education reform had been connected to larger discussions about Colombian society. By the end of the 1990s, parts of the Colombian education system had begun to change in terms of decentralization and institutional structure, however, schools still used traditional methods (e.g., teacher-centered learning, rote memorization), and there was little impact on the nature of teaching and learning in most classrooms. Quality

was a concern. The country's test results in 1999 showed that only 20 percent of the students in the fifth and ninth grades could read and understand texts at an acceptable level and only 11 percent could solve problems that required abstract and conceptual thinking.

As a consequence, Colombian leaders' placed a high priority on improving the quality of education and the Revolución Educativa was instituted and woven into the PND. As an integral component of the larger social change agenda, the Revolución calls for a complete transformation of the education system. In launching the Revolución Educativa, the goal of the Ministerio de Educación Nacional (MEN) was not only to increase student performance on educational tests, but to transform how they learn and what they learn and to support them in becoming critical thinkers and lifelong learners.

The policies of Colombia's Revolución Educativa address the five dimensions of education reform most important to systemic change—curriculum, pedagogy, assessment, teacher professional development, and school organization. None of the MEN's policies exists in isolation and all of their strategies are designed to work in unison to strengthen the system as a whole. Curriculum reform, which attempts to support deeper learning with a focus on competencies and skills, is supported by changes to traditional models of teaching and by changes in the assessment process. New accountability and assessment policies, which target the new competencies, also serve to drive changes in teaching and school improvement. Simultaneously, well-aligned professional development programs and improvements in teachers' working conditions build the capacity of the teaching workforce to thrive in the new system. A shift in school organization towards decentralization empowers teachers and schools to take ownership over the reform process.

The MEN views ICT as a strategic thread that connects all of the efforts of the Revolución Educativa. As the centerpiece of many new models of teaching and learning that encourage students to explore and build their knowledge through the productive use of technology, ICT is especially important to the Revolución's quality improvement strategies. In an interview, Javier Orlando Torres Paez, Jefe Oficina de Informatica said that, "In the Revolución, there are five strategic projects that explicitly use information technology. These are basically:

- Program for the use of new technologies in teaching
- Strengthening the use of ICT in Higher Education
- Creation of a national information management system
- Modernization of the MEN
- Modernization of the secretariats [provincial education administrations]" (Javier Orlando Torres Paez, personal communication, August 3, 2006)

The PND also addresses the role ICT can play more generally in Colombian society through the Agenda de Conectividad (Connectivity Agenda). Working through the Ministerio de Communicaciones (Ministry of Communications), the Agenda is an inter-ministerial group that is attempting to extend Internet access by creating access points in public locations (e.g., libraries, community centers, low-cost cyber-cafes) throughout the country. The success of ICT in the schools and programs like Computadoras para Educar (Computers for Education) has fostered increased collaborations between the MEN and the Ministerio de Communicaciones on the work of the Agenda.

In the Revolución Educativa, teachers must take the lead in implementing many of the reform efforts. The new competencies and curricular goals require teachers to change their practices and improve their content knowledge. The MEN's professional development programs are designed to introduce new ways of teaching, as well as to orient teachers to innovative ICT tools that support student learning.

In this regard, the MEN offers Intel® Educar Curso Esencial (Intel® Teach Essentials Course)—a course that engages teachers in creating their own ICT-rich learning units for student projects. The MEN selected Intel Educar because it supports two goals: teachers' and students' use of ICT and promotion of its new teaching paradigm. Intel Educar centers on a discussion of the pedagogical importance and utility of ICT in inquiry-driven, student-centered learning environments while teachers create their own materials. The course was also adapted and expanded to support the MEN's efforts through the introduction of a module on school improvement plans.

The content of Intel® Educar serves to reinforce the broader efforts of the Revolución Educativa in other ways. According to Mónica López, Sub-Directora de Mejoramiento, an important objective of the MEN is that all professional development opportunities "... serve to strengthen the institution as a whole, and not only the teacher". Intel® Educar meets this objective by engaging cohorts of teachers from the same school in the course, reinforcing each school's sense of itself as a community of learners and professionals. In this regard, Intel Teach is helping Colombia move toward and education system based on Knowledge Creation.

The arrangement between MEN and Intel started as a pilot test in three regions of the country. Across the three regions, 14 master teachers were trained who went on to train 120 other teachers. The results of the year-long pilot resulted in a decision to make the training more specific to the Colombian context and to expand the program across the entire nation. As of the end of 2007, over 15,000 teachers were trained in 14 regions and 54 municipalities, bring the two-year total to over 20,000 teachers trained.

Intel® Learn Case Study

Country: India

Over the last decade, India has become one of the stars in the global economy with a per-annum economic growth that has averaged more than 6 percent. However, the challenge for India is not only to sustain its economic growth but to broaden it to a larger share of population. This is a challenge that the national and state governments are addressing by improving rural infrastructure, increasing funds for education, and creating opportunity for the country's girls and lower castes. The Intel Learn Program in Kerala is helping rural youth acquire the skills needed to participate in an advanced economy and contribute to their community.

Challenges

- Inequitable education: India is known for its world-class tertiary institutions, but the education system falls short of connecting with the real life needs of most of its citizens and creating a broad-based, high-quality workforce.
- Economic growth limited to the IT and service sectors: To sustain its growth, India needs to extend its success to other sectors, particularly the agriculture sector, which employs most of India's workforce.
- Economic exclusion: Poverty is a significant issue in India with nearly 80 percent of India's population living on less than USD 2 a day, according to the World Bank.

Solutions

- Invest in education: The government has committed itself to spending at least 6 percent of GDP on education, promoting technical education among minority communities, and increasing educational access to the poor.
- Develop infrastructure: The government is increasing public funding and encouraging private funding for the development of infrastructure, particularly in rural areas.
- Include rural areas in economic development: The government supports investment in the agricultural sector and rural small businesses.

Details

Like the size of its population, India's challenges are large. With a population of more than 1 billion people and a growth rate of 1.4 percent a year, India is expected to become the most populous country in the world by 2015. India's GDP of $673 billion in 2004 ranked it as the world's 11th largest economy, according to World Bank figures. But in the coming years, the economy will need to create millions of jobs to accommodate young people and an increasing number of rural citizens who will move into the formal economy. While the service sector accounts for 51 percent of India's economy, the agricultural sector employs 60 percent of the nation's workforce, according to *The Economist*, and more than 70 percent of India's population lives in its 650,000 rural villages. Education will play a key role in India's development, but currently only 53 percent of India's youth are enrolled in secondary education, according to the 2005 United Nations Human Development Report. The national adult literacy rate is only 61 percent, and only 49 percent for adult females.

India is a federal system and much of the power to implement programs resides at the state level. The state of Kerala is an example of how one state is stepping up to the challenges of India's sustainable and equitable economic growth. Kerala is a state in the southwest corner of the country and one of India's most densely populated states, with 38 million citizens. Agriculture is the main economic sector in Kerala, employing approximately 50 percent of the workforce. Yet among the state's economic and social development policies is a plan to make Kerala the leading knowledge society in the region.

Launched in 2002, the Akshaya project is an initiative of the Kerala State IT Mission (KSITM) to provide equitable access to ICT throughout the state. The project involves setting up 5,000 multipurpose community technology centers across Kerala, each within 2 to 3 kilometers of every household so as to cater to the needs of 1,000–3,000 families. A variety of services like business process outsourcing, online services, vocational training, and financial services, including e-banking, have been made available to the rural population. The project piloted in the district of Malappuram is being replicated all over the state. The Intel Learn Program is a key partner in this effort.

The Intel Education Initiative has been active in India since 1999, when the Intel Science and Talent Discovery Fair was started. India has also participated the Intel Higher Education and Intel Teach programs. More than 570,000 teachers from 14 state governments have been trained since the Intel Teach Program started in 2000. Launched in India in November 2004, the Intel Learn Program focuses on building technology literacy and 21st century skills for youth living in rural communities who have little or no access to technology. The initial program was piloted as part of the Akshaya project in the Mallapuram district in collaboration with the Kerala IT Mission, and has been implemented through over 300 community technology centers. The program has since expanded to other states and programs and to date has affected more than 48,000 youth across 14 states and union territories.

An example of the impact this program has created is evident in Pulvetta Akshaya center. Pulvetta is a small village in the Malappuram district. Students that came to this center were from lower-middle-class families and had no prior experience with computers. But as at other centers participating in the Intel Learn Program, children at the Pulvetta center learned by exploring computer applications through activities and projects they undertook with fellow learners. An example is a team of youngsters in the program who selected "Problems of Pulvetta," as their project in which the learners used technology to gather and analyze information from the community. By conducting door-to-door surveys in the village, the students identified the immediate needs of the community, which included scarcity of water and lack of a playground for the youngsters. They also worked on solutions to the identified problems. After considerable deliberation and critical thinking, the learners—assisted by their facilitator—reached consensus that it would be more cost efficient to renovate the existing playground than build a new one. They also determined it would be easier to convince the community leaders to renovate the existing playground than ask for a new one. As part of their Intel Learn unit, students developed a flyer using the technology and creative skills they had learned in the program. They distributed the flyer in the community inviting them to a showcase of their project. The learners earnestly presented their projects to a highly appreciative audience presided over by the President of the village council. The council president was so impressed with the presentation that he made an immediate commitment to resolving the problems, and work for building a water tank and renovating the existing playground were undertaken soon after the meeting. Grateful villagers still remember the presentation made by the learners and attribute the success to the Intel Learn Program.

Intel International Science and Engineering Fair Case Study

Country: Pakistan

Pakistan has an apparent dichotomy between its economic and social indicators; the former bring the country on a par with economically prosperous countries in the region; the latter categorize it with lesser-developed ones. Education remains inequitably distributed among various income groups and regions in the country. Pakistan's Education Sector Reforms (ESR) aims to rectify these problems by dramatically increasing the participation in education, particularly among girls, and reforming science education. The Intel International Science and Engineering Fair (ISEF) is part of the country's effort to develop private-public partnerships to improve educational quality and access.

Challenges

- Low education participation: Pakistan has a combined primary, secondary, and tertiary enrollment rate of 35 percent of its school-aged youth, according to the United Nations Development Program (UNDP), ranking it 165 among 173 countries. Literacy rates are below those in other South Asian countries with similar levels of economic development.
- Inequitable access to education: The combined primary, secondary, and tertiary enrollment rate for males is 43 percent and 31 percent for females.

Solutions

- Increasing access to education: A centerpiece of the government's Education Sector Reforms ensure girls' equal access basic education.
- Improving quality of education: The reform effort is committed to improving the quality of its education system, particularly the science facilities.
- Private-public partnerships: The government is encouraging the formation of private-public partnerships as a way of achieving its goals in education reform.

Details

The Pakistan ESR acknowledges that the accumulation of human capital is of equal importance as the accumulation of physical capital for sustaining development. It goes on to say that in the absence of a healthy and literate population, it will be difficult for Pakistan to bring about real increase in productivity. With the education reform effort, the government is committed to improved access to education services that enhance the human capital of the poor and enable them to generate income through asset utilization and gainful employment. However, the participation rate in 2000–2001 at the primary level in Pakistan was 68 percent, while the participation of female participation rate was a lowly 53 percent. Consequently, gender equality has become a major emphasis for Pakistan's ESR and Education for All Action Plans, the goal being to eliminate gender disparity in primary and secondary education and achieving gender equality in education by 2015. The ESR action plan also acknowledges that science education at secondary and upper secondary level is an important area, which has great importance as the gateway to professional and higher education. Improvements in science education through the ESR include the planned construction of new science labs in about 3,000 schools and the provision of additional equipment to about 5,000 institutions where labs are deficient in equipment. In support of the goals of the ESR, the government has provided incentives for public private partnerships to flourish in the education sector and has stepped up its efforts to include various other stakeholders in education delivery.

The Intel ISEF is part of Intel's effort to contribute to development and education reform in Pakistan. The Intel Science Olympiads in Pakistan have now been running for three consecutive years. Since

2004, the provincial and federal ministries of education have supported the program, and in 2006, the Federal Ministry made a special project for the National Science Olympiad, committing USD 65,000 over three years just for this event. Workshops and science fairs across the country reach out to over 2,500 (grades 9 through 12) students and 500 science and math teachers annually. Approximately eight research workshops are held each year to educate students and teachers about research-based learning and the Intel ISEF program. Four district fairs and four provincial fairs feed into the National Science Olympiad, which is the only fair in Pakistan affiliated with the Intel ISEF.

In 2005, Pakistan student Fatima Shami was an international finalist with her project titled "Effects of Reused Edible Oil on Human Health." More than 1,400 young scientists from 41 countries came together in Phoenix, Arizona, for Intel ISEF 2005. In 2006, Hamza Sheikh, a grade 9 student from Islamabad, won the second prize in Chemistry (USD 1,500) at Intel ISEF 2006. He also won a special award from the Society of Environmental Toxicology and Chemistry.

Fatima Shami illustrates the impact that Intel ISEF can have on individual students and how this can ultimately lead to economic development. Fatima is a 16–year-old who lives with her family in Islamabad. At the time of her project, she was working on the O levels at Islamabad Convent School. In describing herself, Fatima said, "I really like people who want to help others and make a difference in the world. Personally, I want to help special people and make their lives as normal as possible."

Her research question was: "Is reused oil harmful to human health?" Approximately 1.5 billion people in South Asia use fried foods, foods usually cooked in reused oil. "No one had ever tested this oil for its harmful contents formed due to its reuse," said Fatima, "and I was the first to test the reused oil in which specifically samosas, pakoras and jalabis are cooked. The shopkeepers and vendors keep using the same oil to cook these foods. I tested samples of reused oil both from home and the market and found out there was 100 percent abuse of oil samples taken from the markets. I also found out the effects on oil caused by its reuse and about the different toxic chemicals formed and diseases caused by them. I was helped by Dr. Zaheer Ahsan, NARC, Islamabad, who assisted me in the analysis of samples of reused oil. I used books, research studies, the Internet, and students (for my survey). Next I would like to do a detailed research to investigate polymerization in edible oil under local situations and try to invent a chemical additive for increasing the oil's capacity of reuse."

In commenting on how the ISEF program influenced her life, Fatima responded, "I have started observing things more carefully and try to understand how they actually work. Now I know how to write a proper research paper. My observation skills have definitely improved, and I try to find out more new things around me." The program also affected her plans for the future, "My goals in life have suddenly changed. In the future I would want to find a cure to the common cold by developing a vaccine. I am planning to do my Ph.D. at Harvard University and want to win a Nobel prize for my country. I am more confident and have learned never to give up."

Intel® Higher Education Program Case Study

Country: Russian Federation

While Russia has a history of world-class research and development in science, mathematics, and engineering, the country has fallen behind in the past decades. The country is now in the process of rebuilding its research capacity. By providing advanced technology, curriculum support, and technological expertise at Nizhni Novgorod State University, the Intel Higher Education Program is helping to cultivate highly skilled faculty and graduates who can contribute to economic competitiveness in the region and country.

Challenges:

- Declining capacity: Over the decades, research facilities in Russia have deteriorated and lost their competitive edge in science and engineering.
- Traditional approaches to education: In developing countries, it is difficult to connect university education to applications in the real world that can contribute to economic growth and competitiveness.
- Attracting students to science and technology: Now that students have a wide range of choices for education and career, it is hard to attract capable students to science, mathematics, and engineering.

Solutions:

- Develop technological resources: The Intel higher Education program provides world-class laboratory equipment that is needed by any university to be competitive.
- Develop technical expertise: Curriculum support and mentoring from Intel engineers help make education relevant and attract capable students.
- Advanced management approaches: The program also provides management and innovation models that support efficiency, competitiveness, and entrepreneurship.

Details:

Russia has a highly educated population with a combined primary, secondary, and tertiary enrollment rate of 90 percent according to the United Nations Development Program. Yet according to *The Economist*, Russia is only the 16th largest economy in the world, with a GDP of USD 433 billion, trailing behind South Korea and Mexico. Russia is seeking to rebuild the quality of its higher education institutions as a foundation for a revitalized economy.

Nizhni Novgorod State University is one of Russia's top universities, and it has a history of excellence in radar and radio science and research that goes back to the late 1940s. As in the rest of Russia, the scientific capacity of the university declined over the past decades. But it was this history of excellence that attracted Intel to Nizhny Novgorod. Intel established the Russia Software Development Center in 2000 and the Intel Nizhny Novgorod Lab in 2004. The lab is now one of the largest Intel research facilities in Europe. The software development center specializes in creating new and innovative software development products for Intenet-related technologies and employs more than 450 specialists.

Intel is committed to working with governments and institutions in Russia to build research capacity and help the country become more competitive in the commercial use of ideas and technology. To help the Nizhni Novgorod State University build its technological capacity and provide a foundation for a world-class workforce, Intel joined forces with the university through the Intel Higher Education Program. Through the program, Intel provided the university with two advanced IT and wireless laboratories, along with curriculum support and technical expertise. Intel also provided expertise in management and entrepreneurial skills needed to take technology to the market. This expertise and the university's research capacity is providing the foundation for start-up companies in Novgorod. These resources contributed both to the university's research

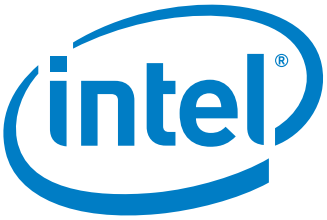
program and to improved curriculum offerings, and the laboratory attracts highly capable students. Students participate in projects in the laboratory as part of their academic work, and these projects provide students with the skills they need to participate in the knowledge economy. The laboratories are used by 70 to 100 university students each year and many more students who come to the university for summer workshops.

Andrey Eltsov and Vlaidmir Filimonov are two students who have benefitted from the program. Andrey, 22 years old, chose radio physics as an area of study, in part because his father is a physicist and his mother is an electrical engineer. Vladimir, also 22, is the sole bread winner in his family since his father, a riverboat captain, died and his mother, a programmer, retired. Both students participated in the wireless laboratory during their university studies. "Involvement in the lab gives me a great chance to deal with real research problems," commented Andrey. Both students worked on the Steerable Antenna, an Intel-supported project to design a new type of low-cost antenna for long-range Wi-Fi links between rural areas in developing countries.

Commenting on his participation in the project, Vladimir said, "I passed through all the steps of research. I started with creating the theoretical model for the antenna, and then I dealt with computer simulations using my model . . . after that, I implemented several optimizers, adapted for working with real signal sources. And now I'm dealing with prototyping and measurements."

"Of course, it is absolutely impossible to do research without necessary equipment, and it is one of the most valuable resources of the lab," said Andrey. "Maybe an even more valuable resource is laboratory staff—university professors, leaders of science schools, and Intel employees."

Their project work resulted in both students interning at a research project at the University of California at Berkeley. Vladimir is finishing his master's degree and Andrey is entering his Ph.D. program. "I'm grateful to the wireless lab and Intel for this opportunity to become an intern at Berkeley," said Vladimir. As illustrated by these students, the connection between the private sector, education, research, and real-world application at Nizhni Novgorod State University creates a highly capable workforce, and that forms the basis for economic competitiveness.



Technology leadership.
Community commitment.
Intel is the world's leading innovator in advancing silicon technology, with more than 35 years of leadership in computing and communications. In addition, Intel is a leader and contributing member in the global community, inspiring people through educational initiatives and outreach efforts.

Learn More
To learn more about how Intel helps governments, universities, schools, and educators prepare youth for the demands of tomorrow, visit: **www.intel.com/education**

Programs of the Intel Education Initiative are funded by the Intel Foundation and Intel Corporation.

0408/LT/CMD/PDF 318496-002US