Fueling Innovation Worldwide Through Creative Education

Intel's commitment to education helps create future innovators and world leaders.

By Patricia Brown

When B. Magdalene Premalatha first started teaching at the Panchayat Union Middle School in the village of Karakottai in Southern India, where 90 percent of the population work in agriculture, primarily as farm laborers, she found that many children were kept out of school or forced to drop out so they could work in the fields to earn money for their families.

Like any great teacher, though, she took the challenge and turned the issue itself into a learning opportunity. She introduced problem solving and interactive discussions into her lectures. She challenged her students and launched a project-based learning initiative that delved into the causes and results of child labor in the region — and explored alternatives.

This is the classroom of the 21st century. It is both action-oriented and high tech. Premalatha's work is a by-product of Intel Corporation's commitment to education as a foundation for economic development and social empowerment.

Intel has invested more than $1 billion in the last decade in education programs at the K–12 and university levels worldwide. The commitment is founded on the belief that advancing education through technology and teacher training will create future innovators and world leaders. The educational training is centered on well-thought-out programs that enable and promote professional development among teachers and university faculty by allowing them to integrate technology effectively into the classroom and to help students acquire and develop the problem-solving, collaboration and innovation skills that are now critical to succeed in today's interconnected world.

The Intel® Teach program helps an Indian teacher prepare her students with the skills needed to compete in a global economy. To date, more than 695,000 teachers in India have been trained through the Intel program.

These skills are not only useful for students in the future, but can make a dramatic difference in their lives today — as was the case in Premalatha's classroom. After conducting Internet research and initiating public rallies, carrying placards they had designed and built using word processing software, her students began to make inroads into the minds and hearts of the villagers, who started to realize the importance of education. The village council, thanks largely to the work of the students, soon declared Karakottai a child labor-free village. "As a result, seven children regained enjoyment of their childhood, their rights and their education," Premalatha says.

Intel's programs go far beyond disseminating technology information. Teachers' methods are transformed as instructors move away from regurgitating statistics and information from a book toward helping students develop project ideas and take charge of their learning. The common denominator running through Intel's programs is the idea that a commitment to education can activate the innovation cycle and prepare students for the global workforce and the knowledge economy. They include:

- Intel's Teach Program, which helps teachers in grades K–12 worldwide become more effective educators. To date, Intel has trained 4 million teachers in nearly 50 countries and plans to train 9 million more by 2011. Intel has made tremendous inroads in some countries. In Jordan, for example, 60 percent of the teachers have been trained, and plans are in place to train 100 percent of teachers in Korea over the next few years.

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- Intel International Science and Engineering Fair (ISEF), which encourages students worldwide to pursue careers in math and science through science competitions and scholarships. In addition to Intel's ISEF, the company sponsors the annual Intel Science Talent Search (STS) competition, which is open to high school seniors in the United States (see sidebar).
- Intel's Higher Education Program, which is a worldwide effort to advance technology innovation by developing a diverse pipeline of technical talent. Intel is working with 150 universities in 34 countries to bring cutting-edge technology expertise to the classroom.

It's all central to the philosophy that an educated

Tapping Today's High School Students for Tomorrow's Scientists

For any high school senior in the United States, the prospect of winning America's oldest and most prestigious precollege science competition — and a shot at big money — is no small goal. But for those who are so inclined, participating and winning can have a lasting influence on their lives and careers.

Just ask Mary Masterman, a 17-year-old Westmoore High School senior from Oklahoma City. She is the 2007 first-place winner of the Intel Science Talent Search (Intel STS), receiving a $100,000 scholarship for the spectrograph system she built. By using parts she machined herself and aligning her own optics, she was able to obtain accurate wavelength measurements without using an expensive laser. The cost of Masterman's spectrograph was about $300. Compare that with the average cost of a commercial unit of $20,000 to $100,000, and you have a winning formula.

The second-place prize went to a senior from North Carolina who solved a classic open problem in differential geometry, and third place was awarded to a Russian-born senior from Oregon for his sophisticated investigation of ways to associate algebraic structures with topological spaces.

This competition, considered by many as the

Mary Masterman of Oklahoma captures first place in the 2007 Intel Science Talent Search and receives a $100,000 scholarship.

junior Nobel Prize because of the numerous winners who go on to win a Nobel Prize, is extremely prestigious and motivating for the students involved. "Even if you think what you want to do is impossible, go ahead and go for it because you never know what you can accomplish," Masterman says.

In 2007, the winners and their schools received $1.25 million in scholarships and awards. Each of the 300 semifinalists — who are selected from some 1,500 students — receives $1,000, and so do their schools. After a weeklong program in Washington, D.C., the top 10 winners also receive scholarship awards ranging from $20,000 to $100,000.

These projects start with a good idea, motivated by curiosity and an enthusiasm for research and science. It's clear from the sophistication of these research projects that students like Masterman and other Intel STS winners will drive tomorrow's innovation. Intel is actively involved and committed to enabling students to tackle challenging scientific questions and develop the skills that are necessary to solve tomorrow's problems.

— Patricia Brown

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workforce is necessary if we are to maintain and grow the economy worldwide. Craig Barrett, chairman of the board of Intel Corporation, will address this and other topics at the World Business Forum in New York City this month. He'll discuss how deploying the appropriate technology can transform education — as well as health care, entrepreneurship and government services — to create social and economic opportunities.

"As a parent and grandparent, I have realized that the best gift you can give the next generation is a good education," Barrett says. "Every child deserves that opportunity."

The Intel programs are long-term initiatives based on an enlightened sense of self-interest, which considers the education of people around the world an investment in the growth, health and workforce of the computing technology industry, as well as a stimulus for economies on every continent.

Intel has invested more than $1 billion in the last decade in education programs at the K–12 and university levels worldwide.

"The value of technology is a tool to solve real problems," Barrett says. "Educators are recognizing how the effective integration of technology into the curriculum makes learning more meaningful and exciting for children. It's time to stop talking and do what we know works."

Improving Teaching Practices

Intel® Teach, considered the flagship program for the education initiatives, helps educators understand how, when and where to incorporate technology tools and resources into the learning environment to foster their students' critical thinking and collaboration skills. These skills, in turn, empower students to create changes and take responsibility for the world around them and for their own learning.

It's these skills that are making a difference for the students in Hoda Ka-een's language arts class for seventh and eighth graders at the Houssam Eddine Hariri High School in Makassed Saida, Lebanon.

Ka-een and her fellow teachers are focused on

The Intel® Teach program focuses on teaching students how to use technology as a tool for developing better problem-solving skills.

two types of content for their curriculum. They're teaching traditional content, such as history and civics, as well as 21st century content. To do this, "strategies, methods, techniques and even teaching aids have been modified," explains Ka-een. "For example, flash cards and picture cards were the most common types of teaching aids. Nowadays, we have proven that videos are one of the most powerful teaching aids."

In addition, teachers have started to base their lessons on authentic tasks related to real-world issues. "Teachers now realize that education isn't confined to a single place or time," she notes, pointing to the opportunity e-learning has created to expand her educational circle of influence.

As a result, teachers worldwide are moving into the role of facilitators as well as educators, mentoring students to become more critical and thoughtful in their thinking.

An interconnected and networked world is challenging teachers to not only acknowledge the rapidly changing technology environment, but also to recognize that simply having the right tools is not enough.

"There is, in fact, a real danger that without careful thought and analysis into what we teach and why we teach, we will continue to teach 21st

Higher Education Harnesses the Technology to Support Tomorrow's Businesses

By Patricia Brown

Developing a solid, sustainable technology curriculum is one of the most challenging tasks in academia at the university level. Established technologies are evolving constantly, new technologies are emerging daily, and these developments all have an immediate impact on existing computing platforms.

By introducing leading-edge technology and processes, Intel works with universities around the world to cultivate tomorrow's innovators today.

It is critical that computer science students around the world graduate with the ability to write or modify applications for the new hardware architecture. Only by continually training in the classroom with the most up-to-date technologies and applications will students be in the best position to collaboratively develop and field the next generation of killer applications and innovations that will change the world.

Through its Higher Education Program, Intel is working to advance technology and entrepreneurship education by developing curriculum in partnership with premier universities around the globe.

Georgia Institute of Technology in

Atlanta and Intel recently formed one such partnership. At Georgia Tech students have access to some of the best innovative thinking in academic research. The university is particularly focused on adopting forward-looking educational initiatives to keep students as informed as possible about global developments. Specifically, the College of Computing (CoC) places a premium on technical knowledge and skills to prepare students for the global workforce while also fostering an entrepreneurial spirit.

That's why Georgia Tech considers it so important to provide students with a course experience that connects the dots between legacy environments, current developments and emerging trends.

Whether it is virtualization, grid computing or multi-core technologies, students must be well versed in all emerging technologies in order to deal with real-world applications in the private, public and nonprofit sectors. Intel and Georgia Tech are upgrading the university's core curriculum in computer science and systems. Their goal is to develop a number of compact training modules that focus on issues arising from the technology revolution. These modules will be incorporated into the course work and instruction of several disciplines.

The project is collaborative in nature. The material is available to non-Georgia Tech engineering faculty and allied institutions — nationally and internationally.

Outside of the U.S., Intel is working with professors at top computer science programs in India and China to institute a multi-core curriculum. Multi-core is a computing design in which a single physical processor contains the core logic of more than one processor. Because of industry-wide adoption of multi-core technology, universities must update curricula quickly to ensure that students graduate with skills applicable to the job market.

Ten universities in India — including the Indian Institute of Technology (IIT) Kanpur and Visvesvaraya Technical University (VTU) Belgaum — were selected as top-tier participants in the program.

Like Intel's Teach program, this training is also having an effect throughout the region, as faculty and staff at these universities train personnel at other Indian universities. To date, some 25,000 students worldwide have been trained in the multi-core curriculum.

The objective is to equip students and future software engineers with a thorough understanding of multicore processor architecture. Currently, there's a special focus on the importance of parallelism, a term that refers to using more than one processor — or computer engine — to execute a program, for maximizing system operation and performance. "We need to prepare our students for parallel programming to make efficient use of the fast-growing hardware and meet the [needs of] current applications," says Nandini Sidnal, professor at VTU Belgaum.

In the fall of 2006, IIT-Madras and VTU Belgaum offered their first multi-core courses at the graduate level. Sidnal notes that the course has been "proactively welcomed" as students get excited about "parallel programming."

Earlier this year, Intel expanded its

multi-core university program to 37 universities in China. "As a global technology leader, Intel has been committed to advancing technological innovation and cultivating IT talent," says Wee Theng Tan, vice president of Intel and president of Intel China. "Advanced manufacturing processes such as nanotechnology and multi-core applications have brought sweeping changes for the entire IT industry. The joint multi-core labs will help integrate multi-core technology into teaching and research conducted in universities in order to cultivate more technical talents adaptive to this new era."

By next year, Intel plans to have multi-core curriculum programs in 235 universities throughout Asia and in more than 400 universities worldwide. Intel understands that recent industry initiatives in the fields of computer science and engineer-

Cutting-edge engineering curriculum from Intel helps prepare the next generation's workforce.

ing make it clear that emerging and future computing platforms will differ considerably from past-generation platforms. Intel and its university partners understand that by bringing cutting-edge technology expertise to the classroom, students are encouraged to pursue technical degrees and help move technology and innovative solutions into local economies.

century students in a 20th century way," says Anne Baird, a teacher in grades three to eight in North West Victoria, Australia. "The challenge for us as teachers is to implement changes to our pedagogy that reflect this change and to adapt and adopt."

Toward that end, Baird and her colleagues are focused on how best to:

- Challenge their students with project-based learning. In order to incorporate these practices into the classroom, teachers are introducing well-designed lessons that present real-life scenarios with connections to the students' lives and their communities.
- Recognize the power of the Internet and the ability to access and manage information. Teachers are creating online learning environments that encourage collaboration, self-reflection, analysis and critical thinking. (See story below.)
- Understand that the role of the teacher and the student is changing. The teacher's role is no longer solely to act as the knowledge source, but to help guide students to discover and manage the knowledge that is available to them.

In addition to teaching in the classroom, Baird has earned the designation of 'Senior Trainer'. After receiving training from Intel, as a Senior Trainer she then trains 'Master Trainers' who are required to go back to their districts to make changes within their classrooms and begin training others in their schools and universities to do the same. In 2006 & 2007, she trained over 40 Master Trainers across the state and overseas in South Korea. She also trained 15 educators in her school. This gives her and her colleagues a common language and level of understanding when developing lesson plans. She notes that 94 percent of the Australian teachers who have undergone the Intel® Teach training are now actively using technology as a learning tool in the classroom.

Students Learn in New Ways

Meanwhile, science teacher Glen Westbroek has been teaching in the Orem, Utah, school district for 12 years and says he has always been a proponent of collaborative, project-based teaching. It is, he says, the key to getting students more engaged and excited about learning.

"If I tell my students I want them to create a

podcast or write an article that we can later submit to our local newspaper, they are forced to work together in collaborative groups," he explains. In the process, they develop skills that allow them to break down a problem, analyze it and determine what is really being asked of them.

Through Intel® Teach, students are more engaged with their education and learn to showcase their work.

This new approach to teaching better reflects the educational needs of today's more informed student body. "[The students] are recognizing that the world is global; that we no longer are just worried about what's happening in our own city or state. My students are more aware of how issues affect the entire world," he says.

Since receiving the Intel® Teach training, he has trained 70 percent of the teachers in his school. As a result, students are seeing important differences between the teaching styles of those who have received training and those who haven't. He adds that, remarkably, students are now asking the teachers who haven't taken the training, to do so.

Ehab Elanany, an English teacher at the Banha Secondary School in Banha, Egypt, reports a similar phenomenon in his country. Many of his students are exploring the world through the Internet. They're accessing and sharing projects with students all

over the world through e-mail, online chats, Voice over Internet Protocol (VoIP), blogs, wikis and instant messaging.

> *" [The students] are recognizing that the world is global; that we no longer are just worried about what's happening in our own city or state."*

These changes in learning are critical for students. "If we look at the work changes here in Egypt — and, I suppose, all over the world — we will find that good jobs are rare." Employers take their time to find the best employee and are looking for those prospective employees with the right combination of technology skills and the ability to work collaboratively, he adds.

A Bright Future

We find ourselves today in an increasingly global world. Technology permeates all societies across the map, creating new opportunities to establish common ground in the disciplines of business, politics, economics and even culture.

But it is a mistake to think that this positive outcome is inevitable. To reap the full promise of the 21st century, a major worldwide transformation of our educational system is necessary. It is the only way to manage the significant complexity that comes with an interconnected world. Innovation at all levels of society is key to attacking the problems of global poverty and bringing about quantum leaps in global economic development.

Through its substantial investment and commitment to the world's education system, Intel is preparing students everywhere with the skills required to thrive in this knowledge economy. Intel is supplying the next generation of innovators with the necessary tools and learning skills to take on real-world issues and better prepare themselves to make a difference in their communities. Consequently, this next-generation workforce will be in the best position to be innovative and successful, regardless of the changes that will certainly occur in these early decades of the 21st century.

New Technology Tools in Old Schools
Generate Tangible Outcomes

Margaret Bowerman, a third-grade teacher in the Kyrene School District in Tempe, Ariz., has been teaching for three decades, and she will be the first to tell you that the classroom today is a very different place than it was when she started.

Where students may have used overhead projectors and acetate slides to study desert topography in a science class, now, they build full Web presentations, including hyperlinks that allow students to seamlessly add and delete various parts of the ecosystem. It's a meaningful way to explore such questions as, "What happens to the desert ecosystem when you take snakes out of the food chain?"

What's happening in Bowerman's classroom is part of a larger trend among educators trained in the Intel® Teach program to build on what they've learned from Intel and integrate leading-edge technologies like collaboration tools and online resources into the classroom. These tools are changing the way students communicate among themselves and with their teachers. These new applications, often referred to as Web 2.0 technologies, underlie the

MySpace, Facebook and YouTube phenomena that allow today's teens and young adults to share information and create communities around anything from indie rock groups to cult-classic movies.

Halfway across the globe in North West Victoria, Australia,

Most students no longer receive information only in the classroom; they explore the world through the Internet.

teacher Anne Baird is using these applications not for music and movies, but for math and social studies. She is applying these technologies to accomplish a different mission: to instill in her students a love and an ongoing quest for knowledge and to break down any geographical or cultural barriers to learning.

The Intel® Teach program introduces technology tools and resources into classrooms, fostering students' critical thinking and collaboration skills.

> *Both Intel and today's teachers recognize that the next idea to change the world will come from today's students.*

Her students, who range from grades 3–8, have their own online collaboration site, commonly referred to as wikis, where they keep examples of their lessons and offer reflections on their progress. Created initially as a private space, students now invite teachers and friends to view their work and ideas. Baird and her colleagues recently

started a collaborative project with a U.S. school in Andale, Kan., where eighth graders work in cross-continental teams via e-mail, wikis and Skype to investigate environmental issues that affect both of their communities.

Through its contributions, Intel supports the notion that these technologies are allowing the educational sector to join the digital society and extend its reach beyond the schoolhouse and beyond traditional school hours. It provides teachers, students and parents with the flexibility to access key resources when they need them, from wherever they happen to be. Both Intel and today's teachers recognize that the next idea to change the world will come from today's students.

— *Patricia Brown*

Special Advertising Section

Building Bridges Between Entrepreneurs and Innovation

Imagine a world where everyone has access to clean water, or a world where algae can be used to produce biodiesel. This type of environment is a lot closer than most people think, primarily due to a global surge in entrepreneurship, which is bringing new technologies like these to market faster and in more locations.

It's easy to see why progress is occurring so quickly. Between advances in communication and transportation, and a smaller and flatter world, the role of innovation continues to grow.

It is for these reasons that Intel — in conjunction with the Lester Center for Entrepreneurship and Innovation at the University of California-Berkeley's Haas School of Business — sponsors a curriculum in entrepreneurship education. The program includes the Entrepreneurship Challenge and the Theory to Practice Seminar, a two-day class that teaches faculty about the concept and value of technology entrepreneurship.

Students from around the world are invited to participate in the Intel Challenge by submitting business plans that commercialize new and innovative technologies. During last year's competition, entrepreneurial teams from 19 Arab, Chinese, Indian, Mexican, Russian, Singaporean and U.S. universities participated.

"The global nature of entrepreneurship is pretty amazing," says David Charron from the University of California-Berkeley, associate director for the Lester Center. "There are extraordinarily smart people all around the world. [American universities] have no exclusive hold on the top end of academia or brilliance."

That was clear from the diversity of last year's winners. A Berkeley, Calif.-based team won the grand prize of $25,000 for its advanced biodiesel technology that's based on algae. The founders of Aurora BioFuels are adamant that of all the potential sources of renewable energy, algae hold the most promise to replace petroleum-based fuels. The reasons are simple: Algae grow quickly on marginal land, do not compete with food crops and they remove CO_2 from the air as they grow. Most of today's biodiesel feedstock comes from agricultural crops, but if the founders of Aurora have any say, algae will provide a viable alternative that's more scalable, less expensive and more environmentally accommodating.

Meanwhile, tying for third place was a team from Arizona State University who had a vision that many share: to enable a world where every person has access to clean, potable water. The founders of Watel Solutions Corp. are mostly African students and alumni. The company has developed and is preparing to commercialize a top-of-the-line atmospheric water generator (AWG), which will extract humidity out of the air to create clean, potable water.

A team from Bangalore, India, won second place and $10,000 for developing proprietary technology that imparts hygroscopic properties to ordinary paper, enabling it to absorb moisture from the atmosphere and remain moist perpetually.

Most of these students would not get the exposure necessary to commercialize their products without competitions like these. Through programs like The Intel + Berkeley Entrepreneurship Challenge and Theory to Practice Seminar, students from all over the world get an excellent venue for international competition and access to renowned educators. Intel, in collaboration with universities like UC-Berkeley, is focused on advancing technology innovation and developing a diverse pipeline of technical talent.
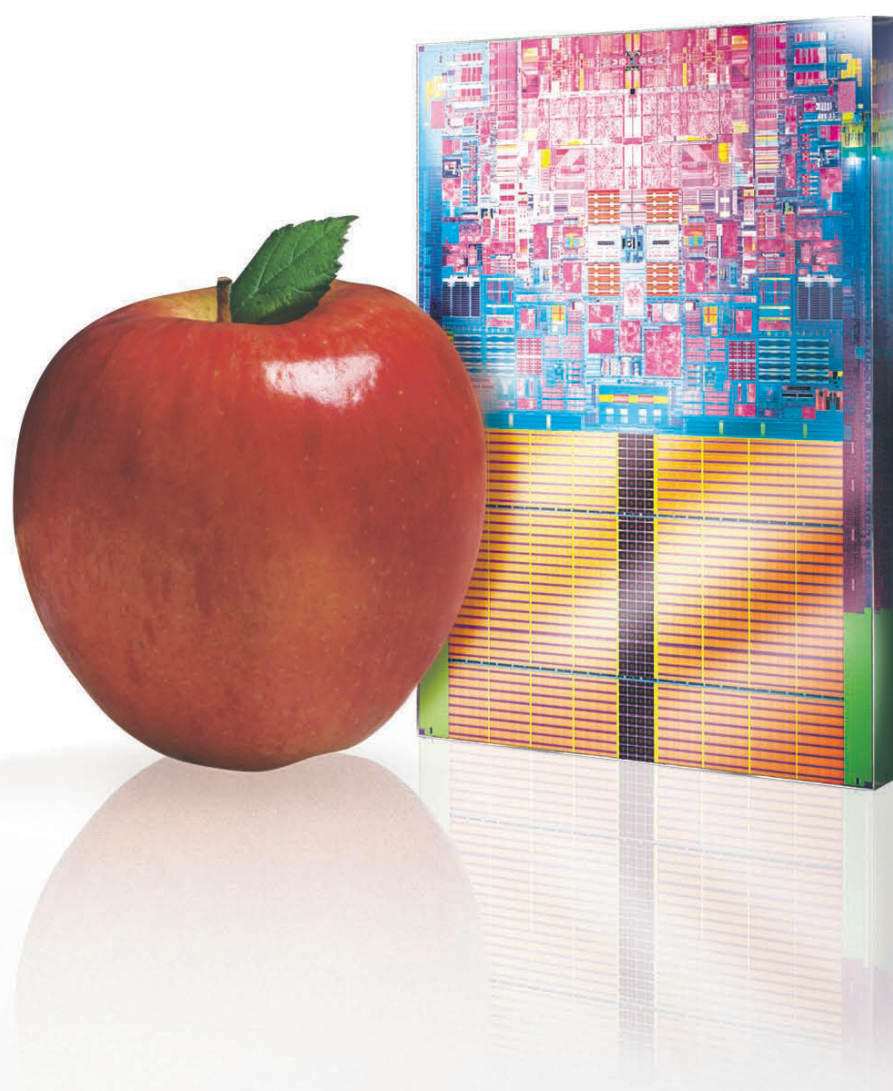
— *Patricia Brown*

Through entrepreneurship programs from Intel, university students worldwide have opportunities to commercialize their innovative ideas.

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