Shaping the New EXPERIENCE of Learning

Across the globe, human ingenuity is transforming all dimensions of education. More learners are learning differently and exploring emerging fields. Educators and institutions are rethinking their approaches to adjust to learners’ evolving behaviors, enhance the art of teaching and redefine the educational path. This special edition of articles reprinted from Compass magazine brings together stories that are shaping these boundaries.

The digital revolution is a catalyst for this transformation. With its 3DEXPERIENCE® platform, Dassault Systèmes is driving the global economy’s digital shift while working with educators worldwide to make digital transformation a social success and a rewarding human experience.
Contents

A New ART

6 Leading learning
9 Challenge everything
12 Teaching teachers
16 Evaluating teachers
19 Retooling apprenticeships
22 Personalized education
26 Best of the best

DIGITAL Horizons

30 Boon or boondoggle?
33 Game on
36 On the flip side
40 Opening the book
42 Virtual training
44 Education and research in 3D

SUBJECT MATTERS That Matter

49 Reading, writing and algorithms
52 Factory of the future
56 Digitally savvy
59 International cooperation

ALL Learners

62 i.am dreaming big
65 Technology and training
68 Teaching boys
70 GoldieBlox: Geared for Girls
72 Universal education
74 Engineering gender diversity
A New ART

Education is a collective effort, but it targets individuals. New organizational models make learning more widely available and more affordable, and new educational methods make it more efficient.
LEADING LEARNING

Processes borrowed from business help educators to serve students better

Like businesses, educational institutions exist to service the needs of a client group – in this case, students, who need good educations to be successful in life, and communities that, in order to thrive, need well-educated citizens.

“Even if universities are autonomous, they have to perform functions and to develop procedures in order to fulfill the expectations of the customers,” Mihaela Drăgan, Diana Ivana and Raluca Arba of Babeș-Bolyai University in Romania wrote in a paper for the 21st International Economic Conference in Sibiu, Romania. “In order to improve students’ and graduates’ satisfaction and to remain competitive, universities should manage their business process(es) similar to enterprises.”

Studies suggest that universities are poised to invest heavily in technology. US-based technology research organization Gartner, for example, predicts that worldwide higher education sector spending on technology will grow 1.2% in 2016 to reach US$38.2 billion and lists predictive analytics at Number 2 in its Top 10 strategic technology recommendations for higher education CIOs. Gartner notes that higher education leaders have shifted focus from reducing costs and driving efficiencies toward using technology to enhance competitive advantage and support emerging business models.

“Higher education is still mostly considered a conservative and slow-moving industry, with the majority of innovation coming from outside the traditional education IT organization,” said Jan-Martin Lowendahl, vice president and distinguished analyst for Gartner, in a press release announcing the findings. “However, it is only a matter of time until all this innovation will impact the institution and, ultimately, the CIO.”

PREDICTING EDUCATION

Businesses in many industries use big data to get detailed insights into their markets, customers and product success. Now educators are using big data to understand how they can deliver the best service to students.

“Every educational institution has large volumes of student data, but in the past we’ve mainly been reacting to it,” said Param Bedi, vice president for Library & Information Technology at Bucknell University in Lewisburg, Pennsylvania. “Now, we’re using that information to do predictive analytics and identify some of the things we need to pay attention to, which allows us to make data-informed decisions.”

In 2015, Bucknell University examined student data covering five years and identified better predictors of student success and engagement. The aim is to increase its already high rate of student retention between the first and second year of study.
"If we’re admitting students, then it’s up to us to make sure we’re giving them the environment to succeed on campus," Bedi said. "In most institutions, the biggest loss of students is between the first and second year. So we looked at pre-enrollment and first-semester data for our first-year and second-year students, and we were able to identify certain elements that contribute to a student choosing to leave. This enables us to make data-informed decisions and put in place processes, programs and interventions aimed at keeping those students."

The project is being introduced for students admitted for the fall 2016 semester, and Bedi is confident it will be a success. "At Bucknell, our first-to-second-year retention is strong at about 93%, but we want to take it to 97%," Bedi said. "This is a long-term process and we’ll know if it’s working by the next census date (September 2017), when we look at the retention rates. But we have created a good predictive model based on our examination of the data and a lot of consulting. We’ll be engaging with faculty governance groups and others to see how we can work collectively to put measures in place for these students."

Other universities are implementing data-based business processes as well, but Bedi believes Bucknell is on the cutting edge of the trend. The university is also looking at implementing best-of-breed enterprise resource planning (ERP) systems to standardize processes and increase efficiency.

"These ERP packages are causing a lot of disruption in our business processes because each department in education is so used to doing things a certain way," Bedi said. "We probably have 10 different ways to do one thing right now, but we’re aiming to standardize that and look at the commonalities among them. These best-of-breed systems are causing a lot of disruption in our business processes because each department in education is so used to doing things a certain way, but Bedi believes Bucknell is on the cutting edge of the trend. The university is also looking at implementing best-of-breed enterprise resource planning (ERP) systems to standardize processes and increase efficiency.

"These ERP packages are causing a lot of disruption in our business processes because each department in education is so used to doing things a certain way," Bedi said. "We probably have 10 different ways to do one thing right now, but we’re aiming to standardize that and look at the commonalities among them. These best-of-breed systems are causing a lot of disruption in our business processes because each department in education is so used to doing things a certain way, but Bedi believes Bucknell is on the cutting edge of the trend. The university is also looking at implementing best-of-breed enterprise resource planning (ERP) systems to standardize processes and increase efficiency.

*Every educational institution has large volumes of student data, but in the past we’ve mainly been reacting to it. Now, we’re using that information to do predictive analytics and identify some of the things we need to pay attention to, which allows us to make data-informed decisions.*

**Param Bedi**

**Vice President for Library & Information Technology, Bucknell University**

In 2015, Pennsylvania’s Bucknell University studied five years of student data and identified better predictors of student success. The aim is to increase student retention between the first and second year of study. (Image © Bucknell University / Timothy Sofranko)
solutions are causing some disruption on campus, but they’re really helping us to think about best practices rather than Bucknell practices.”

**SCHEDULED FOR SUCCESS**

Efficient scheduling – a skill mastered by many businesses – is a particularly difficult challenge for schools that need to deliver hundreds of courses. American Public University System (APUS) offers its courses online; new sessions start each month, 12 months a year. Many of its courses have several sections running simultaneously, and each of those sections might be assigned to one or more faculty.

For many years, all of this was scheduled manually by more than 40 program directors. Starting in 2013, however, APUS worked with a corporate planning, scheduling and supply chain optimization software company based in the Netherlands and the US to implement an Automated Course Scheduling and Balancing System (ACSB).

“The purpose of the ACSB was to simplify the course scheduling process to become more scalable, eliminate costly overruns, ensure course sections are always available for student registrations, optimize faculty scheduling and standardize scheduling practices,” said Brian Blodgett, associate vice president of Scheduling at APUS.

“The objective of the tool is to automate the scheduling process in order to reduce program director administrative tasks and increase the scalability of processes to accommodate growth. Manual scheduling of faculty is not a sustainable business practice.”

The ACSB went live in March 2013, and was run by a scheduling team of just three people. The system allows APUS to develop an annual schedule that balances faculty/student counts and course loads over the entire calendar year while optimizing faculty course assignment.

“Optimizing full-time faculty capacity over the course of the year also helps us budget more accurately in terms of part-time faculty versus salaried full-time faculty,” Blodgett said. “Having an automated tool also helps us to standardize scheduling practices and make sure that best practices are used. For example, we can ensure that faculty does not teach too many students at once and that they do not teach too many unique courses at once.”

**CULTURAL CHANGE**

In a digitally connected world, data-driven processes are changing the expectations of students and educators alike. For example, after the Australian National University (ANU) implemented a suite of IBM Business Analytics software to gather, verify, analyze and present information that had previously been stored in 30 separate IT systems, it saw a change in the types of discussions occurring among its staff members.

“The most important change is cultural,” Chris Grange, executive director for Administration and Planning at ANU, said in an IBM case study about the project. “By using our data to show people new opportunities, we’re moving from a debate about finance to a debate about how the university achieves its goals.”

“**SERVICE-USER TERMINOLOGY, SUCH AS DISCUSSIONS OF ‘CUSTOMER JOURNEYS,’ IS PERMEATING EDUCATION.**”

Sheila MacNeill, senior lecturer in Digital Learning at Glasgow Caledonian University in Scotland, notes that students’ expectations about the use of data, and the language used by educators, are becoming increasingly businesslike.

“Service-user terminology, such as discussions of ‘customer journeys,’ is permeating education,” MacNeill said. “Students also are more used to data, ratings and metrics being used in their everyday lives, such as on retail websites or social media. This is not yet widespread in an educational context, but there is a changing balance.”

MacNeill noted that business processes can help educational organizations get the best from their data, but they need to take a rigorous, ethical approach to its use.

“As we use more technology in our learning and teaching, we have to be clear, consistent and transparent about how we’re using that data and put processes in place to make sure it’s properly anonymized,” MacNeill said. “At a holistic level, there’s a huge opportunity for educators in understanding business processes better and looking at things from a data perspective, but a lot of work is needed to define the key insights we want to gain from our data.”

The challenges associated with manually registering for university courses may be going away. American Public University System has instituted corporate scheduling optimization software that balances the schedules of students and professors, automatically reducing gaps in the availability of courses.

(Image © Photofusion/UIG via Getty Images)
Anette Kolmos remembers the day her daughter came home from kindergarten and shared what she had learned about water. “Her class talked about why water always fell down,” Kolmos said. “What if they could make water go up? What sort of things might they be able to do or invent if they could just make water go up? By stimulating children’s curiosity through play, by encouraging them to reflect, that is the key to Problem-Based Learning.”

Today, many years later, Kolmos is a professor in Engineering Education and Problem-Based Learning at Aalborg University in Denmark and holds the chair of the United Nations Educational, Scientific and Cultural Organization (UNESCO) in Problem-Based Learning (PBL), also known as Project-Based Learning, a relatively novel idea 15 years ago, is now a fast-growing trend in many schools and universities worldwide.

It’s a trend driven in large part by the job market, where employers need workers with critical thinking skills, people who can challenge accepted ways and find new solutions to age-old and emerging problems. As new technologies reinvent how things get made, employers in manufacturing and engineering are among the most vocal groups pushing for changes in education.

“Manufacturing has changed so much in the past 35 years, it’s almost unrecognizable,” said Richard Wysk, an engineering professor at North Carolina State University’s Edward P. Fitts Department of Industrial and Systems Engineering in Raleigh. “Students really need to be well trained in a broad set of areas. It’s not simply lecturing to people on a blackboard; it’s putting them in a lab and asking them to create something that was impossible to create before they thought about it.”

Kolmos understands industry’s frustration with traditionally trained students. “Problem-Based Learning is happening because traditional approaches to education aren’t working anymore,” she said. “For example, a recent report in England said that 70% of graduates are unemployable because they’ve been textbook trained. Innovation has become more and more complex, so students need not just technical knowledge but the knowledge of how to apply what they know.”

THE NEW CLASSROOM

In a PBL classroom, teachers are not so much instructors as project facilitators. Students take charge, teachers advise. Working in teams, students identify what they already know and then what they need to learn to solve a particular challenge. The teacher, acting as a tutor, guides the process. This “active learning,” case-based format is similar to the medical school approach originally developed in the 1960s at McMaster University in Ontario, Canada. Since then, the PBL format has spread to other schools worldwide and expanded to the fields of engineering and design. Some universities also are working to develop PBL programs for mathematics.

Implementation of new teaching models varies by country and region, however. For much of Europe, change is most often instituted from the top levels of education administration downward. In the United States change tends to spring from below, at the classroom level, and work its way up.

In a world plagued by intractable social, environmental and political challenges, students who graduate with heads full of facts are of little use to organizations focused on finding never-before-thought-of solutions. Problem-Based Learning, which teaches students how to find innovative answers by asking never-before-thought-of questions, is designed to bridge the gap.

* by Dan Headrick
In systems highly focused on teacher evaluation, PBL represents a difficult challenge. In some countries, teachers and administrators are paid, evaluated and promoted based on students’ performance. Tenure is on the line in many school systems. But when a team of students at Delft University of Technology in the Netherlands came up with a vertical train station as an elegant solution to a transportation problem in a crowded city, how could the individual team members be graded?

“There is extreme resistance among academics to change,” Kolmos said. “Nobody wants to change.” But push for change is growing. Socially, the world needs solutions to challenges of energy, the environment, sustainability and rational economics. From industry, the cry for able talent with relevant skills grows with each graduating class. The voice of industry, Kolmos said, often shouts the loudest and with a single voice.

British company GKN Aerospace, which makes precision parts for most of the world’s major airframe and propulsion manufacturers, is one of the industrial voices calling for change. New materials, innovative technologies and revolutionary processes in modern manufacturing demand new skills among its workforce, its executives say.

“This is a big challenge because you have to think about things in an entirely new way,” Richard Oldfield, GKN’s technical director, told the British journal The Engineer, and that new thinking must start in the classroom. “They have to have access to these techniques as early and as widely as possible, because it’s really

Germany’s Girls’ Day, held annually since 2001, gives thousands of students aged 10 and older Problem-Based Learning experiences that teach them about future opportunities. The day is organized by an alliance of government ministries and industry associations. (Image © Andreas Rentz / Thinkstock)
by playing around with these suites of systems and toolkits that they create the correct mindset to design in this space and understand the potential of these new systems.”

GKN’s CEO, Marcus Bryson, puts it another way. “We don’t really know what the aircraft of the future will look like,” Bryson said. “But we absolutely know that we won’t be building them the same way we do now.”

TECHNOLOGY ADVANCEMENTS

The same technological developments that are pushing education to change are making its evolution possible, said Roger Hadgraft, deputy dean for learning and teaching in the School of Engineering at Central Queensland University in Melbourne, Australia.

“The development of technology — such as software that lets students experiment and communications like the Internet — allowing students to collaborate, that has really pushed Problem-Based Learning into something that can be applied effectively,” Hadgraft said. “It’s only when you get students into action that you discover what they don’t know. It changes the students’ engagement with what they are learning. They work out what strategies worked, what didn’t. The ability to work with fundamental questions depends on how well we drive the software. But you have to make up the questions, and people are getting better and better at that. The students ask much better questions. This problem-solving business matters.”

Hadgraft is among those working on the challenge of how to best structure PBL in the classroom. In Australia, for example, most children in early primary education are encouraged to question and explore their worlds. Throughout much of their secondary education, however, young people are taught with traditional textbook and lecture-based methods to earn the scores needed for admission to a university.

After years of rote learning, Hadgraft found that he had to slow down his university-level PBL courses to reacquaint students with the collaborative, inquiry-based, problem-solving educational environment they had experienced in their primary education. Early engineering courses therefore include non-technical matters: interpersonal relations, collaboration, humanities, sustainability and environmental and social issues.

“What’s changed is this humanitarian aspect,” Hadgraft said. “Problem-Based Learning helps to integrate those values into an engineering curriculum.” As a result, he said, more women are entering technical fields, which are coming to be seen as “life-orienting disciplines.”

For Kolmos, PBL harnesses the greatest force of our time: our expanding ability to share knowledge and discuss ideas. “There is no design that is done individually anymore,” she said. “You are not on your own. Understand that global collaboration is so important. The global learning part will take over in such a way that we can’t imagine how it will be.”

More than 265,000 children from 80 countries tackle high-tech challenges each year in the FIRST LEGO League competition, which challenges students to solve specific engineering problems while demonstrating to teachers the best ways for students to learn 21st century skills. FIRST means For Inspiration and Recognition of Science and Technology and is sponsored by LEGO, the Denmark-based company that makes toy building bricks. (Image © Tim Boyle / Thinkstock)
As an increasing number of schools across the globe invest millions of dollars in tablets, laptops and other technologies, educational observers note that they often forget one fundamental prerequisite: instructing teachers how to use the technology and incorporate it into their classes.

“In many places, there’s a mad rush to buy new technologies,” said Andy Dickenson, a former teacher and creative director at LearnNewStuff, an educational consultancy based in the UK that has been involved in writing the IT curriculums in the UK, Saudi Arabia, South Africa and Spain. “It’s only once it’s in schools that staff ask: ‘What are we going to do with all this new stuff?’ Deploying lots of technology is expensive. When new tech is introduced in the classroom and staff are expected to adapt – without support – then it won’t get used.”

Bob Tate, a senior policy analyst for the Education Policy and Practice department at the National Education Association, the largest US teachers’ union, agrees: “Too often a well-conceived approach to professional development for the educators who will be expected to use new technologies – one that fully involves educators themselves in its development – receives less attention than the purchases, or is unfortunately an afterthought,” he said.

THE PARADOX OF TECH USE

Schools across the globe are making major investments to get students equipped for the Internet Age. “We have states like Maine and countries like Uruguay where every student has their own digital device,” said Mary Burns, a former teacher and senior technology specialist at Education Development Center (EDC), an international nonprofit organization based in Boston.

However, a number of studies show that relatively few teachers use technology as part of their day-to-day teaching. A 2013 survey by Harris Interactive, a market research company based in Rochester, New York, found that 86% of US teachers surveyed think it’s “important” or “absolutely essential” to use apps, computer games, websites, digital planning tools or digitally delivered curricula designed to help students or teachers. But only 19% of teachers use subject-specific content tools, just 14% use digital curricula, and fewer than 10% are implementing bring-your-own-device programs, the study found.
A similar picture can be seen across Europe. The European Union’s “2013 Survey of Schools: IT in Education,” found that around half of European students are taught by teachers with positive attitudes on the use of IT in the classroom. However, the percentage of teachers using IT in more than 25% of lessons has not increased since 2006.

Teachers in Africa are also failing to use technology, despite national strategy plans. “The mission of the Kenyan National Strategy is ‘to integrate technology in education and training to improve access, learning and administration,’” explains Niall Winters, who has conducted research in Sub-Saharan Africa in his role as deputy head of the Department of Culture, Communication and Media at University of London. “However, the majority of teachers in Africa still feel unprepared to use technology for teaching and learning in their classrooms.”

And in Asia it’s the same story. “Research shows that technology enhances teaching and learning practices at schools,” said Jonghwi Park, program specialist for

“SCHOOLS NEED TO REALIZE THAT A BUDGET NEEDS TO BE CREATED FOR PROPER TRAINING.”

ANDY DICKENSON
FORMER TEACHER AND CREATIVE DIRECTOR, LEARNNEWSTUFF
information and communications technology (ICT) in Education at the United Nations Educational, Scientific and Cultural Organization in Bangkok. “However, teachers who are using technology to transform their pedagogical activities are still more the exception than the norm. And this has been seen not just in schools in Asia but all across the world.”

To close the gap between intent and practice, educational experts advocate more training for teachers in how to integrate computers into established lesson plans. “To really help integrate technology to support all components of the learning process – content, instruction and assessment – professional development needs to be hands-on, focused on problem solving, conveying higher-order thinking skills, modeling effective practices and helping teachers work with different populations,” Burns said.

EDUCATING THE EDUCATORS

Dickenson agreed that every teacher needs support, advice and training on how to implement new approaches. “Schools need to realize that a budget needs to be created for proper training,” he said. “A few one-off sessions won’t help; continuous, progressive, professional development is key. Teaching universities need to establish appropriate teaching and a suitable up-to-date kit. If they also offered subject-leader specialties, then new teachers would be ready to lead.”

A 2013 survey of 2,462 teachers in the US by social science analyst Pew Research Center found that 85% of the teachers surveyed have had to seek out new ways to effectively incorporate digital tools into their teaching. Three of four teachers say the Internet and other digital tools have created new demands on their time, increasing the range of content and skills they must know.

The EU-commissioned study found that only 25%-30% of students in Europe are taught by teachers for whom IT training is compulsory. Yet around 70% of students at all grades are taught by teachers who have engaged in personal learning about IT in their own time.

Latin America also suffers from a serious lack of teachers properly trained in the use and monitoring of technology in the classroom; just 10% of primary and secondary teachers in 14 out of 27 countries are qualified to teach basic computer skills, according to a 2013 study by UNESCO titled “ICT in Education in Latin America and the Caribbean: A regional analysis of ICT integration and e-readiness.”

Training also is an issue in Asia. At Ban San Kong school in Mae Chan, Thailand, for example, 90 children received a tablet computer in 2013 as part of the government’s ‘One Tablet Per Child’ initiative. But, according to The Japan Times, teachers have been given no specific training. “I have some knowledge,” Siriporn Wichaipanid, a teacher at the school, told the newspaper. “At home, I use an iPad. But if I don’t understand, I don’t know how to teach the children.”

The EU study recommends that increasing professional development opportunities for teachers will help boost IT use in teaching and learning by helping to build highly confident and positive teachers. The study advises that all countries should consider making IT a compulsory component of teacher education programs, and should seek to improve the quality and consistency of IT training across institutions.

Tate agrees. “We need both smart investment in technology in schools and a robust, supportive school...
environment for teacher professional development on how to integrate technology effectively into their instruction,” he said.

**COLLABORATION IS KEY**

Online professional collaboration also can help. The EU report says that although online resources and networks are widely available, only a minority of teachers exploits their benefits. Therefore, the report advises educational administrators to further promote online platforms and the opportunities they can afford.

“An online community of practice could make a massive difference,” said Nicholas Smith, chief learning officer at HotChalk, a global education network based in Campbell, California (USA). “If we make it easy for teachers to find out what other teachers are doing – what’s working, what’s not – and do it in a way in which the best ideas bubble to the top of the list, I think that will be really helpful in improving teacher effectiveness with technology.”

Eric Williams, superintendent of York County School Division in Yorktown, Virginia (USA), is ahead of the online learning curve. Williams (@ewilliams65) uses Twitter to reach out to teachers in his district who have demonstrated new and impressive methods of classroom instruction, and to learn from the network of educators who populate his feed.

“Principals and superintendents need to work collaboratively with teachers to develop a shared vision of teaching and learning,” he said. “Once you have a shared vision, great teachers will model the effective use of technology, and momentum will help you scale effective use of technology across your school and district.”

**MAKING IT WORK**

Bucknall Primary School in Lincolnshire (UK) is a shining example of how technology can transform a classroom. In 2012, the school gave every one of its students an iPad. Today, the tablets are a fundamental part of lessons and homework. “Of course there were challenges at the beginning,” said Garry Cassey, a key stage 2 teacher at the school. “Staff had mixed levels of confidence when it came to using technology, so we had to ensure they were all singing from the same hymn sheet.”

Doing this, he said, required training and support. “Our head teacher at the time attended several of Apple’s education conferences and gave a great deal of support and feedback to staff,” he said. “Communication and collaboration on this project has been absolutely key.”

The school also brings an external consultant into classes on a regular basis. “The consultant will help us plan lessons, create educational games and answer any questions,” Cassey said.

Overall, Cassey believes that technology has transformed his school. “We’re a small school with mixed-year groups,” he said. “Technology helps us meet every child’s individual learning need. It helps us assess better and – perhaps most importantly – it makes learning fun for our students.”

**FUTURE PERFECT**

With a better support system in place, teachers will be able to take advantage of the endless opportunities technology has to offer, experts agree. “Support is absolutely fundamental to success,” Smith said. “There is a reason that the best athletes in the world have a coach. The same can be said for students and teachers alike. I believe that technology will help us to be more effective at creating more great teachers, but only with the appropriate training and support in place.”

“TEACHERS WHO ARE USING TECHNOLOGY TO TRANSFORM THEIR PEDAGOGICAL ACTIVITIES ARE STILL MORE THE EXCEPTION THAN THE NORM.”

JONGHWI PARK
PROGRAM SPECIALIST FOR INFORMATION AND COMMUNICATIONS TECHNOLOGY IN EDUCATION, UNESCO
Determining whether a teacher is effective is difficult, but essential. Leaders in the profession are exploring how a multitude of evaluation methods can be combined to measure individual teacher performance accurately – and fairly.

*by Rebecca Gibson*

Laura Nurminen, labour market advisor at the Trade Union of Education in Finland (OAJ), cites an analogy when asked how teachers should be evaluated: “If a man has been involved in a serious accident and a surgeon manages to save his life, but is forced to amputate his legs, did the surgeon succeed or fail?”

Nurminen then compares her example to the world of education: “Similarly, is a teacher ‘good’ or ‘bad’ if they manage to teach a pupil with learning disabilities to read, write and comprehend a short text, if this student still can’t spell correctly at the end of the year?”

It’s a difficult conundrum faced by many governments, educational associations and schools, and finding an answer is critical. In May 2015, a report from the Organisation for Economic Co-operation and Development (OECD) titled “Universal Basic Skills – What Countries Stand to Gain,” found that more than 66% of students in nine of the 76 countries studied, including a significant proportion of those in some of the world’s richest OECD countries, leave school without necessary basic skills. The findings have prompted many countries to re-examine how they assess their teachers, especially because the report also revealed a strong correlation between the quality of a country’s education system and an increase in its gross domestic product.

“Science, Technology, Engineering and Math education (STEM) is closely linked with US economic prosperity in the modern global economy, and strong STEM skills are a central element of a well-rounded education and essential to effective citizenship,” said James Brown, executive director of the STEM Education Coalition. “Numerous studies have validated that nothing is more important to a child’s educational success than a good teacher. It’s incredibly important that the US make robust and sustained investments in preparing and retaining new teachers that are skilled in STEM pedagogical content knowledge. This will also help to excite students about pursuing STEM careers.”

**MULTIPLE METHODS**

From student test scores to classroom observations, peer reviews and student surveys, many countries studied by the OECD have set up structured systems to evaluate teacher performance. Yet most agree that accurately, fairly and reliably measuring a teacher’s impact on student learning remains a challenge.

“Essentially, teachers should be considered effective if their students progress and deemed ineffective if pupils show no improvement,” said Andreas Schleicher, director for the Directorate of Education and Skills and special advisor on Education Policy to the OECD’s Secretary-General. “However, as there is no set definition of ‘effective teaching,’ it’s difficult to quantify it accurately. Do we equate quality with experience? Do we praise a teacher who has raised student scores, rather than those who can engage students through critical thinking and discussion? Or are teachers only effective if they can do all of the above and more?”

John Hattie, director of the Melbourne Education Research Institute (MERI) at Australia’s Melbourne Graduate School of Education, believes that only two questions should matter when trying to evaluate teacher performance: what evidence can teachers provide to demonstrate their overall impact on students, and what actions has the teacher taken as a result?

“Every student should achieve a year’s growth for a year’s input, but what constitutes a year’s growth will differ across schools,” Hattie said. “So teacher effectiveness should always be judged in relation to the school’s expectations.”

**USING STUDENT SCORES**

Some countries opt to evaluate teachers against standardized criteria defined by external authorities. In 2015, for example, Mexico’s President Enrique Peña Nieto implemented a contentious mandatory standardized skills test when hiring, evaluating and promoting teachers.

Standardized test scores, also called value-added measurements, have
been the norm in the United States since the No Child Left Behind (NCLB) Act was introduced in 2001. According to the OECD, more than 90% of US teachers are assessed this way, and the Obama administration’s “Race to the Top” initiative awards additional federal funding to state and local schools that use student test scores as part of their teacher evaluation programs.

The premise of such programs is simple: The more effective the teacher, the higher their students’ standardized test scores. How advocates and opponents of the practice respond to it, however, is anything but simple.

“While no one doubts that teaching is complex and success in the classroom can, and should, be measured by multiple indicators, it’s clear that effective teachers improve student achievement,” said Kate Walsh, president of the National Council on Teacher Quality in the US, where the student test-scores issue has been especially contentious.

“(Any meaningful and objective understanding of ‘effective’ teaching must be rooted in results for children, and focusing on student growth in teacher evaluations reflects a teacher’s primary responsibility to improve student academic success. Consequently, student growth and/or value-added data should be the most critical part of a performance measure.”

James Liebman, Simon H. Rifkind Professor at Columbia Law School, and director at Columbia Center for Public Research and Leadership, agrees. He argues that value-added analysis of student test scores helps to provide an ‘apples-to-apples’ comparison of teachers and schools – provided differences in student populations are taken into account.

“Students want to know how much they have learned,” Liebman said. “And now that the ‘Smarter Balanced’ and ‘Partnership for Assessment of Readiness for College and Careers’ assessments in the US have been improved, test scores are an appropriate, if incomplete, measure of that critical learning outcome.”

**HIGH-STAKES ACCOUNTABILITY**

Evaluating teachers based primarily on student test scores has generated intense backlash, however, with critics claiming that standardized tests don’t accurately reflect the complexity of the teaching and learning process and that relying on them is unfair to teachers.

Peter Z. Schochet and Hanley S. Chiang’s “Error Rates in Measuring Teacher and School Performance Based on Student Test Score Gains” (2010), for example, reported a 35% statistical error rate when using one year of test data to measure a teacher’s average performance and a 25% error rate when using three years of data. Meanwhile, Thomas J. Kane and Douglas O. Staiger’s “Volatility in School Test Scores: Implications for Test-Based Accountability Systems” (2002) indicated that 50%-80% of any improvement or decline in a student’s score can be attributed to one-time factors; for example, a dog barking in the parking lot during the test.

Some US teachers’ unions, including the Tennessee Education Association and the Houston Federation of Teachers in Texas, have filed federal lawsuits to contest these test-based measures, claiming that, in many cases, teachers of non-state-tested
subjects have been unfairly penalized if their pupils scored poorly.

“Standardized tests should only be used to provide educators, parents and schools with the information they need to help students progress, not to sanction individual teachers,” said Mary Cathryn Ricker, executive vice president of the American Federation of Teachers, AFL-CIO (AFT). “NCLB started the test-and-punish policies that caused teachers to focus on preparing students for high-stakes tests rather than providing deep instruction. However, this fixation on testing hasn’t improved the quality of teaching or students’ overall learning. We need to end the misuse and over-use of testing to provide children with the high-quality education they need to succeed.”

TEACHERS ARE LEARNERS TOO

According to Schleicher, 65% of teachers across the OECD consider student test scores an important part of feedback on their performance. However, many of the countries with top-ranked educational systems prefer evaluations that analyze how closely a teacher aligns with learning objectives and with their individual roles within their institutions.

This year, for example, Ghana began piloting a new Pre-tertiary Professional Teacher Development and Management policy to assess and reward teachers on the basis of their commitment to, and rate of, professional development. Principals at Rk Globe Academy in London introduced weekly football-style coaching sessions with individual teachers. In Finland, which is widely acknowledged to have one of the world’s best education systems, teachers set professional development goals and are recommended to attend annual performance appraisals with their principals.

“Finland’s teachers must hold a master’s degree, so they are considered to be pedagogical experts and are entrusted with professional autonomy,” OAJ’s Nurminen explained. “Just as students learn better without the pressure of standardized assessments, teachers with pedagogical freedom are wholeheartedly committed to understanding how to truly improve their methods rather than learning how to pass yearly evaluations.”

TAKing AN active role

Most researchers and educators agree that, whatever the primary purpose and method of their evaluations, teachers can only become more effective if they are well trained and able to control their professional development.

The OECD’s report “TRILS 2013 Results: An International Perspective on Teaching and Learning” indicated that this approach has worked well in numerous countries. For example, 80% of teachers in Japan noted ‘moderate to large’ growth in their teaching competencies after acting on feedback from formal appraisals. Similarly, in Singapore, which vied with Shanghai to top the Programme for International Student Assessment (PISA) rankings in 2012, 99% of all new teachers join formal induction programs; 40% have a mentor and more than 80% of principals mandate that teachers take responsibility for improving their own and their students’ learning.

“While we can use current evaluation systems to measure factors such as a teacher’s pedagogical content knowledge, there are myriad unquantifiable aspects that potentially contribute to a teacher’s impact on students’ learning,” said Stuart Kime, a director of evidence-based education, a UK-based education consultancy. “For example, there is moderate evidence suggesting that classroom management is a contributory factor to learning, but measuring this reliably is difficult – even with the best available measurement systems – making assertions about its contribution to learning even more challenging.”

Kime is working with researchers from England’s Durham University, as well as Oslo (Norway), Rutgers and Harvard universities, US educational testing and assessment organization ETS, and the German Institute for International Educational Research to explore new ways of evaluating teaching quality reliably and validly. “Several systems have been tested to explore how providing teachers with diagnostic insights into their practice, and peer-coached consultations between trusted colleagues, can help them identify areas for improvement,” he said. “If we provide teachers with comprehensive, triangulated information from multiple sources and trust them to act as professionals, a sustainable, iterative process of reflective practice will develop.”

Like many education experts, OECD’s Schleicher believes that, in future, the most accurate evaluation systems will incorporate different methods and empower teachers to take an active role in their professional development.

“Ultimately, if we want to attract and retain the top teachers, we need to ensure that they all receive high-quality education and training, ongoing mentoring and career development opportunities,” Schleicher said. “We also need to empower them to teach with a reasonable degree of professional autonomy in a supportive and collaborative culture. Teacher evaluations are not a magic tool, but if they are carried out in the right way they can certainly make a crucial difference to the quality of teaching and student success.”

BUILDING BETTER EVALUATION SYSTEMS

Many argue that until there is a universal definition of effective teaching, developing valid instruments that can accurately measure teacher performance will remain almost impossible.
RETOOLING APPRENTICESHIPS

On-the-job training lowers unemployment rates by closing the skills gap

The missing link for closing the gap between unfilled jobs and available skills may be hidden in the age-old idea of apprenticeships: combining education with formal, hands-on training. Each nation employs apprenticeships differently and benefits vary, but the practice is gaining traction, with plenty of room to grow.

U.S. employment statistics encapsulate one of the great conundrums facing companies everywhere in the 21st century: the gap between available jobs and workers with the skills to fill them. At the end of June 2015, for example, the US had 5.2 million job openings, according to the US Bureau of Labor Statistics (BLS), many of them left unfilled because firms could not find enough workers with the right job skills. Meanwhile, in July 2015, 2.8 million young people between the ages of 16 and 24 were unemployed, a rate of 12.2%, the BLS said.

A similar youth unemployment problem prevails in much of the developed world, and developing countries face an even greater challenge finding enough skilled workers. However, one increasingly popular solution to closing the job-skills gap in many advanced economies retools a relatively old idea: apprenticeships that combine education with formal, on-the-job training.

GROWING NUMBERS

In the US, the number of apprenticeships has been relatively low and largely confined to heavily unionized sectors such as construction, plumbing and electrical work. To change that pattern, US President Barack Obama announced in September 2015 a US$175 million grant to 46 organizations across the US to develop or expand apprenticeships in high-growth areas. “Apprenticeship offers a smooth pathway to the middle class and to a college degree for those who wish to continue their education and training,” Secretary of Labor Thomas Perez said. “I like to call it the other college – without the debt.”

The US is not alone. In the UK, the number of apprenticeships quadrupled between 1996 and 2009, then doubled again between 2009 and 2013, bringing the total number of apprenticeships available annually to almost 800,000, according to Tom Bewick, former CEO of the International Skills Standards Board.
Organization (INSSO), a London-based workforce development consultancy. Apprentices are now employed by organizations as diverse as The Royal Opera, Jaguar Land Rover and British Aerospace, a major advocate with more than 1,000 apprentices.

One of the largest programs in the UK, Microsoft’s Partner Apprenticeship program, takes high school dropouts aged 16-18 and trains them in computer skills, for which there are 160,000 unfilled jobs annually. The program plans to train 3,500 apprentices by the end of 2015 at a variety of firms, ranging from large employers to hundreds of small enterprises. “We view this as a massive success,” said Dominic Gill, Microsoft UK’s apprenticeship lead, who helps facilitate the apprenticeship program. “It has a retention and employment rate of about 95%, far above the industry average of 80%.”

800,000
The total number of apprenticeships available annually in the UK.

TRAINING THE YOUNG

The idea of apprenticeships emerged in the Middle Ages, when skilled craftsmen in European guilds trained young people in exchange for room and board, increasing each craftsman’s capacity while ensuring that their skills were passed to the next generation. Although apprenticeships continue to exist in many countries, Germany, Austria and Switzerland have the most developed systems and, not coincidentally, the lowest youth unemployment rates. In Germany, an estimated 51% of young people undertake some form of apprenticeship.

“Independent studies show that where there are structured apprenticeships, not only is there a net benefit and financial return for employers, but also a net return to taxpayers for their public subsidy,” INSSO’s Bewick said. For every British pound invested in public apprentice programs, Her Majesty’s Treasury estimates the state gets a return of 12 pounds in tax revenues and other benefits, such as productivity increases.
One big difference between the German-speaking countries and some English-speaking nations is the age at which apprentices are recruited. In Germany, students are often streamed into vocational training and on-the-job work programs at about age 15 – about the same time that students in the US and Britain are beginning secondary school. There, apprenticeships generally don’t begin until after high school graduation, when most students are approximately 18.

One reason is that, in the US and Britain, schools are more oriented toward educational attainment than career achievement, said Robert I. Lerman, an institute fellow in the Center on Labor, Human Services, and Population at the Urban Institute, an economic and labor policy think tank in Washington, DC. “We want everybody to have a chance to go to college, even if that might not be the optimal route for many people who learn better in other ways,” Lerman said.

He notes that graduation rates from community colleges, which traditionally have provided technical and vocational training in the US, remain troublingly low at 20% of full-time students in the first three years. Apprenticeship programs, he said, offer a viable alternative for many students.

### ADVANCING APPRENTICESHIPS

Meanwhile, employers are seeking apprentices with a high degree of job-related educational attainment. Britain has three levels of apprenticeship; the highest level, sought by firms such as British Aerospace, requires passage of four advanced qualifying exams. Apprenticeships take one to four years to complete, depending on their level.

In Germany, a relatively new program called AusbildungPlus (TrainingPlus) offers a dual-track system in which apprentices work for a firm while earning a university-level engineering or business administration degree, up to the doctoral level. “The main benefit is that it becomes easier to access university education when starting out as an apprentice,” said Samuel Mühlemann, a professor of human resource education and development at the Munich School of Management, Ludwig-Maximilians-Universität München. “The program allows firms to educate their future engineers exactly to the needs of the company, since apprentices will have several years of work experience by the time of graduation.”

Another country with an innovative approach to apprenticeships is Australia, which has even more apprentices per 1,000 workers than Germany. One approach used successfully in Australia is known as Group Training Organizations (GTOs), which serve as intermediaries between companies and state/regional governments.

Nicholas Wyman, CEO of the Institute for Workplace Skills and Innovation, operates a GTO called WPC Group in Australia that trains more than 500 apprentices with more than 200 host employers. Wyman published a book about the program called Job U: How to Find Wealth and Success by Developing the Skills Companies Actually Need. The GTO firms play an important role, Wyman said, by assuming responsibility for the apprentices: paying their salaries, handling the paperwork and providing uniforms while mentoring them and tracking their progress. The companies the apprentices work for fund the GTOs.

“You can’t rely on the government to support the apprenticeship programs,” Wyman said. “That’s why the mentored apprenticeship model, where the employer is the main financial contributor, works very well.”

With governments around the world pouring money into financial assistance to fund apprenticeships, many experts believe the idea has reached a tipping point. With fewer than one in 10 of the firms in the UK employing apprentices – and even fewer in the US – there is plenty of room for these programs to grow.

“The apprentice route should not be seen as the soft option people are forced to go for because they can’t get into college,” Bewick said. “There is too much of a sense that there are two systems, with the university route offering higher paying jobs. The apprentice route is geared toward occupations that need different learning styles than formal university education.”

“THE PROGRAM ALLOWS FIRMS TO EDUCATE THEIR FUTURE ENGINEERS EXACTLY TO THE NEEDS OF THE COMPANY.”

SAMUEL MÜHLEMANN
PROFESSOR OF HUMAN RESOURCE EDUCATION AND DEVELOPMENT,
MUNICH SCHOOL OF MANAGEMENT, LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN,
REFERRING TO THE NEW GERMAN APPRENTICESHIP PROGRAM AUSBILDUNGPLUS
PERSONALIZED EDUCATION

Proponents argue that students learn best when lessons are wrapped in topics they enjoy

Research has shown that the traditional “one size fits all” teaching model does not work for many students. Today, many educational institutions are using digital technology to offer “personalized learning,” which helps students develop a broad set of competencies in the context of their personal interests.

by Rebecca Gibson

At AltSchool, there are no textbooks and no whole-class lessons that teach one subject to every pupil in the same way. Instead, children use digital tablets to support their real-world and immersive lessons, and document their learning via online personalized learning “playlists” they have co-developed with teachers and parents. Meanwhile, teachers use wall-mounted cameras to capture students’ important learning moments and further their own professional development.

Even Facebook has designed a platform for Summit Public Schools in California and Washington state to create classroom experiences focused on their students’ future ambitions.

“Personalized learning is a core tenet of the next-generation, adaptive-learning strategies that are redefining education by allowing students to focus on their interests,” said Sarah Luchs, K-12 (Kindergarten through 12th grade) program officer at Next Generation Learning Challenges (NGLC), an initiative of the Colorado-based non-profit EDUCAUSE. “NGLC grants have already helped around 100 US schools deploy digital tools to give students the learning autonomy to fulfill their personal aspirations.”

Launched in 2013 by former Google executive Max Ventilla, AltSchool is an expanding network of private “micro-schools” for primary and middle school students in the United States. AltSchool emphasizes student-driven, project-based learning and entrepreneurship.

It’s just one of a growing number of educational institutions worldwide that have adopted online platforms that empower students to pursue their own learning goals. Popular platforms include US-based learning management system Schoology, Canada-based D2L’s competency-focused Brightspace and US-based math software provider DreamBox.

EDUCATION FOR THE DIGITAL AGE

North America doesn’t have the monopoly on personalized learning, however. In 2012, entrepreneur Maurice de Hond founded Onderwijs voor een Nieuwe Tijd (Education for a New Era, or Ö4NT) and the Steve JobsSchools network in the Netherlands after discovering that his young
daughter would be taught in the same way his older son was during the 1980s.

“Why should young children, many of whom can competently use smart devices at an early age, be taught for 1980s life rather than to succeed in the future digital world?” de Hond said. “Instead of continuing to fill every child with the same information ‘just in case’ they need it, our teachers help students develop the ability to find and apply solutions to learning problems as they encounter them.”

The Steve JobsSchools first opened in August 2013 and now total 20 locations across the Netherlands. Children who attend the schools complete 45% of their learning through adaptive online programs on their digital tablets; the other 55% of learning occurs during 30-minute workshops. To ensure students meet the Dutch government’s academic standards, teachers meet with children and their parents every six weeks to refine each child’s individual learning development plan.

“Unlike in most schools, where parents only have twice-yearly discussions about their child’s progress with teachers, our system gives them a central role in their child’s education,” de Hond said. The approach is catching on: in 2016, 04NT will open schools in Dubai, United Arab Emirates; suburban Johannesburg, Republic of South Africa; and São Paulo, Brazil. “Many parents thank me for changing their child’s life. We’ve even got children whose misdiagnosed attention deficit disorders have been ‘cured’ because they’re in a more stimulating environment.”

A year after adopting personalized learning, the De Ontplooiing Steve JobsSchool in Amsterdam has recorded growth in students’ math and reading skills. However, director Jaap Pasmans said, the benefits extend far beyond academic achievement.

“Our children are happier and more motivated now that they’re focused on their interests,” Pasmans said. “I’d recommend this teaching model to everybody, because it gives you more time to coach each individual so they have the tools they need to learn core subjects by exploring their passions.”

KICK-STARTING CAREERS

Secondary school network Big Picture Education Australia (BPER) has found that self-directed students are better prepared for higher education and employment. BPER was established in 2006, joining a global network that began with the founding of Big Picture Learning in the US by Elliot Washor and Dennis Littky in 1996. At BPER, advisers and parents help students to develop learning plans that tie their personal interests to Australia’s national curriculum and to the workplace. This requires students to participate in internships with personal mentors in the community twice a week for four years and present self-directed “Projects for Learning” four times per year.
“Many young Australians do not complete school, so we wanted a learning model that would encourage them to pursue passions but still be academically rigorous to allow them to pass national exams,” said Viv White, co-founder and co-managing director of BPER, which has 40 schools across Australia. “Not only do the projects cover 80% of the subjects included in the national curriculum (the remaining 20% is covered in traditional classes), but the internships enable students to see how the skills they develop in school can be applied in their careers. This really motivates them to improve.”

Suspension rates have dropped, attendance and self-discipline have improved and students are making measurable progress, White said.

Student testimonials on BPER’s website also provide testament to the program’s widespread success. In Launceston, Tasmania, Shauna Carlon’s internship with celebrated Australian pastry chef Adriano Zumbo led her to study at one of Australia’s top hospitality, tourism and food institutes. Eighteen months after arriving in Tasmania, Nepalese student Sameer Pandey helped to develop a lighting system for a new factory during an engineering internship with multispecialist infrastructure consultancy Pitt & Sherry. Meanwhile 15-year-old Abby McLeod’s interest in TV crime drama “NCIS” prompted her to work with the police department and criminal law professors at the University of Newcastle in New South Wales.

“I can map a lot of the stuff I’ve done back to the curriculum – there’s English because I’m doing a lot of writing, science because it’s based on biology, and I’ll be doing blood-spatter pattern analysis, which uses trigonometry and math, and the history of forensic science,” McLeod said in an interview for BPER’s website. “Mum’s a lot happier to see that I’m learning so much. I’ve learned more in one term than I have in a year at other schools because when you really enjoy what you’re learning, it’s so much easier to come to school and work.”

SIGNS OF SUCCESS

Several reports have indicated that personalized and blended education systems based on modern technology platforms have both quantitative and qualitative benefits.

The Bill & Melinda Gates’ Foundation (BMGF) and RAND’s November 2014 report “Early Progress: Interim Report Personalized Learning,” indicated that students in 23 public charter schools across the US that received funding from the BMGF to implement personalized learning over a two-year period generally
did better on a computerized reading and math assessment than similar students in comparable schools without personalized learning tools. Similarly, a study from California’s Clayton Christensen Institute—a nonprofit think tank dedicated to promoting disruptive innovation in education—found that personalized learning helped the graduation rate in Utah’s Washington County School District improve from 80% in 2012 to 88% in 2014. Meanwhile, US-based information services firm Hanover Research found that the personalized learning classrooms in the West Allis-West Milwaukee School District in Wisconsin “demonstrated almost two full years of growth in one academic year.”

INFLATED EXPECTATIONS

Benjamin Riley, founder of Texas-based Deans for Impact, isn’t convinced of the benefits of personalized learning. He cautions that many schools mistakenly expect “something magical” to happen simply by replacing textbooks with tablets. Deans for Impact focuses on transforming teacher training, an area its leaders believe can do more to improve student-learning outcomes than can be accomplished by adding technology to the mix.

“Educators worldwide have repeatedly piled resources into ‘innovative’ learning concepts without any evidence that they’ll be successful, and inevitably they fail,” Riley warned. “I’m worried that in 20 years, we’ll ask why we invested in personalized learning tools only to find they weren’t actually that helpful.”

Riley questions whether young students have the motivation to direct their learning, particularly in subjects they find difficult or that they dislike.

“Just as a tennis player needs a coach to identify and correct common mistakes in their technique, students need a teacher to jump in when they’re struggling or challenge them when they’re bored,” he explained. “I watched pupils at schools in both New York and New Zealand give elaborate multimedia presentations, but they couldn’t answer my basic questions about the topics they’d covered. I’ve no doubt these students acquired beneficial skills, but they simply learned how to make a presentation. Education should focus on skilled teachers imparting knowledge so that it can be recalled easily, using fancy technology to make learning ‘cool’ isn’t necessarily the best way to do this.”

NGLC’s Luchs, however, argues that when implemented and monitored correctly, personalized learning technologies can empower children to use their natural curiosity and intrinsic motivation to acquire and retain knowledge.

“Typically, teachers who enable pupils to choose when, what and how to learn see much better levels of student engagement,” Luchs said. “Effective personalized education systems should offer customized, self-paced learning opportunities that are responsive to individual students’ needs, interests and progress.”

Jim Flanagan, chief learning services officer at global nonprofit International Society for Technology in Education (ISTE), believes that students need both: personalized learning systems are only effective when supported by human interaction with skilled teachers.

“If students are to remain motivated, technology must be applied in a highly adaptive way that’s balanced with human interaction,” he said. “For example, a student might use Khan Academy [an online provider of free, educational YouTube videos] to increase math skills, but they may need one-to-one support from a teacher when they hit a challenging topic.”

BUILDING A PERSONALIZED FUTURE

Personalized learning advocates like ISTE’s Flanagan anticipate that the trend of students directing their own educations will continue to grow.

“Students expect schools to provide the same customized services they experience in their personal lives and, in the future, they’ll have more opportunities to demonstrate competency outside of traditional education models,” he said. “More parents and teachers will see beyond educating children in the archaic ways they learned, and instead consider how they’d like to be educated for today’s world.”

BPER’s White agrees: “More schools will see that students need to focus on their interests in a family-like environment where the skills they’re developing are valued by peers, teachers and the wider community. Personalized education models like Big Picture really will give our young people the power and motivation to co-create the future.”

“WHY SHOULD YOUNG CHILDREN, MANY OF WHOM CAN COMPETENTLY USE SMART DEVICES AT AN EARLY AGE, BE TAUGHT FOR 1980S LIFE RATHER THAN TO SUCCEED IN THE FUTURE DIGITAL WORLD?”

MAURICE DE HON
FOUNDER OF ONDERWIJS VOOR EEN NIEUWE TIJD AND THE STEVE JOBSSCHOOLS NETWORK IN THE NETHERLANDS
BEST OF THE BEST

World’s top schools individualize learning

Finnish, Korean and Canadian schools consistently lead international comparisons of top-performing educational systems. The common denominator? High regard for the teaching profession and individualized learning tailored to each student.

* by Christian Füller

It’s just after 8 a.m. at the Olari High School in Espoo near Helsinki, Finland. The pop music of Robin, the Finnish version of Justin Bieber, rings out over the public address system. Everyone in the school starts tapping their feet. Have the students taken over the school?

“No,” headmistress Kaisa Tikka says, then smiles. “We want to start school each morning with something that is fun. This is why the students determine which music will start the day and the learning.”

STUDENTS AT THE HEART OF LEARNING

The Olari High School is not an alternative school, but it is one of the best schools in Finland. For example, Olari’s students have repeatedly won the Scandinavian Mathematical Olympiad. Despite its track-record of excellence, however, Olari is an ordinary Finnish school. What makes it special among schools globally is its focus on putting students at the center of everything.
When comparing schools in Finland, Canada and Korea, countries that occupy the top places in the global school comparison study “Program for International Students Assessment” (PISA) year after year, a pattern of putting the student at the center is the first obvious commonality. The way each system places students at the center of the curriculum varies based on culture and continent:

- Tiny Finland has rebuilt its schools over the past 40 years into a model of academic success, a transformation known as the “school miracle.”
- In Korea, the Confucian culture of learning leads with discipline and rigor that also allows for significant levels of individual, personalized learning.
- Canada, an industrialized Western country, permits each of its widely varied provinces to adopt its own school model; Canada doesn’t even have a national ministry of education.

**ONLY THE BEST TEACHERS**

Andreas Schleicher, better known as “Mister PISA” because he invented the worldwide school comparison, sees another main similarity among top-performing schools: their teachers.

“Finland, Korea and Canada have made teaching an attractive career choice that invites the best candidates,” said Schleicher, who leads the Education Department of the Organization for Economic Cooperation and Development (OECD), a global alliance supported by 40 nations. “They support their teachers to make innovations in the art of teaching, to improve their own performance and that of their colleagues, and to pursue professional development that leads to stronger educational practice. Their teachers work with professional autonomy, but in a collaborative culture.”

Schleicher surveyed teachers worldwide with a focus on how they are trained. The result: Finland, Korea and Canada are all nations where teachers enjoy a high reputation in society. In Finland, for example, only the best high school graduates are admitted to teacher education — and the best students want to be teachers because the profession is so attractive.

“Finland’s elite teach,” said Jukka Sarjala, former head of Finland’s Central Education Office and one of the architects of the Finnish “school miracle.” But the actual secret to a good school, Sarjala said, is not selectivity, but integration. “All children aged 7-16 go into the same school. In each municipality, ranging from the rich south to the poor north, there is only this type of school.” The pattern is the same in Korea and Canada, which also are characterized by non-selective school systems.

“It is the different style, the different education, which makes the integrative school,” Sarjala said. “The teacher is responsible for 25 different children, and must develop 25 different educational concepts.”

**AN ENGLISH LESSON IN FINLAND**

The result cannot be read in studies, but can be observed first-hand in the classroom. Consider the teaching of English at Olari High School. At first glance, the approach to teaching appears no different from the traditional lecture method. At the front of the room, the teacher has written “Charlie Chaplin” on the schedule. But this teacher doesn’t lecture. Instead, his eighth-grade students analyze the master movie director for themselves, using English-language resources and presenting their findings in English.

Each small group chooses from a list of topics: “The Great Dictator” (one of Chaplin’s most famous films), Chaplin’s life; Chaplin’s contributions to film. Then, each group of students researches its topic online. Later, the students present their findings to the class while the teacher films the group. Afterward, the teacher discusses the presentation with the students, giving feedback on their use of English. The advantage of this “no more lecturing” style is that students are able to explore Chaplin for themselves. This approach ensures that every student is involved, using full sentences to express their ideas on a topic of genuine interest.

**IN KOREA, PASSIVE LEARNING IS OUT**

The Korean education system is stereotyped as being purely focused on repetitive drills. A closer look, however, reveals that in Korea, as in Finland, individual tasks allow students to learn independently.

“In the past, students could prepare for university entrance exams with ‘passive’ learning” characterized by lecture and memorization, explained Inn-Woo Park, a professor of pedagogy (the art and science of education) at Korea University. “However, things have changed and passive learning is no longer a good way to prepare for the exams.”

Years ago, students in Korean classes sat side by side or in neat rows, listening quietly to their teachers. Today, the situation is far different. Each class begins with students receiving an introduction to the lesson from a teacher at the front of the classroom. Then, however, they split into working groups, studying independently with computers.

“In the past, a strong student was one who was able to remember what he or she had learned,” Korean elementary teacher Cha-Mi Kwon says in an OECD documentary on Korea’s educational transformation. “Nowadays, they need to be able to select what is useful from various sources of information and re-create it as their own.”

**STUDENT ADVOCATES IN CANADA**

Video studies from Canadian schools, meanwhile, show a similar picture. Teachers rarely stand in front of formal learning groups and speak. Instead, Canadian schools prefer group and independent work tailored to the needs of individual students, either through...
IN FINLAND, “THE TEACHER IS RESPONSIBLE FOR 25 DIFFERENT CHILDREN, AND MUST DEVELOP 25 DIFFERENT EDUCATIONAL CONCEPTS.”

JUKKA SARJALA
FORMER HEAD OF FINLAND’S CENTRAL EDUCATION OFFICE

The educational systems of Finland, Korea and Canada also are in constant change, embracing new technology and student individuality to maximize success. In all three countries, leveraging computers and the Internet in digital learning environments enables three distinct advantages: helping students learn traditional subjects in non-traditional ways; preparing students to use key technologies of the 21st century; and facilitating individualized learning.

As with individualized learning, the three countries’ approaches to digital learning are as different as their cultures.

Korea’s national strategy of digitization began in 2007, when the concept of technological development was adjusted so that each Korean student uses only digital textbooks. Starting in 2015, each Korean student will receive a tablet computer at no cost to the student.

In contrast, decentralized Canada has no national plan for digitized learning. Each province adopts its own approach.

In Finland, meanwhile, each school has autonomy. For example, following a history field trip, a student might summarize the experience by assembling an e-book on a tablet from texts, films, and photos available online. An entire class at Olari School received a set of tablets for their “time travel” excursion to a period in Finland that occurred long before recorded history: the Ice Age. With the devices, the students documented excavations, interviewed experts, wrote their texts and built their graphics. “We started with iPads because we wanted to have something very new,” Olari School headmistress Tikka said. “The learning process is more in groups, not individual. With iPads, students are sharing more things.”

In Espoo, no national support is needed because the headmistress has a budget she can spend at her discretion. “I knew the benefits of tablets and bought a set of equipment for my school,” Tikka explained. “A project group of teachers tested them.” As of 2013, every student at the Olari school receives a tablet in the 11th grade.

So what can the rest of the world learn from the examples of Finland, Korea and Canada? Perhaps the best lesson is what not to do.

Pasi Sahlberg of Finland, who teaches at Harvard University, is one of the world’s most sought-after educational advisors and school reformers. He observes: “There are interesting factors that you can’t find in any of these high-performing systems – government-driven privatization of schools, reliance on standardized testing, putting schools in competition against one another, or confrontation between authorities and teachers.”

Christian Füller is a German journalist and author who has written about failing school systems and teaching for the 21st century. He has studied international school systems, including those in the Netherlands, the Scandinavian countries, Poland, Vietnam, and the USA.
Digital technology is making fundamental changes to learning and teaching, transforming it in ways that were unimaginable a few years back, while achieving a broader reach and better outcomes.
BOON OR BOONDOGGLE?

Free online courses offer knowledge, but no credit

Massive Open Online Courses (MOOCs) have taken the education world by storm, promising to deliver rich content to a significant number of people via the Web – for free. While students are signing up in droves and employers are beginning to take notice, educational experts question whether courses without certifications deliver any real value.

• by Lindsay James

MOOCs exploded onto the education scene in 2011, when a free artificial-intelligence (AI) course offered by Stanford University in the USA attracted 160,000 students from 190 countries. Since then, dozens of top universities have caught the MOOC wave, including Harvard and Yale in the USA, Copenhagen University (Denmark) and École Polytechnique (France) in Europe; and the Hong Kong University of Science and Technology in China.

In addition, a number of commercial start-ups offering MOOCs have formed in association with universities, including Coursera, Udacity and Edx in the USA, and FutureLearn in the UK. Coursera estimates that more than 3 million users attend MOOCs – nearly double the attendance it estimated less than a year ago.

ADDRESSING THE NEED FOR CHANGE

Many would agree that higher education needs a shake-up. Costs are high and climbing, and students increasingly must pay their own way. According to Times Higher Education, Finland (in 2010) and Hungary (in 2013) have introduced fees. Others, including the UK, have vastly increased tuition costs. State funding in the USA, which hit a 25-year low in 2011, contributed to fee increases of 42% in the past decade. According to the Federal Reserve Bank of New York, 43% of 25-year-olds globally had student debt in 2012, an increase from 27% in 2004.

Cost isn’t the only factor limiting access to higher education. “Many people do not have the credentials that would get them admitted in higher education,” said Stéphan Vincent-Lancrin, project leader in the Directorate for Education at the Organization for Economic Cooperation and Development (OECD).

“One big problem for access comes from learning (and dropout) prior to higher education.”

The availability of education also is inadequate, Vincent-Lancrin said. “There may be more demand than places offered because of the cost of enrolling all interested students. For students located in developing countries, they may not be able to access the best quality or the most relevant courses in their field.”

MOOCs have the potential to change all this. “In the past few months, hundreds of thousands of motivated students around the world who lack access to elite universities have been embracing those (MOOCs) as a path toward sophisticated skills,” Tamar Lewin wrote in the New York Times article “Instruction for Masses Knocked Down Campus Walls.”

Kritika Desai, a student of English literature at Jadavpur University in Kolkata, India, is one example. Desai recently enrolled in an “Introduction to Finance” course on Coursera, offered by the University of Michigan. “In India, no university provides a combination of literature and finance,” Desai told University World News. “The MOOC has made it possible for me to study an extra subject from a top American university free of cost.”

A free online course in artificial intelligence offered by Stanford University attracted 160,000 students from 190 countries.

As well as benefiting students, MOOCs help universities build global awareness. Educause, a non-profit association focused on advancing higher education, observes that universities can use online...
courses to extend their reach and reputation internationally.

“The notion of a teacher standing in front of a classroom is yesterday’s news,” said Tracy Gray, managing director of the Center for STEM (Science, Technology, Engineering and Math) Education and Innovation at the American Institutes for Research. “There are relatively few teachers that can captivate the digital native students of today. MOOCs allow all students to access the very best educators.”

MEETING EMPLOYER NEEDS

MOOCs also help graduates acquire the specific skills they need to get better jobs. “Even with high unemployment, employers are complaining about the lack of candidates with the specific technical know-how needed for open positions,” said John Challenger, CEO of US-based outplacement specialist Challenger, Gray & Christmas. “Forward-thinking employers already recognize MOOCs as one possible solution.”

In fact, MOOCs can help employers cherry-pick prospective employees and better identify training needs. “Having a degree or certificate in hand is no guarantee that a candidate will actually be able to do the work for which he or she is hired,” Challenger said. “Because the MOOC environment is digital, providers of this new system of education have unprecedented access to information that can be easily mined to identify candidates. And because we are so early in this trend, employers have a much better opportunity to shape curriculums to fit their needs.”

Some top companies are already adapting MOOCs for in-house training. McAfee and General Electric, for example, are exploring which design features of MOOCs best suit their corporate learning and development programs. “MOOCs can really benefit employers when they’re used internally,” said Jeanne Meister, founding partner at Future Workplace, a US-based consulting firm dedicated to assisting organizations in re-inventing the workplace.

Meister believes that employers increasingly are embracing MOOCs. “There is clearly momentum toward the acceptance of non-degree credentials in general,” Meister said. “For example, many entrepreneurial incubator programs have better reputations than Ivy League schools when it comes to churning out brilliant business minds.”

Challenger agrees. “Long-term, MOOCs hold a lot of positive potential. They will
become more and more specific to employers’ needs. They will also be used increasingly as a way for employers to provide continuing education to existing employees. And they will be critical in helping unemployed workers keep their skills and knowledge-base fresh.”

CHALLENGES REMAIN

Despite the potential of MOOCs, a number of challenges remain. Dropout rates are high. For example, of the 160,000 students who attended Stanford’s AI course, only 23,000 finished. Accreditation is also an issue. Most MOOCs are offered as non-credit courses. To date, only the Global Campus of Colorado State University (CSU) has agreed to provide students with full transfer credit toward a CSU bachelor’s degree if they complete an introductory computer science MOOC. Many providers simply offer a certificate of accomplishment – and only for students willing to pay a fee.

The lack of human interaction is another sticking point. “Education is a two-step process,” said Eric Mazur, professor of Physics and Applied Physics at Harvard University and area dean of Applied Physics. “MOOCs are only replicating the easy part – delivering information – without paying attention to how students make sense of that information. If you were to take my course and turn it into a MOOC, there’d be nothing to film because students are actively engaged in activities. This simply cannot be replicated online.”

Navneet Johal, associate analyst for Education Technology at London-based global analyst firm Ovum, cites a long-term study by the Community College Research Center at Columbia University’s Teachers College. “It suggests the students most often targeted in online learning’s access mission are less likely than their peers to benefit from – and may in fact be hurt by – digital as opposed to face-to-face instruction,” Johal said. The study found that, especially for adult students, the academically under-prepared, and members of some minority groups, students fared less well in online courses than in face-to-face classes.

Educational institutions also lack a standard business model for how MOOCs will be funded once venture capital dries up. “The funding won’t last forever,” Mazur said. “Education is expensive. You may be able to supplement it with free MOOCs in the short term, but how are these courses going to be supported ten years from now? As a substitute for a book, or as a supplement to lectures, then MOOCs are fine. But this isn’t the future of learning.”

THE FUTURE OUTLOOK

MOOCs do have their supporters, however. “MOOCs are a good way of engaging with a new topic or getting to grips with a new skill rapidly,” said Mike Sharples, chair in Educational Technology at the UK’s Open University, which has offered distance learning for more than 30 years. “They’re not going to replace traditional higher education, but they will help to shape the future of learning.”

The Bill and Melinda Gates Foundation, which promotes universal education, is investigating whether the MOOCs model can be translated into remedial and introductory courses. According to the Foundation’s website, only about half of those who enroll in a four-year university course earn a degree, and barely 20% of those pursuing an associate degree earn one within three years. The Foundation is investing US$550,000 in providers that will develop MOOCs specifically for remedial and introductory courses.

MOOCs also seem to be making headway in areas where there is a lack of qualified teachers, such as the STEM fields. “There’s a pressing need for qualified instructors who can teach and engage students to enter and stay in STEM-related fields,” Gray said. “The opportunity to engage students through innovative approaches such as MOOCs and online/blended learning platforms have the potential to reach and engage significant numbers of students in the STEM fields, and also to enhance teaching and learning as we know it today.”

"MOOCS ALLOW ALL STUDENTS TO ACCESS THE VERY BEST EDUCATORS."

TRACY GRAY
MANAGING DIRECTOR
CENTER FOR STEM EDUCATION AND INNOVATION
In 2013, a study by Netherlands-based Spil Games found that more than 1.2 billion people of all ages and genders (17% of the global population) play digital games. The statistic demonstrates that games have the power to capture the attention of young and old – and now educators are applying gaming principles in the classroom to help young learners build academic and life skills.

“The culture around digital games is growing to encompass a substantial proportion of the world’s population,” said Samantha Adams Becker, senior director of the New Media Consortium (NMC), of Austin, Texas, a US-based international alliance of universities, museums and corporations that charts the landscape of emerging technologies for learning. “Major organizations, including IBM and the World Bank, have embraced gamification for its benefits in professional and academic growth,” Becker said. “Now, parents and teachers are increasingly recognizing its potential to engage learners.”

PLAYFUL LEARNING

Gamification is the application of game-like mechanics – including point scoring, climbing a level as an award for achievement (known as “leveling up”) and the opportunity to earn virtual superpowers – to non-game environments. Gamification can include game-based learning (GBL), but while GBL involves games with a specific learning outcome, gamification aims to engage students and encourage behaviors such as teamwork, participation in class discussions, and creative and critical thinking.

Various digital gamification tools have been developed especially for educators; for example, the behavioral feedback and reporting app ClassDojo and the online role-playing game Classcraft, which can be layered on top of existing lesson plans.

But the approach needn’t be high-tech. “Gamification involves using the most motivational aspects of games in non-game settings,” explained Michael Matera, a teacher of world history and international relations at the University School of Milwaukee in Wisconsin (US). “It plays nicely with almost any other style of teaching and it can be used almost anywhere, from a low-tech to a no-tech school to a fully integrated online classroom.”

WINNING WAYS

A key strength of gamification is that it puts students at the center of the learning experience, immersing them in a subject that might otherwise seem dry.

“GAMIFICATION HELPS MY STUDENTS SEE THEMSELVES AS KEY PLAYERS IN THEIR LEARNING.”

MICHAEL MATERA
TEACHER OF WORLD HISTORY AND INTERNATIONAL RELATIONS,
UNIVERSITY SCHOOL OF MILWAUKEE

“World history can be one of the driest classes, or it can be a fabulous exploration of the story of humankind – our story,” said Matera, who has been “gamifying” his entire curriculum for two years. In Matera’s 6th grade world history course, for example, called “Realm of Nobles,” each class represents one of four houses striving for the throne following the king’s death. Each house comprises four “guilds” in which small bands of citizens work together on various challenges, discovering items, gaining new skills and uncovering mysteries along the way.
“Gamification helps my students see themselves as key players in their learning,” Matera said. “They tackle side quests as well as group or individual projects that build greater content knowledge as well as life skills. Throughout the learning experiences, students are motivated to be extremely creative as well as critical thinkers. Students love it when history comes alive. For example, while we were studying the Middle Ages, I transformed the classroom into an Italian monastery where the students worked on illuminated manuscripts. Simulation days are always a huge hit and yield incredible dialogue.”

The results are evident in student achievement, Matera said. “By all measures, my classes became more academically rigorous. For example, I used to do things like give a study guide and allow a note card during tests. In my gamified classroom, I’ve done away with all that, yet my class averages have increased on all assessments in both years. I attribute much of this success to the role of feedback and ‘learning from mistakes’ in gamification. In a game experience, students receive frequent micro-feedback that helps them make micro-decisions. Over time, they feel more comfortable independently operating, thinking and creating.”

MEASURING SUCCESS

Where gamification is in use, parents and educators are focused on the best way to apply gamification in schools – and how to measure its effectiveness.

“Parents, educators and learners are open to new approaches if they have a clear view of the learning outcomes,” said Kevin Glesinger, a teacher of geography at Brooke Weston Academy in Corby, UK. “Behavior for learning
and levels of progress are key strands for educational standards bodies such as Ofsted in the UK, and gamification addresses these areas.”

But Sean Hampton-Cole a teacher of geography and thinking skills at Crawford College Lonehill in Johannesburg, South Africa, worries that gamification could cement educational practices he opposes, including most traditional forms of measurement.

“Before moving to gamify a classroom, teachers and schools should consider whether they are truly innovating, or simply entrenching problems that already exist,” Hampton-Cole said. “Done right, gamification can enhance the 21st-century classroom. But there are problems with a system based on externally focused measurements, data, performance and grades. Gamification, with its rewards-based framework, may hide those problems behind what looks like a more fun, relevant and immersive experience.”

Glesinger anticipates another potential objection, but this time from schools that excel at meeting traditional achievement measures. “Some establishments, such as an academy trust with a strong brand identity, might hesitate to move away from traditional teaching methods,” Glesinger said. “But even if gamification isn’t used in the core curriculum, it could be valuable for off-timetable projects.”

For Debbie Morris, the parent of a 5th-grade girl in Norwich, UK, the measure that matters most is gamification’s value to her child. “My daughter loves computer games, and if gamification helps her to learn and develop life skills at school, I’m all for it,” Morris said. “But I would discuss the teacher’s plans with them to make sure my daughter and I are happy with the approach.”

**PLAYING FOR KEEPS**

Gamification is a relatively new trend in education, but it is likely to grow.

While gamification has gained the most traction in European and North American schools, it is attracting interest across the world. In Singapore, for example, the National Institute of Education has developed a videogame to support the chemistry curriculum, while gaming company Rockmoon and FutureSchools@Singapore are collaborating to promote a mobile app that supports self-directed, immersive learning.

Gamification may take longer to establish in some regions, but interest in game-based learning is strong. In Brazil, for example, the NMC noted the development of digital games for specific learning scenarios, as well as research into educational methodologies such as teaching game design to K-12 students.

“Major companies, such as Microsoft with its Kinect technology, are working with schools and educators to integrate gaming in the classroom,” Becker said. “Simulation-based learning is also a trend to watch, and we may see more enterprise/academic partnerships with gamification as a mission.”

The trend is helping to change public attitudes toward gaming, which traditionally has been seen as a time-waster, Becker said. “Games may have initially been viewed as a distraction, but it’s now clear that there are exciting applications for gamification in teaching and learning.”

Michael Matera, a teacher of world history and international relations at the University School of Milwaukee in Wisconsin (USA), uses gamification to make history come alive. Here, his students recreate the Battle of Marathon, which pitted the Persians against the Greeks in 490 BC. (Image © Michael Matera)
BACK in 2007, Jon Bergmann and Aaron Sams, two Colorado (USA) high-school science teachers, discovered a piece of software that could record a PowerPoint slideshow, including voice and annotations, and then convert the recording into a video file that could be easily distributed online. The tool forever changed the way they approach teaching.

"Being able to pre-record lectures was a revelation," Bergmann said. "It meant that students who had missed classes would be able to catch up quickly and easily. What’s more, it meant that we could free up time in the classroom to spend face-to-face with students."

Within a few months, the two teachers were recording all of their live lessons using the software. “We started recording short videos and posting them on YouTube for students to watch at home in place of more traditional homework,” Bergmann said. “We’d then dedicate class time to more practical experiments and to help students who needed one-on-one support.”

The experiment gave birth to the flipped classroom concept. “It’s all about spending more valuable time with students,” Bergmann said. “Standing up and lecturing is not the best use of time; there are deeper and more meaningful things you can do. We’ve had school wrong for too long; we’ve been sending students home with the hard stuff. By flipping the classroom you send them home with the easy part and we do the harder, more creative learning in class.”

GLOBAL ADOPTION

Since Bergmann and Sams made their first foray into flipped learning, the concept has sparked global interest. In Iceland, Keilir (a school which prepares students, who have a vocational training and/or sufficient practical experience in industry, with the knowledge and competency necessary for further studies at university level) was the first educational establishment to adopt a flipped approach. Since doing so, its students have achieved their highest scores on the country’s state test. “We established the school in 2007, and from the outset we wanted to be innovative,” said Hjalmar Arnason, Keilir’s principal. “Since flipping classes we’ve seen less disruption in class because students are actively involved in something. They also have much more support from teachers and they’re achieving better results. There’s simply no way we could go back to traditional teaching now.”

In 2012, the Indian School of Business (ISB) with its main campus in Hyderabad, India, introduced the flipped classroom to teach students in its flagship postgraduate management program a course on entrepreneurial decision-making. Arun Pereira, executive director of the Centre for Teaching, Learning and Case Development at ISB, used the methodology to teach a class of 70 students from the postgraduate program and won the school’s Best Professor award. The experiment was such a success that Economic Times reports ISB plans to expand the use of this active learning methodology.

In the US, a 2012 study by the Flipped Learning Network, a not-for-profit organization designed to promote flipped learning, found that 67% of the 453 teachers who flipped their classrooms reported increased test scores, with particular benefits for students in advanced-placement classes and those with special needs. The study also found that 80% of teachers reported improved student attitudes and 99% said they would flip their classrooms again the following year. Clintondale High School in
Clinton Township, Michigan (USA), saw the failure rate of its ninth-grade math students drop from 44% to 13% after adopting flipped classrooms. And at Byron High School in Byron, Minnesota (USA), the number of seniors completing four or more credits in math rose from 29.9% in 2006 to 86.6% in 2012 after flipping the classroom.

In Canada, Graham Johnson, the head of mathematics at Okanagan Mission Secondary in Kelowna, British Columbia, said that the flipped approach has transformed the way he teaches. “Before, many of my students seemed disengaged; some appeared to sleep through class, others texted under their desks and a few were not even bothering to come in the first place,” he said. “Using the flipped classroom, I now have an opportunity to provide my students with a rich learning environment in a way I could not do before. I can now spend 10 to 15 minutes working with one student who is struggling on a concept. Or I can challenge one of my stronger learners to extend their thinking. These are things that just never could have happened in my classroom prior to flipping.”

Johnson’s students seem convinced by the changes too. “I don’t have to sit through long lessons,” one student commented. “The teacher has more time for me as an individual student and creativity is more involved.” Another noted that “before in math I barely ever did homework; now I haven’t missed any.”

And it’s not just the students that appreciate the approach. As a parent of two high school students currently enrolled in Johnson’s math classes, Brenda Kirsch believes that the flipped approach has fostered very positive learning experiences. “Both of my daughters learn differently,” she said. “My 12th grade daughter needs more time to think, manipulate and process math concepts, whereas my 10th grade daughter excels with math material. They both love the flipped

“USING THE FLIPPED CLASSROOM, I NOW HAVE AN OPPORTUNITY TO PROVIDE MY STUDENTS WITH A RICH LEARNING ENVIRONMENT IN A WAY I COULD NOT DO BEFORE.”

GRAHAM JOHNSON  
HEAD OF MATHEMATICS, OKANAGAN MISSION SECONDARY
class approach for different reasons. The flipped classroom truly differentiates the learning for students and provides step-by-step instruction that is clear to follow. I think the flipped classroom is an innovative approach to engaging students.”

“FLIPPED LEARNING ALLOWS DIRECT INSTRUCTION AND FREES UP THE TEACHER TO MEET THE INDIVIDUAL LEARNING NEEDS OF EACH STUDENT.”

AARON SAMS
HIGH SCHOOL SCIENCE TEACHER

Parents of students attending flipped classes at Byron High School also have high praise for the concept. “Having the chance to spend more time in class with the teacher to ask questions and work through the homework has given my son a much better understanding for the material and a more positive outlook on getting things done,” said the parent of a 12th grade calculus student. “He is far less frustrated than before as there is more time to work with the teacher to ensure he understands the material fully.”

The parent of a 10th grade geometry student concurs. “Since my math skills are a little rusty, I appreciate that any homework questions can be asked in the classroom rather than at home,” the parent said. “That approach is much more helpful to students. There’s less frustration for all of us!”

ROSE-TINTED SPECTACLES?

Despite these successes, many other educators are skeptical. Frank Noschese, a physics teacher at John Jay High School in Cross River, New York (USA), argues that the concept isn’t really a step forward. “Flipped learning is still about passive instruction,” he said. “Although it’s via a video, it’s still a lecture. And, although students can pause and re-wind the video so they can listen again, they can’t actually ask a question midway through like they can in class. It’s a flawed concept.”

Lisa Neilsen, a seasoned US public-school educator, self-professed ‘innovative educator’ and author of the book Teaching Generation Text, also is unconvinced. “I have a real problem with the idea that students are being sent home to watch videos,” she said. “Home life should be fun; children should be out exploring and running around. They are sitting for hours a day in school and now are being told to go home and watch a screen!”

Neilsen argues that flipping doesn’t change anything – except location. “These videos are simply a 21st-century workbook. It’s just another way of doing the same old thing. The flipped classroom is built on a traditional model of teaching and learning. I lecture, you intake. While this method of teaching works for some learners, many others thrive with a model that takes a more constructive approach.”

But Bergmann is quick to defend his cause. “I encourage teachers to keep videos short,” he said. “Ideally one to one-and-a-half minutes per grade level. So a grade-four student, for example, will be watching a six-minute video. This is far less time than students would spend on traditional homework. As for the argument about screen time, kids are going to get screen time whether we like it or not. We’re not adding to it; we’re replacing it with something far more valuable.”

THE TECHNOLOGY CHALLENGE

Access to technology is also a widely cited issue with the flipped learning model. Not all students will have access to a computer or the Internet. “This is a challenge, yes, but it can be easily overcome,” Bergmann said. “At our school in Colorado, 25% of kids have no Internet at home. We simply downloaded the videos onto flash drives for them. For those without a computer, we burnt the videos onto a DVD.”

Aaron Sams, Bergmann’s colleague, agrees that technology access is a challenge easily resolved. “A little creative thinking and innovation can help overcome the issues of access,” he said. “Problems are meant to be solved. Don’t let access be a deal-breaker.”

While many argue that a flipped approach allows students to learn at their own pace, Neilsen insists that isn’t the case in practice. “True flipping should include a careful redesign of
the learning environment, but this is often overlooked,” she said. “If we really want transformation in education, one thing we must do is stop grouping students by date of manufacture, which the flipped classroom is ideally suited for. But have schools put the structures in place? Are they ready to let students move at a pace that meets their developmental readiness and come to the realization that not everyone at the same age needs to be at the same place at the same time? I’ve certainly not seen this.”

But Sams said he believes that flipped learning better addresses individual needs. “One of the biggest challenges of traditional education is trying to provide an individualized education to a class of 30 students,” he said. “Flipped learning allows direct instruction, which traditionally takes place in a large group, to be delivered to the individual and frees up the teacher to meet the individual learning needs of each student.”

INVESTING IN SUCCESS
A further challenge highlighted by many detractors is the time it takes to make the videos. “Teachers adopting the flipped approach will need to learn new software, make the videos and, in some cases, spend time burning the videos to flash drives or DVDs,” Noschese said. “Is that really a good use of a teacher’s time?”

Teachers at the Keilir School found a solution to this stumbling block, Arnason said. “While many teachers are quite happy to invest time in creating videos, others have chosen to leverage the many existing videos that can be found online,” he said. “For example, a number of instructors turn to the Khan Academy and other similar organizations for assistance. This is highly effective.”

The Khan Academy, a US-based provider of free online educational content, has partnered with a number of schools and colleges around the world to deliver flipped content, including the Stanford University School of Medicine in Stanford, California (USA). Since flipping its applied biochemistry course, Stanford has seen class attendance rise from 20% to more than 90%. Tina Cowan, who teaches the course, said that student evaluations for the class when it featured traditional lectures were so low, they had nowhere to go but up.

“Flipping is hard,” she told Inside Higher Ed. “It’s more work to flip than to pull the lecture that you used last year out of the drawer.”

It’s a message that Okanagan Mission Secondary’s Johnson is eager to bring home. “Flipping classes is far from easy,” he said. “I have to spend a lot more time prepping practical class sessions to make sure they are interesting and that they promote deep learning. But it’s a challenge worth meeting. Flipped learning has such huge potential to transform lives.”

CHANGING THE FUTURE
In the years to come, flipped-classroom proponents are convinced that the approach will have a significant impact on teaching. “We need to move from the ‘lecturing from textbook mode,’ which so many traditional teachers are still caught up in, toward learner-centered education,” Bergmann said. “Flipped classrooms are central to this transition.”

“I hope teachers use the flipped classroom approach as a transition to greater things,” Sams added. “I want teachers to try a flipped classroom, but I don’t want them to stop there. I hope teachers use a flipped approach to take some of the attention away from themselves and direct the attention to the learners. Once they have done that, some amazing things can happen.”

◆

90%
Since flipping its applied biochemistry course, class attendance has risen from 20% to more than 90%.

STANFORD UNIVERSITY SCHOOL OF MEDICINE

“I hope teachers use the flipped classroom approach as a transition to greater things,” Sams added. “I want teachers to try a flipped classroom, but I don’t want them to stop there. I hope teachers use a flipped approach to take some of the attention away from themselves and direct the attention to the learners. Once they have done that, some amazing things can happen.”

◆
By 2018, eBooks will represent 14% of the total global revenue from educational books, according to a report by multinational professional services network PwC (formerly PricewaterhouseCoopers). This might seem like a humble figure, but it’s double the share educational eBooks represented in 2013. Although growth is hampered by educators’ dependence on tight government budgets, which do not allow for new textbook purchases every year, this evolving format is well supported by publishers, especially in higher education.

“We are seeing a gradual increase in eTextbook usage among students,” said Linda Dunbar, director of corporate public relations at Wiley, a major textbook publisher headquartered in Hoboken, New Jersey. “Generally, students who use an eTextbook once are more likely to use one again because they’ve had a positive user experience.”

Charlie Pearson, development manager at UK educational publisher Pearson Publishing, sees steady growth ahead. “Our ‘nimbl’ advanced mobile publishing platform is generating a lot of interest in schools,” he said. “It will take time to translate into big sales, but we expect demand to pick up, starting with the 17-18 year olds, who are more independent learners.”

“BEYOND THE BOOK

eTextbooks extend the traditional book to include a flexible repository of resources and media, plus progress tracking and instant feedback capabilities. “The long-term transformation is not books going online,” Mary Skafidas told Scholastic Administrator magazine when she was working as a marketing executive at New York-based publisher McGraw-Hill Education. “It’s the creation of different tools, a step beyond digital prose.”

French publisher Hachette’s “Technique” collection took that step by partnering with educational technology experts to create 3D animations for a digital version of a technology handbook used in French high schools. Animations enable students to observe, manipulate and deconstruct technical 3D models, while French and English voiceovers build language skills.

“These animations integrate well with a combined approach of hands-on experiments, lectures and lab sessions,” said Sylvain Grenaille, who teaches technology at Viollet-le-Duc High School in Villiers-Saint-Frédéric, France, one of the schools that tested Hachette’s eTextbook. “Students like to study digital technologies that they’ll use more thoroughly later on. The class using 3D animations was more efficient since students were more interested in what they were doing.”

“TOP OF THE CLASS

As students bring their work home, successful eTextbooks must provide rich interactive content on a wide range of devices. Ewan Campbell, a teacher trainer working for the British...
Council’s Pre-ELT (English Language Teaching) project in Malaysia, delivers courses that combine face-to-face learning using paper textbooks with homework on digital platforms. “The big challenge with digital books is how to display content on different devices,” he said. “Here in Malaysia, most trainee teachers have smartphones and few have laptops, so digital resources must work on the devices available to them.”

Forward-thinking publishers are focused on that challenge. “We are creating content to look good on all screens,” Pearson said. “The markup language for eTextbooks must be richer because the content is required to do more.”

READING THE FUTURE

Looking ahead, eTextbooks promise a broad spectrum of innovative and engaging resources. The publishers’ goal is to make them increasingly sophisticated and interactive. “eTextbooks will evolve over time so that there is a higher level of interactivity, even for a standard offering,” Wiley’s Dunbar said. “This will come about initially as publishers progressively move their content into more dynamic, reflowable formats. A range of offers will emerge, from standard text on a device to an adaptive, integrated learning platform with a wide range of enhancements.”

These versatile resources could generate new business models, enabling more people to access the educational materials they need. In several US states, for example, educators and administrators are abandoning costly paper textbooks and using platforms such as Wikispaces for Teachers, Netvibes, Moodle and Edmodo to create their own eTextbooks. Wiley’s eTextbooks can be purchased or rented, and educators can select the content they need to create customized textbooks in the format of their choice.

In a recent blog for EduTech, Michael Trucano, senior information and communication technology and education policy specialist at the World Bank, suggested that learners in developing countries could buy eTextbook chapters as needed, much as consumer-goods companies sell affordable, one-load packets of laundry detergent.

“As eTextbooks gain traction, they will continue to evolve through partnerships with publishing, education, media and technology providers. These interactive resources promise compelling experiences for a broad spectrum of learners, with plenty of new chapters ahead.”

“GENERALLY, STUDENTS WHO USE AN ETEXTBOOK ONCE ARE MORE LIKELY TO USE ONE AGAIN BECAUSE THEY’VE HAD A POSITIVE USER EXPERIENCE.”

LINDA DUNBAR
DIRECTOR OF CORPORATE PUBLIC RELATIONS, WILEY

Image © Wavebreakmedia Ltd / Thinkstock
Training technicians and engineers involves costly, fragile and sometimes hazardous equipment. The alternative? Virtual labs. Based on digital technology, these labs have become powerful learning tools, allowing students and teachers to overcome the constraints of the physical world to train safely.

The Internet is revolutionizing education with MOOCs (Massive Open Online Courses), distance learning, flip teaching and more. While these online learning tools have already proven effective, some skills still require hands-on training. Whether learning to work in a nuclear power plant or run an oil rig, the virtual lab provides hands-on experience in a setting where making an error is safe and nothing blows up.

A COST-EFFECTIVE SOLUTION

With 3D simulation, the learner interacts with digital equipment that behaves like the actual device, providing a flexible setting to gain understanding through all kinds of practical exercises, from the most basic to the highly complex. The idea, which simulation software experts have dreamed of for more than 20 years, took shape with the emergence of computing tools powerful enough to run these compute-intensive programs.

“Physical systems are excellent teaching tools, but they must be multiplied by the number of students so that everyone can use them at the same time,” said Frédéric Xerri, a teacher in mechanical engineering at Louis Armand High School in Nogent-sur-Marne, France. “For hands-on exercises in my industrial product design curriculum, I use high-tech equipment; some physical models cost between €10,000 (US$13,500) and €15,000 (US$20,500). In my classes of 24 students, this poses financial difficulties, even if I divide students into small groups. Thanks to the virtual lab, students can experiment on a realistic model of the tool on their computers and then take turns trying out the real system. This ‘cyber-physical’ combination optimizes the time spent on the actual demonstrator and offers a more instructional experience.”

Another advantage is that the learner can make mistakes in the virtual world, which better prepares him to handle the delicate physical equipment, thus promoting the idea of “getting it right the first time.”

APPLICATIONS IN ROBOTICS

The Georgia Institute of Technology (Georgia Tech), a university in Atlanta that counts engineering as one of its specialties, organizes summer workshops for high school students. There, teenagers use the LEGO Mindstorms NXT2, a popular introductory kit for programming and robotics that serves as a virtual form of hands-on training.

“The students must build robots capable of moving through an obstacle course,” explained research engineer Srujal Patel, who supervises the students. “But they cannot do it with LEGOs alone. They must design the missing pieces themselves.” Students test everything on the computer and do not proceed to 3D printing their robots until their virtual trials are conclusive.

“PHYSICAL SYSTEMS ARE EXCELLENT TEACHING TOOLS, BUT THEY MUST BE MULTIPLIED BY THE NUMBER OF STUDENTS SO THAT EVERYONE CAN USE THEM AT THE SAME TIME.”

FRÉDÉRIC XERRI
TEACHER IN MECHANICAL ENGINEERING,
LOUIS ARMAND HIGH SCHOOL, FRANCE
Students in different locations can share and work on common digital models at the same time. Together, they can tweak their models without having to be at the same computer, resulting in an optimized robot before manufacturing – without distance getting in the way.

A NUMBER OF ADVANTAGES

Despite criticism surrounding loss of contact with reality, teachers’ enthusiasm leaves little room for doubt about the success of these methods. “It is tempting to do everything virtually, especially for students who were born in the digital age,” Xerri admitted. “But fortunately, we always need to check and give concrete expression to students’ work. Nothing can replace the feeling of accomplishment when we see that the object we have imagined actually works.”

Another advantage of this type of learning is that it avoids mishandling or deterioration of the physical model and eliminates the possibility of accidents caused by a careless student. The new design software that powers virtual labs also is used by companies where students will work, easing their transition from the academic world to the work world.

A TEAM EFFORT

Schools across the globe are making manufacturers of educational training equipment consider this foray into the digital world a positive trend, not a form of competition. “We supply high-quality equipment and care about its return on investment,” said Dr. Tom Lee, chief of education at Ontario, Canada-based Quanser, a leading manufacturer of educational equipment for engineering students, including gyros, helicopters, mechanical arms and pendulums. “To reduce the cost of use per student, we have partnered with CAD specialists to offer both our tools and their virtual counterparts. This allows us to break into markets that would otherwise have been inaccessible.”

Given the wide number of benefits offered by the combination of real and virtual training, these pioneers are blazing a trail that many other educators are likely to follow. Especially in countries where access to education is limited or inaccessible to many, virtual training can open the door to much-needed knowledge and opportunity. ◆

Georgia Institute of Technology in Atlanta organizes workshops for high school students using an introductory kit for programming and robotics as a virtual form of hands-on training. (Image © LEGO)
EDUCATION AND RESEARCH IN 3D

Lifelike learning helps students achieve while expanding the boundaries of knowledge

For decades, industries worldwide have steadily advanced their businesses with increasingly sophisticated 3D virtual models that accelerate discovery, enable collaboration and improve quality. Although 3D also is proven to help both students and researchers accelerate their quests for knowledge, the technology has been slow to permeate education and research. Compass looks at three new projects that are changing that trend, using 3D to help students succeed in school and improve their job prospects, as well as helping researchers accelerate the pace of medical discovery.

by Dora Laïné

Businesses worldwide have proven the power of 3D digital modeling to accelerate discovery, increase quality, simplify design and manufacturing, and enable collaboration and understanding across distances and disciplines. Now, with the advent of Industry of the Future initiatives that simulate and manage every aspect of a facility – from a factory to an entire city – in scientifically accurate 3D via links to the Internet of Things (IoT), knowledge of the technology is becoming increasingly vital to success in the workplace and the research lab.

The growing need for 3D-trained workers and researchers is beginning to stimulate pilot projects designed to demonstrate how 3D can be applied to both education and research. In the process, 3D is teaching hundreds of students that with 3D even the most technical courses can be fun, while giving researchers powerful new tools in their quest for solutions to global challenges.

“3D technologies play an interesting and very important role in bringing students who have abandoned formal learning back into the classroom,” said Jean-François Thoorens, technology teacher at Apprentis d’Auteuil, an academic foundation that provides educational, training and job placement programs to underprivileged students in France.

In his third-year high school class, Thoorens’ students are designing and building a miniature car that they will race against cars developed by students at other schools.

“The students will be involved throughout the different phases of the project,” Thoorens said. “This not only includes the design of a 3D digital mock-up of the car, but its fabrication as well.” In addition, students will generate marketing assets, design a booth for presenting their car at the competition, and give an oral presentation of their work to the competition’s jury.

The project-based learning exercise allows students “to experience the way different disciplines collaborate to share ideas and opinions on design choices and techniques ... all the activities that need to be performed in real-life situations and that students should master for when they enter the job market,” Thoorens said.
Using 3D design tools contributes to the students’ enthusiasm for their work, increasing their chances of success.

“I really like using the 3D design software to create the car,” said Alassane Gueye, a student in Thoorens’ class. “It’s fun to work with others and share ideas as a group and see our design come to life in three dimensions. A project like this is very motivating and opens up new perspectives for me, as I am currently in the process of deciding which career to pursue when I graduate.”

Learning how to collaborate with others to accomplish a shared goal is a valuable aspect of the project, said Alexandre Petit, another student in Thoorens’ class. “I know this is what I want to do in the future,” he said. “This project has taught me how to be an engineer, but above all how to work in a team.”

BUILD, MEASURE AND LEARN

Base 11 is a California-based organization focused on encouraging more students to choose careers in science, technology, engineering and math (STEM) fields, or to become entrepreneurs and start their own companies. With numerous US industries facing profound shortages of STEM-trained workers, Base 11 focuses on creating opportunities for low-resource students to realize their full potential and find high-paying jobs through STEM training.

“Base 11’s mission is to close the STEM talent pipeline gap, fueled by the underrepresentation of women and minorities, and to transform them into a skilled workforce that industry and our country so desperately need,” said Landon Taylor, CEO of Base 11. “Our goal is to produce 11,000 STEM-trained graduates by the year 2020.”

3D solutions help students to advance in their STEM academic pursuits and prepare for their careers, Taylor said. “3D is effective because it really allows them to work in collaboration with others and to actually follow through on something that we teach, which is to build, measure and learn,” he said. “When you have the opportunity to work in a virtual environment, you have the ability to tinker. Low-resource students don’t usually have that opportunity. If they break something, they won’t have another try at it. Consequently, they fall behind. Working
in a 3D virtual environment gives them the ability to iterate, learn, measure and grow. That’s going to increase their motivation and confidence in themselves and, therefore, their skillsets.”

Base 11 has established a partnership with the University of California Irvine’s Samueli School of Engineering, enabling academically gifted but low-income engineering students to study at UCI.

“3D IS EFFECTIVE BECAUSE IT REALLY ALLOWS [STUDENTS] TO WORK IN COLLABORATION WITH OTHERS AND TO ACTUALLY FOLLOW THROUGH ON SOMETHING THAT WE TEACH, WHICH IS TO BUILD, MEASURE AND LEARN.”

Landon Taylor
CEO, Base 11

“This partnership gives them the opportunity to acquire hands-on experience in engineering, in design and in problem-solving,” said Sharnnia Artis, Samueli’s assistant dean of access and inclusion. “Many of our students, when they come, have no idea what type of 3D technologies are out there. And so when we put these technologies and tools that are being used in industry at their disposal, they are excited and motivated to learn.”

UCI and Base 11 built an Autonomous Systems Engineering Academy lab to provide students with hands-on, project-based learning.

“Through this lab, the students are able to take an idea and turn it into a product,” Artis said. “During the design phase, they can conceptualize their idea in 3D, then put it into a format where they can 3D print it and use our laser technology to bring the concept to life. When they graduate, they already know how to use the same tools that are used in the industry so that when they enter the workforce, they hit the ground running.”

Gregory Washington is Stacey Nicholas dean of engineering at the UCI Samueli School.

“The first group of students that participated in the program last year was blown away,” Washington said. “They learned how to take 3D CAD and use design and engineering principles to build an autonomous drone. Throughout the process they learned principles of aerodynamics, computer science and basic electronics and literally built these machines from the ground up. To see individuals come in a little tepid, a little afraid, and to see them leave with an understanding, ‘I can do it, this is doable,’ is very rewarding. Without 3D tools, you cannot get the results that we want to see in our future engineers.”

TARGETING CLINICAL TREATMENT

A continent and an ocean away, researchers at UK-based University of Sheffield are using 3D technologies to break ground in medical research by predicting the outcome of clinical procedures through 3D modeling and simulation.

“Computational modeling and virtual reality are entering many aspects of medical research,” said Dr. Jane Doe, a research scientist at the University of Sheffield.

“By using 3D modeling, we can simulate various surgical procedures and predict patient outcomes. This not only helps in planning surgeries but also provides a sense of confidence to patients and surgeons alike.”

Dr. Jane Doe
Research Scientist, University of Sheffield

The research team at Sheffield is collaborating with hospitals across the UK to apply this technology in real-world scenarios. The goal is to improve patient outcomes by reducing complications and shortening recovery times.

“With the increasing pressure on healthcare systems, this technology has the potential to revolutionize surgical planning and outcomes,” said Dr. Peter Smith, director of the Sheffield 3D Lab.

“Providing surgeons with realistic simulations of surgeries can help them make informed decisions and improve patient outcomes. It’s a win-win for everyone.”

Dr. Peter Smith
Director, Sheffield 3D Lab

Base 11 has established a partnership with the University of California Irvine’s Samueli School of Engineering, enabling talented but low-income engineering students to study at UCI. An Autonomous Systems Engineering Academy lab provides students with hands-on, project-based learning.

(Image © Base 11 / UCI)
engineering, medicine, biology and technology,” said Alberto Marzo, lecturer of computational biomechanics. “3D virtual models serve to bridge the engineering and medical worlds because it provides a contextualization of the model data that can improve the dissemination of this data to a non-engineering audience.”

Among other projects, Marzo and his team are studying the treatment of a cerebrovascular condition known as an intracranial aneurism.

“These are abnormal dilations of an artery that can produce devastating consequences if they rupture, causing bleeding in the brain that can lead to death,” he said. “Our students use 3D virtual reality to understand the anatomy of the patient through the development of a computational, patient-specific clinical procedure and to predict the effect of a treatment before actually performing it on a patient.”

The Insigneo Institute for in silico Medicine, a collaborative initiative between the University of Sheffield and Sheffield Teaching Hospitals NHS Foundation Trust, is applying new 3D technologies to design a medical device or treat a disease.

“We aim to train new students to become the engineers and researchers of tomorrow.”

DAMIEN LACROIX
PROFESSOR OF MECHANOBIOLOGY,
UNIVERSITY OF SHEFFIELD

“We aim to train new students to become the engineers and researchers of tomorrow so that they can actually use the new technologies in a clinical context,” said Damien Lacroix, professor of mechanobiology at the University of Sheffield and director of research at Insigneo.

For Kyle Murdock, a research assistant at Insigneo, 3D is valuable in both research and teaching.

“3D universes create a collaborative space with which we can analyze different objects or concepts simultaneously, providing more detail in our teaching approach because teaching in virtual reality increases the depth of knowledge,” Murdock said. “Without it, we would be limited in how we can discuss complicated physiological concepts with physicians and students.”

3D also helps clinicians make more informed decisions that create better outcomes for patients, Marzo said.

“To diagnose, treat or monitor disease using 3D simulation models in a very advanced virtual reality environment enables clinicians to rely on engineering principles rather than empirical processes to make better, more-informed decisions on which treatment is best for each patient,” he said. “The potential to transform health care is substantial.”

LA FONDATION DASSAULT SYSTÈMES

All of the projects featured in this article are recipients of education or research grants from La Fondation Dassault Systèmes.

La Fondation contributes to transforming learning and research experiences by supporting schools, universities, research centers and other not-for-profit organizations as they apply 3D virtual technology to their processes and share their learnings with others in their fields. La Fondation’s objective is to transform the learning experience, help educators increase the employability of their graduates through a holistic, 3D-based approach to teaching science, technology, engineering and mathematics, and expand the boundaries of knowledge by applying 3D to research and intellectual heritage projects.

For more information:
http://3ds.one/lafondation
3

SUBJECT MATTERS
That Matter

As economic transformation requires new skills and mindsets, the humanities of the 21st century are taking shape.
Semester after semester, Emanuel S. Grant, associate professor in the Computer Science Department at the University of North Dakota in Grand Forks (USA), takes part in an open house for high school students interested in learning about the university’s various programs. Sitting at the computer science table, he watches some students go out of their way to avoid the table altogether; computer science retains that “geek” stigma. Other times, a male and a female student will walk in together; the male may approach the table, but the female pointedly veers away. The hurdles continue in the second semester of college, when students enrolled in computer science begin to fall away. Even students who believe they are interested in the field typically have been exposed only to office and gaming applications, Grant said. They don’t understand that computer science includes sophisticated mathematical algorithms, data structures and computational thinking – creating applications, not just using them. When they find themselves in alien territory, too many of the students give up. “It’s sad to see the falloff in enrollment as students realize that what they thought is computer science is not,” Grant said. “Too few schools at the K-12 level (pre-college) in this area of the state (North Dakota) teach anything truly related to the subject. Students come to us unprepared.”

THE KNOWLEDGE GAP

Grant is among a growing number of educators, legislators and advocacy groups, however, are working to change that pattern. In a world brimming with digital technologies, the study of computer science delivers both educational and economic benefits, experts say, giving students problem-solving skills and entry to high-paying jobs. According to the US Bureau of Labor Statistics, the median annual US salary in 2011 was US$45,230, while the average annual salary in computer and mathematical occupations was US$78,730. In a nation struggling to reduce unemployment, 150,000 computing-related jobs open annually.

Yet the number of US schools offering computer science courses is declining – from 78% in 2005 to 69% in 2011, according to the advocacy organization Computing in the Core (CinC), based in Washington, D.C. (USA). Only 14 states and the District of Columbia treat secondary-school computer science courses as core mathematics or science credits.

“Computer science is an essential skill; it’s fundamental knowledge for the 21st century and where the job growth is,” CinC founder Cameron Wilson said. “Yet many school districts still put it in the same ‘elective’ bucket as non-professional courses.”

A GLOBAL PERSPECTIVE

Mandatory teaching of computer science education varies widely from country to country. China, the world’s most populous nation with close to
1.4 billion people, includes computer science as part of its curriculum, but wide disparities persist between rural and urban schools in how extensively the subject is taught. What’s more, some educators believe the way computer science is taught in China – emphasizing hierarchy, rote learning and copying past masters – stifles the very creativity essential to future competitiveness.

“China has shown the world it can manufacture anything; that’s what has driven its economy for 20 years,” said Dr. James A. Landay, who recently joined Cornell University’s NYC Tech campus in Manhattan, New York (USA) after 2.5 years of teaching in China. “But to move its huge population into a middle-class lifestyle, China can’t just manufacture products; it has to come up with innovative concepts and designs and market products as well as manufacture them. That’s where the money is, and in these areas China lags behind.”

China and India are like the US 25 years ago,” Landay said. India is actively working to tackle the challenge, however. According to the 2011 report “Computing at School: International Comparisons” prepared by Computing at School (CaS) in collaboration with Microsoft and global
In Germany, for example, computer science is not mandatory and cannot substitute for other science subjects, but the credits earned fully count toward graduation requirements. Scotland’s Curriculum for Excellence, which aims to shift teaching focus from facts to skills and competencies, includes computer science in the curriculum. New Zealand revamped its school curriculum in Digital Technologies to include an explicit strand entitled “Programming and computer science.” And in 2012, British Education Secretary Michael Gove moved to replace a “demotivating and dull” information and communications technology curriculum with a flexible one in computer science and programming.

“Instead of children bored out of their minds being taught how to use Word or Excel by bored teachers, we could have 11-year-olds able to write simple 2D computer animations,” BBC News quoted Gove saying.

DEFINING COMPUTER SCIENCE AS “CORE”

Israel is widely regarded as the world leader in computer science education. Not surprisingly, Israel also has the world’s highest level of per-capita venture capital funding and the highest density of technology startups. In 1998, Israel’s Ministry of Higher Education implemented a secondary school computer science curriculum in which Israeli students may choose from tracks for casual or serious interest in computer science. Teachers of the subject receive specialized education and certification.

Computer science education advocates worldwide consider Israel’s computer science education a model for the world. However, its successes may prove difficult to emulate in other countries. With fewer than 8 million people, Israel has a centralized education system. The US, by contrast, has a population of 316 million; its educational system is governed by a complex mix of federal, state and local authorities.

“There’s no single lever to pull to change the US education system,” said Cinc’s Wilson, and the same situation exists to varying degrees in many other parts of the world. Wilson’s top recommendation to authorities at any level is to “clearly define and include K-12 (pre-college) computer science education as a critical part of education initiatives.”

STRATEGIC APPROACH

After years of watching students avoid computer science or choose it only to drop out, Grant of the University of North Dakota is working with instructors worldwide to develop a coordinated global approach to computer science education. At the 2013 International Conference on Computer Science Education in Thailand, Grant conducted a workshop on developing a collaborative paradigm for software engineering curriculums worldwide.

Business is global, Grant said, but curriculum standards are not, making it difficult for companies to know exactly what skills to expect from the graduates they hire. “When you look at what to teach at the college level, you have to consider what kind of preparation those students bring from their primary and secondary schools,” Grant said. “Students need to understand that computer science isn’t just for geeks. It’s cool.”

Frequently, the discussion of global computer science education focuses on national competitiveness—as if one nation’s win is another’s loss. Landay and Grant take a different point of view. “Everyone creating the best products they can is good for all of us,” Landay said. “In the long run, people tend to specialize in what they do best. A rising tide lifts all boats.”

The number of US schools offering computer science courses is declining – from 78% in 2005 to 69% in 2011.

ADVOCACY ORGANIZATION

COMPUTING IN THE CORE

Business is global, Grant said, but curriculum standards are not, making it difficult for companies to know exactly what skills to expect from the graduates they hire. “When you look at what to teach at the college level, you have to consider what kind of preparation those students bring from their primary and secondary schools,” Grant said. “Students need to understand that computer science isn’t just for geeks. It’s cool.”

Frequently, the discussion of global computer science education focuses on national competitiveness—as if one nation’s win is another’s loss. Landay and Grant take a different point of view. “Everyone creating the best products they can is good for all of us,” Landay said. “In the long run, people tend to specialize in what they do best. A rising tide lifts all boats.”

The number of US schools offering computer science courses is declining – from 78% in 2005 to 69% in 2011.

ADVOCACY ORGANIZATION

COMPUTING IN THE CORE

Business is global, Grant said, but curriculum standards are not, making it difficult for companies to know exactly what skills to expect from the graduates they hire. “When you look at what to teach at the college level, you have to consider what kind of preparation those students bring from their primary and secondary schools,” Grant said. “Students need to understand that computer science isn’t just for geeks. It’s cool.”

Frequently, the discussion of global computer science education focuses on national competitiveness—as if one nation’s win is another’s loss. Landay and Grant take a different point of view. “Everyone creating the best products they can is good for all of us,” Landay said. “In the long run, people tend to specialize in what they do best. A rising tide lifts all boats.”

The number of US schools offering computer science courses is declining – from 78% in 2005 to 69% in 2011.

ADVOCACY ORGANIZATION

COMPUTING IN THE CORE

Business is global, Grant said, but curriculum standards are not, making it difficult for companies to know exactly what skills to expect from the graduates they hire. “When you look at what to teach at the college level, you have to consider what kind of preparation those students bring from their primary and secondary schools,” Grant said. “Students need to understand that computer science isn’t just for geeks. It’s cool.”

Frequently, the discussion of global computer science education focuses on national competitiveness—as if one nation’s win is another’s loss. Landay and Grant take a different point of view. “Everyone creating the best products they can is good for all of us,” Landay said. “In the long run, people tend to specialize in what they do best. A rising tide lifts all boats.”

The number of US schools offering computer science courses is declining – from 78% in 2005 to 69% in 2011.

ADVOCACY ORGANIZATION

COMPUTING IN THE CORE

Business is global, Grant said, but curriculum standards are not, making it difficult for companies to know exactly what skills to expect from the graduates they hire. “When you look at what to teach at the college level, you have to consider what kind of preparation those students bring from their primary and secondary schools,” Grant said. “Students need to understand that computer science isn’t just for geeks. It’s cool.”

Frequently, the discussion of global computer science education focuses on national competitiveness—as if one nation’s win is another’s loss. Landay and Grant take a different point of view. “Everyone creating the best products they can is good for all of us,” Landay said. “In the long run, people tend to specialize in what they do best. A rising tide lifts all boats.”

The number of US schools offering computer science courses is declining – from 78% in 2005 to 69% in 2011.

ADVOCACY ORGANIZATION

COMPUTING IN THE CORE

Business is global, Grant said, but curriculum standards are not, making it difficult for companies to know exactly what skills to expect from the graduates they hire. “When you look at what to teach at the college level, you have to consider what kind of preparation those students bring from their primary and secondary schools,” Grant said. “Students need to understand that computer science isn’t just for geeks. It’s cool.”

Frequently, the discussion of global computer science education focuses on national competitiveness—as if one nation’s win is another’s loss. Landay and Grant take a different point of view. “Everyone creating the best products they can is good for all of us,” Landay said. “In the long run, people tend to specialize in what they do best. A rising tide lifts all boats.”

The number of US schools offering computer science courses is declining – from 78% in 2005 to 69% in 2011.

ADVOCACY ORGANIZATION

COMPUTING IN THE CORE

Business is global, Grant said, but curriculum standards are not, making it difficult for companies to know exactly what skills to expect from the graduates they hire. “When you look at what to teach at the college level, you have to consider what kind of preparation those students bring from their primary and secondary schools,” Grant said. “Students need to understand that computer science isn’t just for geeks. It’s cool.”

Frequently, the discussion of global computer science education focuses on national competitiveness—as if one nation’s win is another’s loss. Landay and Grant take a different point of view. “Everyone creating the best products they can is good for all of us,” Landay said. “In the long run, people tend to specialize in what they do best. A rising tide lifts all boats.”

The number of US schools offering computer science courses is declining – from 78% in 2005 to 69% in 2011.

ADVOCACY ORGANIZATION

COMPUTING IN THE CORE

Business is global, Grant said, but curriculum standards are not, making it difficult for companies to know exactly what skills to expect from the graduates they hire. “When you look at what to teach at the college level, you have to consider what kind of preparation those students bring from their primary and secondary schools,” Grant said. “Students need to understand that computer science isn’t just for geeks. It’s cool.”

Frequently, the discussion of global computer science education focuses on national competitiveness—as if one nation’s win is another’s loss. Landay and Grant take a different point of view. “Everyone creating the best products they can is good for all of us,” Landay said. “In the long run, people tend to specialize in what they do best. A rising tide lifts all boats.”

The number of US schools offering computer science courses is declining – from 78% in 2005 to 69% in 2011.
FACTORY OF THE FUTURE

Educators focus on teaching skills to help students master both physical and virtual worlds

Manufacturers are increasingly using new technologies, including the Industrial Internet of Things, robotics and additive manufacturing, to eliminate waste and raise productivity. But educators are challenged to train the new workforce and retrain existing ones with the skills they need to work successfully in these factories of the future.

by Jacqui Griffiths

In the factory of the future – also known as the smart factory or Industry 4.0 – people and technology work together in an environment that seamlessly combines virtual and physical worlds, all aimed at improving efficiency and sustainability.

“The combination of ‘virtual’ and ‘real’ in order to get a full view of the complete value chain will allow factories to produce more rapidly, more efficiently and with greater output using fewer resources,” according to the International Electrotechnical Commission (IEC), a Switzerland-based international technology standards organization, in its “Factory of the Future” white paper.

While the vision may be futuristic, it’s already paying off for the world’s most advanced manufacturers. The American Society for Quality’s “2014 Manufacturing Outlook Survey” found that 82% of organizations that had implemented smart manufacturing reported increased efficiency, 49% said they experienced fewer product defects and 45% said they had increased customer satisfaction.

For all manufacturers to benefit from the factory of the future, however, requires “highly skilled technical talent,” the IEC advised – workers who can understand and manipulate virtual models of the physical environment. That represents a challenge for educators, and some of the world’s top technical training institutions are adopting new approaches to helping workers develop the skills demanded by futuristic factories.

PREPARING FOR INDUSTRY 4.0

The concept of smart factories or Industry 4.0, conceived in Germany as “Industrie 4.0,” has demanded new ways of thinking about both manufacturing and education.

“We face the same challenge in our curricula as the industry does with its production processes,” said Vera Hummel, professor of Logistics and Industrial Engineering at ESB Business School at Reutlingen University in Germany. “Industry 4.0 is not simply about production efficiency. It is also about how you can build up new business models based on dedicated technologies. By understanding the potential of digital transformation and of the integration of the physical factory with the real-time digital image, which bi-directionally maps the virtual and the real world, students will be prepared to become the future experts of our economy.”

For students, this entails learning three nontraditional skills.

“The first challenge for students is learning to use the hybrid working system in combination with the technical assistance and cyber-physical systems,” Hummel said.

“INDUSTRY 4.0 IS NOT SIMPLY ABOUT PRODUCTION EFFICIENCY; IT IS ALSO ABOUT HOW YOU CAN BUILD UP NEW BUSINESS MODELS BASED ON THE NEW TECHNOLOGY AND SERVICE SOLUTIONS.”

VERA HUMMEL
PROFESSOR OF PROCUREMENT, PRODUCTION AND TRANSPORTATION LOGISTICS, INDUSTRIAL ENGINEERING, REUTLINGEN UNIVERSITY

“We the second is the seamless digital engineering environment. In the past, students only had to work with either CAD, process engineering or robot simulations, but now they have to work with all...”
Engineering programs worldwide are reworking their curricula to prepare students for Industry 4.0 settings, such as this digital E3-research factory at the Fraunhofer Institute for Machine Tools and Forming Technology IWU in Chemnitz, Germany. (Image © Ute Grabowsky /Getty Images)

of these digital tools, which support advanced, world-class production technologies in a seamless development process. The third challenge is learning to manage intelligent products based on highly diverse customer requirements in self-steering production systems.”

Teaching those skills demands a move away from traditional classes, where subjects are separated by discipline, to give students a comprehensive understanding of the interrelationships and dependencies among mechanical, informatics and automation processes, Hummel said.

Master’s degree students therefore spend two days a week for 15 weeks working on projects in a specially constructed “ESB Learning Factory,” which combines the physical infrastructure for production with cloud-based tools for digital engineering.

“They learn how to handle big data, digital processes, new business models and new cooperation models between departments. Our vision is to create a future-oriented ESB learning factory that will give the students hands-on experience with the world’s newest technologies in the context of Industry 4.0.”

WORKING IN A GLOBAL CONTEXT

In France, the National Engineering School of Metz (ENIM) is a member of the National Polytechnic Institute of Lorraine (Lorraine-INP), a collegium of 11 engineering schools at the University of Lorraine. ENIM launched the Factory Futures program, an international collaborative project that employs cloud-enabled product lifecycle management (PLM) technology,

The American Society for Quality found that 82% of organizations that implemented smart manufacturing reported increased efficiency, and 49% experienced fewer product defects.
to prepare students worldwide for futuristic factory environments.

“The pedagogical model of engineering schools in France and abroad provides no curriculum to prepare our youth to carry out engineering projects in a global context,” said Julien Zins, PLM project director and Latin America coordinator at ENIM. “Mobility is mandatory for ENIM students, and we have more than 120 agreements with institutions across the planet.”

The Global Factory project, launched in 2012, together with the Factory Futures program, begun in September 2016, provides opportunities for the institutions’ students to conduct an engineering project with 17 of the universities’ partners, working with 100 students and professors in 10 countries. Another objective, Zins said, was to share the universities’ experience with digital 3D solutions in PLM with their partner universities.

“A problem-based, multidisciplinary approach allows the integration of international partners with diverse skills, such as mechatronics or innovation management,” Zins said. “This year, for example, we have integrated two schools that are members of the Lorraine-INP collegium of the University of Lorraine – the Graduate Schools of Science and Technology Engineering of Nancy (ESSTIN) and the National Graduate School in Innovation Systems Engineering (ENSGSI) – to help us include those two skills.”

Staying up to date is critical if educators hope to deliver the skills their students need. Zins and his colleagues, for example, are closely following the actions of the French government and the “Industry of the Future,” a national initiative that involves technology companies, professional associations and academic partners and promotes the government’s program to digitally transform industry in France.

“From a hardware point of view, French schools can respond easily to this challenge, although educators will have to modernize their courses more often regarding the tools and must remain competent in the latest software,” Zins said. “It’s very important to have both professors and engineering staff certified in the relevant solutions. Luckily, in France, the RIP-PRIMECR network centralizes the training needs of higher education teachers in the 3D solutions we are using. They offer training throughout the year for teachers wishing to train in specialized areas.”

“UNIVERSITIES HAVE TO RECOGNIZE THAT IT’S NOT ENOUGH TO TEACH ENGINEERS THE ENGINEERING ASPECT OF PRODUCT CREATION; THEY ALSO HAVE TO TEACH MANUFACTURING.”

MICHAEL GRIEVES
PROFESSOR AND EXECUTIVE DIRECTOR, CENTER FOR ADVANCED MANUFACTURING AND INNOVATIVE DESIGN, FLORIDA INSTITUTE OF TECHNOLOGY

TRANSFORMING TEACHING

For US educators, the factory of the future could mean a growing number of manufacturing jobs for US workers.

“There is pressure on US universities to educate on manufacturing, which universities really haven’t done that much of in the past,” said Michael Grieves, professor and executive director of the Center for Advanced Manufacturing and Innovative Design (CAMID) at the Florida Institute of Technology. “It’s driven by the need for manufacturing jobs in the US, but also by the use of advanced technologies, which are changing the nature of manufacturing and cutting the cost of production.”

If technologies like the Industrial Internet of Things and additive manufacturing help US manufacturers produce goods at costs similar to those offered by low-wage countries, Grieves said, “the transportation costs will make the difference, and they will want to manufacture near the customer.”

Delivering the skills that tomorrow’s manufacturers need, however, requires institutions to overcome the educational establishment’s traditional silos, Grieves said.

“In the US, the top-tier universities have been turning out engineers without much understanding of manufacturing,” Grieves said. “There’s a whole range of material that we’re not teaching students and that students have to learn once they get out into industry. Universities have to recognize that it’s not enough to teach engineers the engineering aspect of product creation; they also have to teach manufacturing so that those products can go from virtual design to economical and efficient physical production.”

Grieves names the Florida Institute of Technology, Purdue University and the Georgia Institute of Technology as leading US institutions in this area, but notes that even they need a stronger interdisciplinary approach.

“Most US universities have colleges of engineering, not colleges of engineering and manufacturing,” Grieves said. “It’s no longer a case of engineering a product and then throwing it over the wall to manufacturing. A holistic approach to engineering and manufacturing is needed to create a product. So there needs to be a major strategic shift among educators toward that holistic approach in order to catch up with where industry is rapidly moving.”

A MEETING OF MINDS

Manufacturing accounted for just 16% of India’s gross domestic product in 2014, according to the World Bank. That same year, Indian Prime Minister Narendra Modi launched the “Make in India” initiative to attract foreign investors and transform India into a global manufacturing hub.
“To compete at the global level, we need engineers with multidisciplinary talent, and this requires a fresh approach to engineering education,” said Ashok Shettar, vice chancellor of KLE Technological University in India. “We are teaching many of the technologies that are relevant in the factory of the future, such as big data, cloud, analytics, embedded systems, robotics and automation, but we have not been teaching them in an integrated way.

“The factory of the future is also a collaborative space, where many processes can be happening at different physical locations and cross-cultural issues can arise. It’s critical that we create a learning environment that replicates the manufacturing environment so students can contextualize their learning and connect it to the workplace.”

KLE Tech’s engineering curriculum therefore emphasizes experiential learning. First-year courses include social innovation, which develops design thinking relevant to social needs, and engineering exploration, which combines many engineering disciplines to encourage broad production thinking. Subsequent courses encourage a multidisciplinary approach to product realization in the university’s 6,000-square-foot (557.4-square-meter) learning factory.

“Students work in interdisciplinary teams that mix mechanical engineering students with those from electrical engineering, so they gain an understanding of how teams from different disciplines work toward a common goal,” Shettar said.

“Since we expect our students to work in interdisciplinary teams, we needed to do it ourselves first – so we went through that experience before we started teaching it.”

**A NEW COLLABORATION OF INDUSTRY AND ACADEMIA**

For educators around the world, developing the skills needed for the factory of the future brings the challenge of reflecting the interdisciplinary nature of the new manufacturing environment. It’s a challenge that is ushering in increased collaboration among academic disciplines and between education and industry, demonstrating a crucial commitment to new ways of thinking about teaching, as well as manufacturing.

“We need to demonstrate a strong intention to collaborate,” Shettar said, “and to develop a culture of collaboration between industry and academia.”

To teach these skills, KLE Tech’s faculty members needed to expand their own experiences beyond their specialist disciplines.

“We identified gaps in our current practice and collaborated with the manufacturing industry to address those gaps and improve our ability to teach the courses,” Shettar said.
DIGITALLY SAVVY

Educating the first Internet generation poses new challenges
With their enthusiasm for consumer high-tech devices and social media, today’s students differ significantly from those of previous generations. Compass looks at what this new breed of connected learner offers to educational institutions and the business world... and what they expect in return.

*by Amber Stokes*

The proliferation of consumer technology and social media has made the current generation more mobile and socially connected than ever before, changes that have considerable implications for both colleges and future employers.

“A different kind of person is emerging from higher education that can be called a global graduate, but most importantly he/she will be a self-evolving personality,” says Olga Kovbasuyk, president of the International Higher Education Teaching and Learning Association (HETL). “Therefore, he/she will have experiences in global learning studies, and is able to apply global knowledge and skills to effectively interact and collaborate with world cultures. He/she is more self and globally aware, and has multiple perspectives on the world issues and business.”

**CATERING TO THE MODERN STUDENT**

Young adults of Generation Y have never been more globally connected, with access to data and contacts anytime, anywhere. It is second nature for them to use technologies such as smartphones, tablets and game consoles to interact with various communities and social networks, including Facebook, Twitter and China’s equivalent, Weibo. Higher education institutions must keep up with this demand and so are incorporating these technologies into their curriculums.

“Students have to show us the way,” says Dr. Agnes Kukulska-Hulme, associate director for learning and teaching in the Institute of Educational Technology Professoriat at the UK’s Open University. “They are often ahead of ‘us’ in using the technology. We need to tap into their knowledge – not only about technology, but also about different ways of studying.” Any major change in the way people communicate is bound to have major implications for education,” says Daniel Clark, program leader for the Bachelor of Science program in Leadership, Enterprise and Management at London’s BPP Business School. As such, students of the future will expect access to educational resources whenever, wherever they wish. “Some will have had many years of experience creating and sharing content, perhaps quite complex, perhaps to do with education,” Clark says. “Will they be happy to accept timetabled classes and sit through lectures?”

**SOCIAL AND MOBILE LEARNING**

So how can these students’ future employers benefit from their connectedness and social-media savvy? “These new ways of teaching and learning can improve learners’ intercultural communication competencies, which facilitate improved international relations and generate intercultural capital,” Kovbasuyk of HETL says. They also can raise students’ global self-awareness (see sidebar) and help students mature more quickly and fully.

Clark cites the example of Monica Rankin, a history lecturer at the University of Texas, who experimented with Twitter to increase the engagement in course discussions of students from a 90-person class. “I wanted to find a way to incorporate more student-centered learning techniques and involve the students more fully into the material,” Rankin says. Despite the fact that Twitter limits each ‘tweet’ to 140 characters, the experiment “encouraged students to engage who otherwise would not.” Using mobile technologies in and out of the classroom also gives students more flexibility to fit their studies around other activities, a trend that has implications for lifelong learning. “Mobile learning provides more flexibility in terms of time, place, and resources and can adapt to their lifestyle,” Kukulska-Hulme says. “Learners can be more actively engaged in determining what, when, and how to study, that is, choosing their activities and the time and place to perform them.”

**GENERATION Y IN THE WORKPLACE**

Just as students are pushing the adoption of new technologies in the classroom, they will expect similar – or better – levels of access in the workplace.
“Androids, iPads, Google Docs, Dropbox – these and other technologies are everywhere in enterprises today,” Accenture states in “The Genie Is Out of the Bottle: Managing the Infiltration of Consumer IT into the Workforce,” published in 2011. “Often, (these devices) enter the workplace with employees, not under the company’s auspices,” the report says. “They may raise alarms, but they also present valuable opportunities to those who successfully harness them.”

Accenture surveyed more than 4,000 employees in 16 countries across five continents and found that employees believe the technologies they use enhanced innovation, productivity and job satisfaction. More than a quarter (27%) said that they would pay for their own devices and applications to use at work if the alternative was to do without.

According to an Accenture survey, 27% of interviewed employees said that they would pay for their own devices and applications to use at work if the alternative was to do without.

To benefit from this enthusiasm for technology, some businesses are leveraging social media tools to build private networks that create tighter links with their employees while giving everyone improved visibility into activities across the organization.

For example, Miguel Zlot, the enterprise social networking evangelist at Molson Coors, introduced Yammer, a professional social media tool for enterprises, to the beer brewing and distribution company. “Not only is it a great way to stay connected with colleagues from different countries, but it also teaches me something new about our business every day,” Zlot says. “It could be a story about a new account from our sales team, an update on a marketing campaign that is taking off, or even a video of a new can line at work in one of our breweries.”

Another company on the cutting edge of applying consumer technology to the workplace is internet corporation Yahoo! When introducing the program Yahoo! Smart Phones, Smart Fun!, CEO Marissa Mayer embraced the idea that the company’s employees must use the same devices as the company’s customers so they can understand how Yahoo!’s users think and work.

**INTERCULTURAL VIRTUAL LEARNING**

In 2009, Olga Kovbasyuk from the Khabarovsk State Academy of Economics and Law in Russia, Anders Eriksson from the Orebro University in Sweden, and Alyssa O’Brien from Stanford University in the United States, created a shared virtual learning space designed to develop students’ intercultural communication (ITC) skills through shared dialogue across cultures and geopolitical boundaries.

“Overall, we found that globally distributed teamwork on blogging and discussions mediated by ITC can influence people to approach cross-cultural exchanges with greater sensitivity, understanding, and ethical awareness,” Kovbasyuk says.

For example, 96% of students agreed that they improved in “developing cultural sensitivity to and consideration for others from diverse cultural contexts.” Almost 90% agreed that “they gained more self-understanding, developed personal accountability, and thus, are better equipped to construct and fulfill their lives with self-determination,” while 98% of students agreed that they “developed a better understanding of people from different cultural contexts.”

---

Yahoo! Smart Phones, Smart Fun!”

CEO Marissa Mayer embraced the idea that the company’s employees must use the same devices as the company’s customers so they can understand how Yahoo!’s users think and work.

**EMBRACING THE INEVITABLE**

As globalization and technology continue to shape the future, businesses must strive to keep pace if they want to keep their current and future employees happy and take full advantage of their capabilities.

“It consumerization will be one of the biggest tests for organizations in the next five years, but resisting it is simply not an option and is tantamount to capitulation,” says Jeanne Harris, executive research fellow and senior executive at the Accenture Institute for High Performance. “A good first step is to learn just how extensively consumer IT has embedded itself into your workforce. Consider how to manage the risks and opportunities, and experiment with ways to channel employees’ enthusiasm for consumer technology.”

---

**INTERCULTURAL VIRTUAL LEARNING**

In 2009, Olga Kovbasyuk from the Khabarovsk State Academy of Economics and Law in Russia, Anders Eriksson from the Orebro University in Sweden, and Alyssa O’Brien from Stanford University in the United States, created a shared virtual learning space designed to develop students’ intercultural communication (ITC) skills through shared dialogue across cultures and geopolitical boundaries.

“Overall, we found that globally distributed teamwork on blogging and discussions mediated by ITC can influence people to approach cross-cultural exchanges with greater sensitivity, understanding, and ethical awareness,” Kovbasyuk says.

For example, 96% of students agreed that they improved in “developing cultural sensitivity to and consideration for others from diverse cultural contexts.” Almost 90% agreed that “they gained more self-understanding, developed personal accountability, and thus, are better equipped to construct and fulfill their lives with self-determination,” while 98% of students agreed that they “developed a better understanding of people from different cultural contexts.”

---

Yahoo! When introducing the program Yahoo! Smart Phones, Smart Fun!, CEO Marissa Mayer embraced the idea that the company’s employees must use the same devices as the company’s customers so they can understand how Yahoo!’s users think and work.

**EMBRACING THE INEVITABLE**

As globalization and technology continue to shape the future, businesses must strive to keep pace if they want to keep their current and future employees happy and take full advantage of their capabilities.

“It consumerization will be one of the biggest tests for organizations in the next five years, but resisting it is simply not an option and is tantamount to capitulation,” says Jeanne Harris, executive research fellow and senior executive at the Accenture Institute for High Performance. “A good first step is to learn just how extensively consumer IT has embedded itself into your workforce. Consider how to manage the risks and opportunities, and experiment with ways to channel employees’ enthusiasm for consumer technology.”

---

Yahoo! When introducing the program Yahoo! Smart Phones, Smart Fun!, CEO Marissa Mayer embraced the idea that the company’s employees must use the same devices as the company’s customers so they can understand how Yahoo!’s users think and work.

**EMBRACING THE INEVITABLE**

As globalization and technology continue to shape the future, businesses must strive to keep pace if they want to keep their current and future employees happy and take full advantage of their capabilities.

“It consumerization will be one of the biggest tests for organizations in the next five years, but resisting it is simply not an option and is tantamount to capitulation,” says Jeanne Harris, executive research fellow and senior executive at the Accenture Institute for High Performance. “A good first step is to learn just how extensively consumer IT has embedded itself into your workforce. Consider how to manage the risks and opportunities, and experiment with ways to channel employees’ enthusiasm for consumer technology.”

---
INTERNATIONAL COOPERATION

French and Chinese students gain cultural insights working in 3D

As China’s influence continues to grow in the global economy, so does the potential that Western and Chinese engineering students will work together at some point during their careers. Tsinghua University and the French ministry of higher education and research have therefore created a Center of Innovation in Beijing, where Chinese and western engineering students are learning to work together and gain appreciation for the strengths of their cultures.

by Dora Laîné

A dozen French engineering students recently attended a summer camp in China, where they trained for two weeks alongside their Chinese counterparts, learning as much about the strengths of cultural diversity as they did about engineering. The opportunity was made possible by an exchange program jointly sponsored by the French institute AIP-PRIMECA and China’s Tsinghua University.

TWO CULTURES, TWO APPROACHES

During the two-week program, mixed teams of Chinese and French students worked to design kick scooters, a project in the field of advanced design and manufacturing. The group with the most innovative and original design was awarded a prize.

Students began with two days of general training on using their 3D PLM tools, followed by more detailed courses on mechanical and assembly design. Digital mockups, design methodology, manufacturing and simulation, and the design challenges of specific products were all addressed.

“What was interesting was to create multi-cultural groups and have the students work together on a simple project,” said Dr. Nabil Anwer, the
French director of the PLM Innovation Center at Tsinghua University and an AIP-PRIMECA representative. “Presenting students from different cultures with a common challenge led to true international cooperation. It was enlightening to have them produce a tangible result together. Each group had detailed technical specifications as well as instructions to include something of their own culture in their design. It resulted in kick scooters that reflected a mix of Chinese and French styles.”

“Each group had detailed technical specifications as well as instructions to include something of their own culture in their design. It resulted in kick scooters that reflected a mix of Chinese and French styles.”

**DIFFERENT BUT COMPLEMENTARY**

The Chinese students had strong scientific and technical backgrounds and a tendency to focus on every detail. The French students were generally more concerned with the overall picture. “The French students would ask questions linked to feasibility or manufacturability of the product,” Dr. Anwer said, “whereas the Chinese students would focus more on the technical aspect of the kick scooter. If Chinese students had doubts about French students’ suggestions, they would avoid telling them outright so as not to upset them. This is a unique aspect of Chinese culture and it was really unusual for the French students.”

However, students from both countries demonstrated their ability to overcome cultural differences and work together. Because the 3D PLM solutions used by the students facilitated information sharing, they were instrumental in fostering collaboration.

“All students shared one disadvantage: the difficulty of working together in English, a foreign language to them all, but one that most of the students knew to some degree. Working in 3D helped to bridge the gap, becoming the common language for all.”

**EFFECTIVE COMMUNICATION IS THE MOST IMPORTANT THING; SHARE YOUR DIFFERENT THINKING OF A DESIGN AND EXPRESS IT TO OTHER PEOPLE.”**

DONG HUIDONG
STUDENT, TSINGHUA UNIVERSITY

Students’ experiences proved enriching both technologically and culturally. “We not only discovered 3D PLM in the industrial world, but also we had the opportunity to learn about the many facets of Chinese culture and traditions,” French student Mathieu Bernier said. “This project was very exciting,” Germain concluded. “I even forgot that I was working with Chinese students. We were a real team.”

**AIP-PRIMECA**

AIP-PRIMECA is the French Academic Network in Mechanical and Manufacturing Engineering, a national network that federates higher education institutions and is supported by the French ministry of higher education and research. Its objectives are to create synergy among the different member entities through resource pooling, knowledge sharing and skill reinforcement. AIP-PRIMECA also focuses on encouraging the development of innovative educational methods based on new information and communication technologies.

Chinese universities and AIP-PRIMECA have cooperated for many years. The establishment of the PLMIC, a joint Sino-French PLM Innovation Center at Tsinghua University, highlights this partnership for integrated design and manufacturing, as well as innovation through 3D Product Lifecycle Management (PLM) technologies.
The Experience Economy calls for improved levels of social inclusiveness centered on various types of learning populations. Across the world, successful initiatives show that education can be a lifelong experience, reaching all segments of humanity.
Cynthia Erenas moved from Mexico to the Boyle Heights neighborhood east of Los Angeles when she was seven years old; by the time she reached middle school, she was notorious for fighting. Today, however, at age 16, Erenas is a robotics team leader with a gift for project management who dreams of college and a career in engineering. "I don't tell myself excuses, I tell myself reasons to get where I want to go," said Erenas, whose life was transformed through her involvement with the i.am.angel Foundation. "America needs 120,000 new engineers, and my dream is to become one of them."

Enrique Gabriel Legaspi, who was Erenas's eighth-grade history teacher, has known Erenas since she was in seventh grade. "She was a firecracker, always ready to jump into trouble," Legaspi said. "Now she's using her energy in a different way. She has purpose. The employer that taps an intellectual talent like Cynthia's will have a leader who knows how to work hard and take smart risks."

The i.am.angel Foundation, which helped to change Erenas's path, was created in 2009 by will.i.am, a seven-time Grammy Award-winning musician, producer, director, entrepreneur and philanthropist who grew up in Boyle Heights and wanted to help reverse his neighborhood's downward spiral. Recognizing that the problems of Boyle Heights are complex, the i.am.angel Foundation administers multiple programs: i.am Scholarship provides college scholarships; i.am Home assists with financial literacy and home mortgages; i.am College Track addresses college preparation and student life, and i.am Art aims to inspire creative ideas to solve global challenges.

Building on its success in Boyle Heights, the i.am.angel Foundation is spreading its message of collaborative empowerment to New York and London, with aspirations to work anywhere that students need help to become the leaders of tomorrow. "Boyle Heights is the metaphor," said Legaspi, who left teaching to become chief of staff of i.am.angel Boyle Heights. "If we can do it here, we can do it anywhere."

The i.am.angel Foundation empowers through education

The children of Boyle Heights, east of Los Angeles, are heirs to a rich Hispanic heritage, but their neighborhood has been plagued by poverty and violence. The i.am.angel Foundation seeks to change all that. Founded by Grammy Award-winning musician will.i.am, the foundation collaborates with government and corporate partners to educate and empower students.

THE BOYLE HEIGHTS RENAISSANCE

Boyle Heights is one of Los Angeles' oldest neighborhoods, home to many rich traditions of Hispanic cuisine, music, art and culture. But Boyle Heights has also been plagued by poverty, drugs, despair and 32 neighborhood gangs that recruit children into lives of violence. The documentary film Waiting for Superman characterized Roosevelt High School in Boyle Heights as the worst-performing high school in the United States.

All that is changing, thanks to the community's own efforts and support from the i.am.angel Foundation. "We are planting the seeds of rebirth for Boyle Heights through education, arts, music and mentoring," Legaspi said.

The cornerstone of the foundation's strategy is collaboration, linking lawmakers, corporate leaders, educators and neighborhood activists to deliver win/win benefits for all. Legaspi – in addition to being a pioneering classroom teacher, hip hop artist, deejay and poet – is a master at orchestrating diverse people to meet common goals.
Like will.i.am, Legaspi grew up in Boyle Heights. After majoring in business finance in college, he taught eighth-grade US history for ten years at Hollenbeck Middle School, located across the street from Roosevelt High. “I wanted to become the teacher I never had,” Legaspi said.

During his years at Hollenbeck, Legaspi introduced social networking and other paperless technologies to the classroom, persuading companies to donate resources the school district could not afford to buy. “Mom always said, ‘If it’s free, take two,’” Legaspi said with a laugh. “Companies want to help if you can show them how to do so effectively.”

When will.i.am, whom Legaspi had known since he was 14 years old, visited Roosevelt High to meet with community leaders about how to reduce the dropout rate, Legaspi was holding a Career Day in his classroom, showcasing new careers invented in the past five years. He tweeted will.i.am but received no response. Instead, he heard a knock on his classroom door; will.i.am wanted to speak with Legaspi’s students in person. Soon after, Legaspi joined the foundation and helped launch i.am College Track.

GATHERING STEAM FOR SUCCESS

In today’s technology-driven world, students who want to succeed in the next-generation jobs of the future need STEAM – skills in Science, Technology, Engineering, Arts and Math, Legaspi said. To that end, the i.am.angel Foundation partnered with leading global organizations, including JPMorgan Chase & Co., Dassault Systèmes, Raytheon Company, Google, HP, 3D Systems and NVIDIA Corporation, to create an after-school robotics program at Roosevelt High. Also at Roosevelt, the geographic information system (GIS) software company ESRI is helping students learn advanced mapping skills and create a sustainable GIS program at the school.

“These students are super curious, eager to learn,” Legaspi said. “We should be ready for their new maturity. I’ve never seen anything like it. They have multi-faceted skills to read, write, collaborate and problem-solve. Companies need that leadership and intellectual capital for competitive advantage.”

FROM LOCAL TO GLOBAL

The i.am.angel Foundation is strategic and systematic as it works on ways to embed STEAM education into daily classrooms and after-school programs through teacher training.

“Start with a pilot,” Legaspi said. “Train at least two teachers to provide evidence and testimony that the program works. Then scale it.”

The foundation also is forging links with technical colleges to give high school students access to expert instructors and college credit for project work, opening pathways to higher education.
With students, Legaspi emphasizes a three-stage experiential process: create, curate and share. “You unleash imagination and back it up with skills to create content,” he said. “You curate the work to bring it to stage-ready maturity, and then you share it. It’s important for students to be mindful, to make sure the content is ready to broadcast. Then by collaborating in the cloud, they can reach a global audience in real time.”

The i.am.angel Foundation too, is mindfully going global. “You don’t jump from local to global,” Legaspi said. “You build from local to state to national to global, building alliances. The i.am.angel Foundation is working with organizations in New York, London, China and elsewhere to scale our success.”

As it expands globally, the foundation is working through established programs. It has partnered with the 100,000 Strong Foundation, an offshoot of a US Department of State initiative, to provide Chinese-language classes and study-abroad opportunities to the students of Boyle Heights. The i.am.angel Foundation also has donated US$780,000 to the Prince’s Trust to fund a technology program in the UK. The Prince’s Trust, formed in 1976 by the Prince of Wales, is a leading UK youth charity dedicated to improving the lives of disadvantaged young people.

Corporate partners also play an essential role, Legaspi said, providing financing, hardware, software or time. “It’s more than writing a check,” he said. “It’s a relationship. To companies I say, ‘Commit to help one school in one neighborhood.’ That puts a face on it. Target one school and share your resources and expertise to get students to a better 21st century. Be an ambassador for your organization. It will strengthen your future workforce. It will change the world.”

For more information: http://iamangelfoundation.org
As automation and technology replace more jobs in more industries, displaced workers are finding that the programs intended to help them retrain are riddled with gaps and inconsistencies. In some parts of the world, available training doesn’t match available jobs. In others, funding and accessibility are inadequate. Everywhere, however, the challenges – and the numbers of people in need of help – are poised to multiply exponentially.

*by Charles Wallace*

Automation, artificial intelligence and robots are increasingly replacing workers in performing routine tasks. Just ask the travel agents who have been displaced by booking websites, assembly line workers replaced by websites, and the professional drivers whose jobs will soon be eliminated by autonomous vehicles.

How bad will it be? According to one unpublished study quoted by the BBC in August 2015, the coming wave of technological breakthroughs endanger up to 47% of US employment. Y Combinator, an organization promoting the idea that every person on Earth should receive a minimum income, paints an even bleaker picture. “We think there could be a possibility where 95 percent — or a vast majority — of people won’t be able to contribute to the workforce,” said Matt Krisiloff, manager of Y Combinator’s basic income project. “We need to start preparing for that transformation.”

As the trend picks up speed, two burning questions face companies and governments alike: how to retrain displaced employees for new careers and how to ensure that workers who keep their jobs can update their skills throughout their working lifetime.

In the United States, for example, the federal government has two signature pieces of legislation aimed at helping out-of-work individuals: the 2015 Trade Adjustment Assistance Reauthorization Act, designed to assist employees who lost their jobs due to cheaper imported goods; and the Workforce Investment and Opportunity Act of 2014. Both programs provide financial assistance to train or retrain displaced workers.

Because of overlapping jurisdictions, the burden of retraining employees laid off due to technology, however, falls largely on state and local governments, which receive financial support from the federal government.

“Retraining through our nation’s community colleges is a way to reduce the skills gaps” of at least some displaced workers and increase their earnings, Robert LaLonde of the University of Chicago and Daniel Sullivan of the Federal Reserve Bank of Chicago wrote in a recent paper about retraining. “Although workers may still experience significant earnings losses relative to their previous positions, training can be a socially desirable investment that can help trim these losses, and can have positive effects on their communities.”

Washington state, for example, on the northwest US coast, has what is known as a “workforce training and education coordinating board” that works with 34 community colleges and technical schools throughout the state. The students, who numbered nearly 11,000 last year, include laid-off workers learning new skills and employed workers receiving “upskilling” to move their careers to the next level, according to Kendra Hodgson, policy associate with the board.

“The bedrock mission is to educate people to a higher level of skill and knowledge,” Hodgson said, adding that businesses work with individual colleges to produce curricula that meet their staffing needs. For example, when local hospitals reported a severe shortage of nurses a decade ago, she said, a number of schools geared up to teach nursing until the shortages were addressed.

**MISMATCHED JOBS AND TRAINING**

Europe has the most elaborate training opportunities, thanks to the region’s taxpayer-financed social welfare programs, which are far more generous than those in North America and Asia. The European Union has set a target for at least 40% of its population aged 30-34 to be qualified to...
Automation, artificial intelligence and robots are increasingly replacing workers in performing routine tasks.

Image © Vladyslav Otsiatsia / iStock

“There is some debate about whether people are doing [retraining in] the right thing, because we still have shortages in science, technology, engineering and mathematics.”

Steven Bainbridge
Vocational Expert, European Centre for the Development of Vocational Training
at least a university-level education by 2020, said Steven Bainbridge, vocational expert at the European Centre for the Development of Vocational Training, which is known by its French initials, CEDEFOP, and is based in Thessaloniki, Greece. He said that the EU will probably exceed its target.

“We’ve succeeded in raising the qualification levels but there is some debate about whether people are doing [retraining in] the right thing, because we still have shortages in science, technology, engineering and mathematics,” Bainbridge said. “On the other side, we’ve had a rise in people who are overqualified for their jobs.” One reason, he said, is that during the recent recession, when highly skilled workers were willing to take jobs below their skill levels, employers were in hiring mode.

Retraining adults who lost jobs due to automation is “another major problem we have,” Bainbridge said. Publicly funded training programs often are not linked to the labor markets to determine which skills are in greatest demand and then train displaced workers for those jobs.

As a result, some companies in Europe are taking measures into their own hands. Vattenfall, a leading Swedish electricity generator, set up an internal support organization for 445 laid-off workers and provided SKR 205 million (US$23.7 million; €21 million) to provide them with vocational training. The workers received a skills assessment; a tutor then created a specialized course of study for each worker.

PUBLIC-PRIVATE PARTNERSHIPS

One of the most elaborate training programs in Europe is Germany’s vocational program, which is tracked and measured by BIBB. BIBB sets standards for the country’s elaborate system of apprenticeships, a dual system of vocational high schools and universities working with companies for on-the-job training.

BIBB currently is drawing up plans for determining the job qualifications for Industry 4.0, also known as “hyperconnected industry” or the Industrial Internet of Things (IIoT), said Gert Zinke, a BIBB spokesman.

“The new qualification requirements demand a comprehensive understanding of systems and processes, which are not now being addressed by the firms providing the training,” Zinke said. Since robots are doing much of the actual production work, jobs also will require employees to be skilled in topics that include robot maintenance and repairs, factory scheduling and operations planning. The new curricula should be finished, he said, within the next two years.

Many German companies, however, are already designing and building their machines for the IIoT and connecting existing machinery to the IIoT for predictive maintenance. (See “From Equipment to Outcomes” on Page 68 and “A Model in the Making” on Page 66)

ONGOING CERTIFICATION

Another issue being hotly debated involves ongoing training for workers to ensure their skills remain up to date, in the same way that airline pilots and specialist physicians are required to obtain yearly certification with the latest methods and technology.

Till Leopold, project leader of the human skills initiative at the World Economic Forum in Switzerland, says more industries globally are requiring continuous recertification, but that others have yet to determine which skills updates to require.

“Some industries are ahead of the curve and some are struggling,” Leopold said. Determining requirements, he said, is best left to each industry because they know better than government regulators what skills are required.

In Denmark, however, the government gives workers two weeks of training every year to ensure that their skills are up to date with global standards. In Asia, the government of Singapore, which is keen to preserve the nation’s reputation as an Asian hub of excellence, now gives workers a “SkillsFuture Qualification Award” of as much as Singapore $1,000 (US$750; €660) if they complete a job training course and receive a specialist diploma.

INDEPENDENT AND TEMPORARY

Increasingly, Leopold said, workers who still can’t find jobs are turning to hyperconnected businesses for contract work. These self-employment options include driving for on-demand car service Uber or working on a freelance basis for websites that match employers and workers for contract jobs in marketing, accounting, medical recordkeeping and other service-related fields. As a result, more employees are being held responsible for their own training.

Another trend, being reported mainly in the US and Europe, is a growing emphasis in education on outputs rather than inputs. In the future, he said, employers will be less interested in knowing applicants’ grade-point averages and the courses they took than in knowing the skills—the output—a prospective worker can deliver. This will permit employees to have more portable careers, Leopold said, because their qualifications will be more universally recognized and applicable.

Retraining adults who lost jobs due to automation is a major challenge that is likely to grow. (Image © BraunS / iStock)

Related reading
from the International Monetary Fund:
“Toil & Technology” http:/ /bit.ly/ToilFindTech
Educators use technology to bridge the gender divide

Global examination statistics reflect measurable differences between the academic achievements of boys and girls, and boys are lagging. By using electronic tablets and interactive games in the classroom, however, educators have new tools to help boys reach their full academic potential.

by Sean Dudley

The evidence is everywhere:

Traditional schools are failing to educate boys as effectively as girls. Just consider:

• A 2010 report issued by the Center on Education Policy, an independent U.S. research organization, confirmed that boys have fallen behind in reading in every single U.S. state. It found that in elementary schools, about 79% of girls could read at a level deemed “proficient,” compared to just 72% of boys. Similar gaps were found in middle school and high school.

• Statistics from a Jamaican Ministry of Education report show that at Grade 4, 81% of girls mastered tests in literacy, compared to 59% of boys. Meanwhile, 55% of girls excelled on mathematical tests compared to just 36% of boys.

• In 2012, the Joint Council of Qualifications in the UK stated that 73.3% of girls achieved passing grades in their secondary school exams. The proportion of boys achieving the same was just 65.4%.

• In France, there has been a steady gap of between 4 and 5 percentage points in results between girls and boys in the French diploma of secondary education and vocational training.
In fact, according to the French Government’s Ministry of Education, males have consistently lagged in this examination for the past 20 years.

**A DETRIMENTAL DYNAMIC**

Michael Gurian’s groundbreaking book *Boys and Girls Learn Differently!* suggests that “two areas of greater functioning in the female are memory and sensory intake. Comparable greater functioning in the male is in spatial tasks and abstract reasoning.” In short, Gurian implies that boys and girls could benefit from being educated in different ways that support their natural ways of receiving and interpreting information.

“In short, Gurian implies that boys and girls could benefit from being educated in different ways that support their natural ways of receiving and interpreting information.”

**“GENDER-BASED LEARNING HAS BECOME AN ACCEPTED REALITY, AND HAS HAD PROFOUND IMPLICATIONS.”**

**MICHAEL GURIAN**

AUTHOR OF "BOYS AND GIRLS LEARN DIFFERENTLY!"

But this isn’t how most students are taught. “Education has been the same for the past 100 years or so,” said Dr. Alison Carr-Chellman, professor of Education at Pennsylvania State College of Education. “This sees a teacher stand in front of a group of children and deliver information or experiences, and then that child is moved on to the next class. This is not a productive or good way of schooling, particularly in the information age.” The problem is widely recognized. Increasingly, technology is seen as a means to improve engagement with boys. In line with Gurian’s findings, technology solutions offer significant advantages in visual and spatial learning, increasing the opportunities to better engage boys in the classroom.

**ENRICHING THE EXPERIENCE**

Visual technology solutions such as interactive whiteboards, which incorporate video, sound, photography and live Web activity, address boys’ preferences for visual learning. Tablets and touchscreens, too, are gaining traction in the classroom, with several schools already reporting good success.

“There is simply something about the ability to manipulate images and text on a screen and create unique responses to assignments that boys latch onto in a way that staring at a blank piece of paper can never hope to match,” said Betsy Weigle, an elementary school teacher in Spokane, Washington, USA.

Weigle, who runs www.classroom-teacher-resources.com, a website devoted to supporting teachers and providing interesting and useful content for those in the profession, is using Apple iPads and smart-screen technology with her students. “A problem boys have is that they struggle to sit still for long periods of time, and a visual solution like the iPad can help with this,” Weigle said. “Any time a teacher can do more than simply talk at their children, especially boys, they will find that they retain information much better.”

Cedars School of Excellence in Greenock, Scotland, was one of the first in the world to deploy electronic tablets to every pupil. Since the tablets were introduced, teachers have observed a marked improvement in the concentration and attainment of boys. Teachers also have highlighted the ease with which students can conduct research and develop their digital literacy skills, providing an equal playing field for both genders and allowing males to benefit from their strong visual learning capabilities.

In another example, Coedcae School in Llanelli, Wales, has purchased two iPads for the school library. The school is using the devices primarily as electronic books to encourage boys to read more.

**SPATIAL SOLUTIONS: INTERACTIVE LEARNING**

Educational games play a major part in the interactive learning solution field. For example, Nimero, a Bulgarian educational software company, creates games that combine visual and spatial learning with literacy and puzzle solving – tapping into boys’ more inherent learning processes. Nimero’s primary-level mathematics game Jumpido, for example, uses whole-body interaction in a series of exercises and games, providing a kinesthetic and competitive element that is particularly suited to engaging boys in learning.

“Jumpido better engages boys in the classroom, both mentally and physically,” said Kiril Rusev, CEO of Nimero. “The kinesthetic and spatial elements of Jumpido naturally align with the brain processes of boys, and allow for an interactive element that traditional teaching methods don’t offer to the same degree.”

**72%**

*A 2010 report found that in elementary schools, about 79% of girls could read at a level deemed “proficient,” compared to just 72% of boys.*

**CENTER ON EDUCATION POLICY**

In Manhattan, New York (USA), Quest to Learn is a school with a unique view on incorporating technology in the classroom. The school promotes a vibrant learning community that uses the underlying design principles of games to create highly immersive, game-like learning experiences. The project was the brainchild of digital games designer Katie Salen. The school’s dogmatic approach to gaming as a form of education sees technology present in an array of forms with multiple purposes. With technology and gaming so central to this method of education, boys have an opportunity to use their natural brain functions and gain pleasure and enjoyment from education.

**MAKING A DIFFERENCE**

With an increasing range of interactive and innovative education tools available on the market, teachers now have a better chance of tapping into the natural learning instincts of boys more successfully.

“Gender-based learning has become an accepted reality, and has had profound implications on how classrooms are designed, built and used – from kindergarten to college,” Gurian said. “A powerful nexus of social change has been building, one in which girls’ and boys’ issues can be dealt with concurrently.”

---

---
GOLDIEBLOX: GEARED FOR GIRLS

Engineering—it’s a man’s world, but Stanford-trained engineer Debbie Sterling aims to change that with her newly launched GoldieBlox line of engineering toys for girls. Yes, they’re cute. Yes, they’re pretty. But it’s the storybook that goes with every building project that taps girls’ strong verbal skills, making GoldieBlox uniquely tuned to the way girls learn.

by Rachel Callery

Boys like blocks. Girls like books. From the time children are toddlers, this simple gender tendency dictates that 89% of the world’s engineers will be male. But can a world desperate for engineers afford to write off the creative problem-solving potential of half the population before they’re two?

Debbie Sterling, one of the rare girls who grew up to be a professional engineer, believes it can’t. And so she set out to discover the missing link that would guide girls toward an interest in engineering and building. The result is GoldieBlox, a new line of construction toys built on the storybook adventures of Goldie, an inventor heroine who sets out to solve practical engineering problems with the help of her friends. As they read the books, girls get to build what Goldie builds and then set their “machines” in motion to see how they work.

“Growing up, I was always intimidated by the word, ‘engineering,’” Sterling said. “I thought it was just for boys. I’m creating GoldieBlox so that girls, from a young age, can learn that engineering is for them too. By incorporating a female role-model character, storylines girls can relate to, and a sense of humor, GoldieBlox will lessen the intimidation factor and get girls excited about building.”

By combining girls’ natural love of books with an interactive engineering toy that girls assemble as they read, GoldieBlox takes a novel approach in enticing girls to play with construction toys. “It all comes down to one simple thing: boys love building and girls love reading,” Sterling said. “GoldieBlox combines spatial plus verbal because girls want to know why they are building.”

Sterling noticed the engineering gender gap in her program at Stanford. The imbalance gnawed at her for years before she got the inspiration for GoldieBlox and set out to make it a reality. The delay turned out to be providential: By the time Sterling was ready to launch her toy, the Internet offered her an innovative way to finance her venture – with “crowd-funding.” After testing her prototype on more than 100 children, Sterling posted a video on Kickstarter, an online funding platform for creative projects, with a simple request: If viewers believed in what she was doing, Sterling asked them to order and pay in advance for her then non-existent product. In less than 30 days she raised US$250,000—almost double her goal. The first series of book-plus-toy flew off the virtual shelves, selling out before its February 2013 launch.

The prototype was not only well-received by children (ages 5-9), but also by the World Maker Faire, a showcase in New York for do-it-yourself products, where it won Editor’s Choice. As GoldieBlox expands into a series, new engineering principles will be introduced, with lessons around wheels and axles, pulleys, force, and friction. GoldieBlox also will be available as an e-book download for iPad and iPhone with narration and animation to enhance the building experience.

Meanwhile, Sterling has been approached by major distributors interested in stocking the toys.

“With GoldieBlox, girls get to solve problems and develop spatial skills,” Sterling said. “I want her to explore every opportunity and believe she can be anything when she grows up, because every girl you know is more than just a princess.”

For more information:
www.goldieblox.com
Ahem, listen.

I like reading, in
But I like building.
So if you see
this symbol,
try to do
what I
Universal education is one of the eight Millennium Development Goals established by the United Nations in 2000. The aim is that by 2015, every boy and girl around the world will have access to a full course of primary school education. But recent reports indicate that this goal won’t be achieved in the three years that remain.

by Jacqui Griffiths

UNIVERSEAL EDUCATION

UN’s Millennium effort likely to fall far short

In 2000, the United Nations (UN) member states agreed that ensuring every child on Earth access to a full course of primary education was vital to the organization’s goal of lifting 500 million people out of poverty by 2015. Today that education goal, one of eight Millennium Development Goals set by the UN, is in jeopardy. In the early going, progress was encouraging. The number of primary school-aged children worldwide who were not being educated fell from 108 million in 1999 to 61 million in 2008, a decrease of nearly 44%. But in 2012, with just three years left to meet the goal, the tenth Education for All (EFA) Global Monitoring Report found that progress has stalled at 61 million. What’s more, millions of children who do attend school are not learning due to too few teachers and poorly trained ones.

AN UPHILL CLimb

One reason progress stalled is that the easiest groups to help have all been reached. “It is now the most vulnerable and marginalized that are most at risk of not getting into school or not completing primary school,” said Pauline Rose, director of the EFA Global Monitoring Report for the UN Educational, Scientific and Cultural Organization (UNESCO). “They could include migrant children who move around with their families and need a school that moves with them. A large number of the children out of school are likely to be children with
disabilities. The school environment in many countries is just not accessible in many ways to those children, and that needs to be addressed.”

Reaching such populations with education is possible. Rose points to successful initiatives from government and non-governmental organizations (NGOs). For example, in East Africa, NGOs Camfed and BRAC, (which formerly stood for Bangladesh Rural Advancement Committee), are working to educate rural girls, then help them to start businesses. In Bangladesh, a project by non-profit organization Shidhulai Swanirvar Sangstha is providing solar-powered floating schools to reach children from flood-prone river communities. “But initiatives like these are not happening on a large enough scale,” Rose said.

FINDING FINANCE

Since 2000, abolishing school fees has been particularly successful in increasing the number of children in school. “Over 55 million more children are in school today, and one of the main reasons for this is that user fees have been abolished in many countries,” said David Archer, head of Program Development at international anti-poverty NGO ActionAid. “In the past, children in 92 countries had to pay to go to primary school, but in the last decade these fees have been removed. In Tanzania and Kenya alone, 4 million more children enrolled in school since the fees were abolished.”

If the money to fund education doesn’t come from school fees, however, who will cover the gap? Not international aid donors, it seems. Rose noted that stagnation has coincided with freezes or cutbacks in education funding from international aid donors. “This has a massive impact on some of the poorer countries whose governments are the primary funders of education but who have needed aid support,” Rose said. “And where fees have been abolished, they need even more financing.”

In addition, Archer said, more funds are needed to ensure that universal education is not just available, but of high quality. “If you have millions more children enrolling in school you need to employ more trained teachers – otherwise the quality of learning outcomes will fall,” he said. “Today, 250 million children who are in school are not learning because of large class sizes and under-trained teachers working in impossible conditions.”

PRIVATE-SECTOR CHAMPIONS

The EFR Global Monitoring Report identifies a key role for the private sector in helping governments fund education. “Increasing private-sector support for education could make a big difference,” Rose said. “In health, for example, Bill Gates – Microsoft founder and co-founder of the Bill and Melinda Gates Foundation – has had a massive impact. But we don’t have a Bill Gates in education, so we need the private sector to champion our goals.”

61 million
The number of primary school-aged children worldwide who receive no education.

EDUCATION FOR ALL

The private sector does help, but it’s not enough, Rose said. “Some private-sector organizations already provide funding, whether through a foundation such as the MasterCard Foundation or through IT support such as Intel and Cisco. But overall it’s a very small part of what’s given to education in developing countries; it’s around 5% of what aid donors give.”

Like Gates, private donors tend to favor health at the expense of education, but the two issues are closely related. “If all children are in school and learning, the impact is dramatic in terms of improved health for this and future generations, increased women’s empowerment, improved productivity, reduced rates of HIV, greater active citizenship and democratic accountability,” Archer said.

REGAINING MOMENTUM

The outlook for achieving universal primary education is still an open question, but new efforts are being made to regain momentum. For example, UN Secretary-General Ban Ki-Moon’s recently launched Education First initiative aims to rally nations, private companies and foundations worldwide for a final “big push” towards 2015 and beyond. Over the next five years, the initiative aims to put every child in school, both by ensuring that quality, relevant and transformative education is at the heart of social, political and development agendas worldwide, and by generating funding for education through sustained global advocacy efforts.

The next annual EFR Global Monitoring Report, due in late 2013, will look at past trends, particularly in terms of the most vulnerable groups, to suggest a viable date for achieving the Millennium education goals. “We need to start planning for what comes after 2015, but that shouldn’t mean that we take our foot off the accelerator now,” Rose said. “We need people to step up to the mark of supporting education.”

Useful Links:
ActionAid: www.actionaid.org/education
Education for All: bit.ly/eHUYzr
Education First: www.globaleducationfirst.org

EDUCATION FOR ALL
Education for All is a global movement to ensure quality basic education for all children, youths and adults. It was launched in 1990 at the World Conference on Education for All by 155 countries and international organizations. To meet these commitments by 2015, six key education goals were identified at the World Education Forum in 2000. UNESCO currently leads global efforts to achieve these goals.
ENGINEERING GENDER DIVERSITY

Female educators are inspiring women to study for and succeed in engineering careers

Demand for engineering skills is rising but women continue to avoid the field, representing only 20% of engineering students and 10%-20% of working engineers worldwide. To encourage the diversity that improves problem-solving, engineering educators are working to lower the barriers and inspire more women to choose careers in engineering.

by Jacqui Griffiths

When Ditiro Setlhaolo was a first-year student in telecommunications engineering at the University of Botswana, one lecturer’s negative preconceptions about female engineers almost made her abandon the field. Instead, she switched to electrical engineering. Today, she is a consultant in demand-side energy management and an electrical engineering lecturer at the University of Botswana who works to inspire and support other women in engineering.

“Girls should not believe people who say that women are not clever,
because I am evidence that women can reach far,” Setlhaolo told the Nigeria-based African Women in Science and Engineering (AWSE) organization in 2016.

Despite such success stories, gender biases, lack of role models and negative messaging about women’s “brilliance” relative to men’s continue to suppress the number of female engineers worldwide. The United Nations Educational, Scientific and Cultural Organization estimates that women – more than half the world’s population – hold at most 20% of the world’s engineering jobs. The European Union (EU) reports that female scientists and engineers accounted for just 2.8% of the labor force of EU-28 countries in 2013, compared to 4.1% for men.

Graduation rates won’t change those numbers any time soon: the American Society for Engineering Education says that just 21.4% of US engineering undergraduates in 2014 were women; in the EU, 19% of bachelor’s degrees in science and engineering were awarded to women in 2014-15.

But female engineering educators are working to change the trend.

“The work that engineers do shapes the future of our world and our society in many ways,” said Beth Holloway, assistant dean of engineering for undergraduate education and director of the Women in Engineering Program (WiEP) at Indiana’s Purdue University. “It’s hard to fathom that all of the most creative, innovative ideas for the future will come from just one half of the population – men. Diverse perspectives are needed to fully optimize solutions, consider new ways of approaching a problem, consider potential unintended negative consequences of a solution or design and fully understand diverse customer needs and wants.”

A TRIO OF HURDLES

A 2016 University of Washington (UW) study identified three main factors that drive women away from engineering: a masculine culture that signals – accidentally or intentionally – that women do not belong; a lack of sufficient pre-college exposure to the subject; and gender gaps in beliefs about innate ability.

“Students are basing their educational decisions in large part on their perceptions of the field,” Sapna Cheryan, the report’s lead author and a UW associate professor of psychology, told the UW Today website. “Not having early experience with what a field is really like makes it more likely that they will rely on their stereotypes about that field and who is good at it.”

When a woman does choose to study engineering at the university level, discovering that she is the rare female in her classes may drive her away, a pattern repeated if she prevails and joins an engineering workplace, said Nilanjana Dasgupta, a professor in the Department of Psychology and Brain Science at the University of Massachusetts at Amherst.

“Belonging really determines whether you stick it out in a field that interests you,” Dasgupta told the National Science Foundation, the US government-funded agency that supported her research. “You feel a sense of camaraderie and comfort, or you start losing interest, confidence, and start thinking about leaving for another field.”

Engaging men in the cause, therefore, is as important as inspiring women, Holloway said.

“Many men are not fully aware or do not fully understand the challenges that women in engineering may face, but would be advocates and allies for gender equity if they did,” Holloway said.

BREAKING BARRIERS

Recruiting women into engineering is a challenge that must be addressed before, during and after students enter a university, Holloway said.

“We work with pre-college students to try to spark and nurture an interest in engineering, show them positive role models and counteract the less appealing stereotypes of engineers and engineering,” Holloway said. “For our college students, WiEP provides opportunities to engage with mentors and role models and to create a community of support with peers and professionals. We talk about how gender can play out in the workplace and discuss strategies and approaches to mitigate some of those barriers.

“IF COMPANIES WANT MORE MIXED TEAMS – AND IT HAS BEEN PROVEN THAT A MIX OF GENDERS GIVES EFFICIENCY – HALF A DAY SPENT VISITING STUDENTS CAN DELIVER HUGE VALUE.”

Anne-Marie Jolly
Founder, Ingénieur au Féminin

“We’ve also worked on improving the climate in the College of Engineering to be more inclusive and welcoming to all our students. Across all our work, we use strategies that are proven effective through research, and we work to add to the research literature by doing research of our own.”

“Engaging men in the cause, therefore, is as important as inspiring women,” Holloway said.

“Many men are not fully aware or do not fully understand the challenges that women in engineering may face, but would be advocates and allies for gender equity if they did,” Holloway said.
said. “We need to be able to have open and honest conversations about unconscious bias and continue to work together to create inclusive organizations where everyone feels a sense of belonging and value.”

Rehema Ndeda, a member of the RWSE, said the profession also needs to address stereotypes such as “the archaic picture of engineering as dark factories, which is unappealing to girls.”

Setlhaolo agrees. When she speaks to school groups, girls routinely ask her if an engineering career would require them to wear overalls and look greasy. “Society does not have a clear understanding of what engineering is and the different branches of engineering,” she said.

INSPIRING MINDS

Role models are essential in battling stereotypes and communicating not only what women can achieve in engineering, but also what the field can give to them in return.

“Engineering is such a diverse profession that it can be fitted to various expectations of the different periods of life,” said Anne-Marie Jolly, vice president of the Commission des titres d’ingénieur (CTI), a France-based organization focused on science and engineering, and founder of Ingénieur au féminin, which supports efforts to encourage and motivate women in engineering. “It is rare to have a profession where, with the same education, you can work abroad or at home, engage in research or go into production management.”

Without role models to show them the way, few women think of becoming engineers.

“The fact that most of the girls go to engineering domains where there are already many women [59% in chemical and agricultural engineering schools] and not to fields where they will be paid as much as boys and where enterprises wait for them [15% in transportation systems, 17% in computer sciences and 19% in electronics] is symptomatic,” Jolly said.

Jolly works with two French engineering associations for women – L’association Française des Femmes Ingénieurs and Femmes & Sciences – to shift the balance by visiting colleges and high schools, providing young women with perhaps their first exposure to a female engineer.

“I explain what engineering is and the pleasure I have gotten from it, and I am joined by younger women engineers or engineering students from the Femmes Ingénieurs association or the Femmes & Sciences association,” Jolly said. “If companies want more mixed teams – and it has been proven that a mix of genders gives efficiency – half a day spent visiting students can deliver huge value.”

NURTURING DIVERSITY

Across Germany, universities and engineering departments routinely offer motivational programs for women interested in engineering, which exposes students to the universities’ female engineers.

“Universities all over Germany offer summer programs, mentoring, girls’ days and other activities to attract young women,” said Susanne Ihsen, professor of gender studies in science and engineering at Technical University of Munich (TUM). “There is also a lot of activity, such as role models from industry, to keep female students in the programs.”
Students’ attitudes are not the only ones that need to change, Ihsen said. Educators, too, like Setlhaolo’s first-year lecturer, need to look at how they teach engineering.

“Activities in cooperation with other disciplines focus on the central problems in changing traditional, male-dominated cultures like engineering,” Ihsen said. “They help to sensitize engineering professors to gender and diversity needs so they can analyze courses in terms of bias, undertake diversity-oriented marketing activities and so on. In my own teaching, I use topics that will interest future engineers, such as Engineering 4.0, which discusses the changes in industry and society and the expectations of employers, customers and citizens.”

MENTORING SUCCESS

In Africa, additional cultural barriers further complicate the challenge of attracting women to engineering. In Botswana, for example, fewer than 2% of engineering students at university are female.

“Economically, in most cases where there is limited funding, the male child will be chosen to pursue a science-based degree, since there is the notion that the girl will probably fail,” RWSE’s Ndeda said. “Other barriers are attitudinal, with girls believing that they are naturally weaker than boys in science and mathematics subjects. These barriers need to be addressed in order to encourage more women to pursue engineering education.”

Role models and mentoring are central to RWSE’s work to break down those barriers.

“Our mwaliimu (Swahili for “teacher”) project, conducted in several high schools in Nairobi, aims to train teachers on how to teach girls and encourage them into science, since they are the earliest science role models,” Ndeda said. “Through this project, there has been an increased number of students passing mathematics and science [and] having the opportunity to pursue engineering.”

Mentoring is a critical factor, even after a female engineer enters the workplace.

“It has become increasingly apparent that the presence of a mentor in the workplace tends to encourage women to continue in these careers and even become leaders in their fields,” Ndeda said. “Recently, we worked with Kenyatta University through their Female Enhancement in Science and Technology (KUFEST) program on mentorships. Most of the scientists mentored are currently working in industry and are motivated to continue so.”

“Universities all over Germany offer summer programs, mentoring, girls’ days and other activities to attract young women” to engineering careers.

SUSANNE IHSEN
PROFESSOR OF GENDER STUDIES IN SCIENCE AND ENGINEERING, TECHNICAL UNIVERSITY OF MUNICH

The United Nations Educational, Scientific and Cultural Organization estimates that women – more than half of the world’s population – hold at most 20% of the world’s engineering jobs.

Each country faces its own challenges in encouraging and supporting women in engineering, but concerted efforts to help women understand that success is possible and that employers need their insights are beginning to make a difference. With encouragement and inspiring role models, more women will find the confidence to join Ditiro Setlhaolo in rejecting discouragement and making a positive contribution to engineering.

For more information:
http://3ds.one/academia
IF WE want to learn together, can the world be our classroom?

3D virtual learning – a dream our software helps bring to life.

Innovative thinkers everywhere use the 3DEXPERIENCE® software platform from Dassault Systèmes to explore the true impact of their ideas. Insights from the 3D virtual world allow students to share ideas, collaborate and learn together – wherever they are in the world. One question remains: How much more could we learn outside of school?

It takes a special kind of compass to understand the present and navigate the future.

Discover more: ACADEMY.3DS.COM
Our 3DEXPERIENCE® platform powers our brand applications, serving 12 industries, and provides a rich portfolio of industry solution experiences.

Dassault Systèmes, the 3DEXPERIENCE® Company, provides business and people with virtual universes to imagine sustainable innovations. Its world-leading solutions transform the way products are designed, produced, and supported. Dassault Systèmes’ collaborative solutions foster social innovation, expanding possibilities for the virtual world to improve the real world. The group brings value to over 210,000 customers of all sizes in all industries in more than 140 countries. For more information, visit www.3ds.com.