

# The Internet of Everything: Fueling Educational Innovation

Education and the Internet are explicitly linked to global economic development, innovation in industry, and an engaged, productive society. Greater connectivity and technological advancement have enriched and expanded education for us, brightening its promise for personal growth and discovery, satisfying career possibilities, and potential financial success. At the same time, technology is changing our world faster than ever before, so it is imperative for each of us to continue to acquire the knowledge and skills we need to grow. It is also critical for both government and corporate leadership within each industry to empower individuals to make sense of societal and technological changes, and take advantage of them to transform industries and solve the world's biggest problems.

The Internet of Things (IoT) era that we have entered is a current force of change that is connecting more and more things to the network, deriving more and more data from the network, and, if we extend the definition to the Internet of Everything (IoE), allowing people, processes, and things to harness that data to improve decision making for organizations

and assist us in our daily lives. Cisco believes that the 13 billion Internet-connected devices in 2013 will be 50 billion by 2020.

The workforce of the future will be an IoE and digital-savvy workforce. Youngsters coming up through the ranks will be more acclimated to a vastly interconnected life than those who have not grown up with it, yet they will still need both technical skills and business skills to be successful in the new world. And, those already in the workforce will need to find ways to further their growth and talent development if they are to take advantage of the technology of IoE and the greater presence of IT in their lives.

## Skills Needed by an IoE Workforce

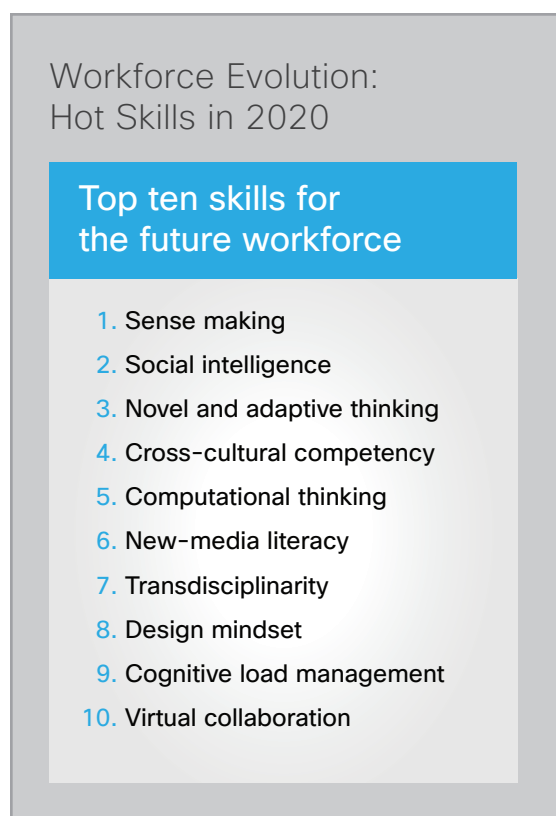
In today's interconnected, globalized, knowledge economy, know-how and expertise are as important as economic resources. Figure 1 below presents core knowledge skills required in the workplace today—skills that many educators today are beginning to build into their educational programs:

Figure 1. Critical Skills in the Knowledge Economy

Critical Skills in the Knowledge Economy		
21st Century Skills	Global Leadership Skills	Entrepreneurial Skills
<ul style="list-style-type: none"><li>• Critical thinking</li><li>• Collaboration</li><li>• Communication</li><li>• Creativity</li><li>• Problem solving</li><li>• ICT proficiency</li></ul>	<ul style="list-style-type: none"><li>• Global mindset</li><li>• Languages proficiency</li><li>• Cultural awareness</li><li>• Team player</li><li>• Professionalism</li><li>• Work ethics</li></ul>	<ul style="list-style-type: none"><li>• Opportunity recognition</li><li>• Self-direction</li><li>• Persuasion</li><li>• Planning skills</li><li>• Risk taking</li><li>• Resourcefulness</li></ul>

In addition, Figure 2 shows 10 overarching skills that will be needed by those in the workforce to be readily adaptable to the changes ahead.

Figure 2. Workforce Evolution: Hot Skills in 2020



Source: [Future Work Skills 2020, Institute for the Future and Apollo Research Institute.](#)

Because so much of the world's knowledge is now within reach of our mobile devices, what becomes paramount to teach then is not so much retention of this knowledge but how to analyze, evaluate, and use all the information, relying on critical thinking, collaboration, and social skills to make decisions.

IoE facilitates this more powerful kind of learning by giving us a richer, deeper network to tap into and take advantage of. Anywhere in the world where there is sufficient bandwidth, we can have more immersive, interactive, engaging, real-time learning experiences with each other.

New job roles for IoE will be in demand, such as cloud architect, cybersecurity specialist, data scientist, mobile application developer, and network programmer. World Bank studies estimate that during the next 10 years, there will be two million unfilled ICT-related jobs globally. To connect the unconnected, it is estimated that 220,000 new engineers will be required every year from 2014 to 2022 to manage the vortex of connected devices.

Education will need to adapt to quickly provide the skills needed for the IoE future. Leah Jewell, Managing Director of Workforce Readiness at Pearson, believes one step is to use IoE to better connect industry and employers to learners and academic institutions to highlight the skills needed and the pathway to future jobs. "There is a gap between what employers are looking for and the skills being developed," she says, "but there is an opportunity to use IoE to connect the demand side to the supply side in ways that facilitate better early training around high-demand occupational skills as well as twenty-first-century skills."

## Scope of This White Paper

This white paper aims to look at what a number of educational institutions and companies are currently doing or investigating to utilize the Internet of Everything to make learning an experience that stays in tune with the needs of the new era. The work of Udacity and Xerox in the corporate arena, Stanford University and Massachusetts Institute of Technology (MIT) in the realm of higher education, and The New York Academy of Sciences (NYAS) in the K-12 sphere will be discussed in the sections that follow.

The first section will review how Udacity has evolved from offering traditional massive open online courses (MOOCs) to focus on corporate training and how Xerox is utilizing its devices to deliver instruction and tech support, and employee-generated video to provide learning over the network at the moment of need. The higher-education component of the paper will look at how Stanford is focusing on the data that comes from MOOCs in search of more innovative teaching practices and how MIT is using MOOCs to scale education to different needs. The K-12 section will describe how NYAS is fostering the built-in affinity of kids toward IoE and how NYAS and Cisco have partnered in the use of a virtual collaboration solution to further global science, technology, engineering, and mathematics (STEM) development.

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In addition, the white paper will visit some of the more recent forays into the use of virtual reality around training and education, as well as other innovations that focus on the network to make learning stimulating and relevant.

## The MOOC Journey at Udacity: An Increasingly Corporate Focus

In the couple years since the *New York Times* labeled 2012 “the year of the MOOC,” the idea of connecting a global learning audience of tens of thousands via a free online university course has evolved. Launched in 2011 as a purveyor of university-style MOOCs in addition to MOOCs tailored more for industry and corporate training, Udacity found course completion rates and pass rates to be disappointingly low with the former category. While it still serves universities, it has shifted its major focus to making online learning highly effective for corporate training.

The company doesn’t use the word “MOOC” these days to describe what it does, but its commitment is still very much to scaling education to large audiences. Udacity has had an enrollment of more than 4 million people to date (representing over 2.5 million unique users). There is an average of 15,000 to 20,000 students in any one course per month.

According to Clarissa Shen, Vice President of Business Development and Strategic Partnerships, Udacity partners with companies like Google, AT&T, Facebook, and Twitter to develop curricula to meet their educational needs on broader topics when the companies can’t do it themselves. Sometimes, according to Shen, a partner is interested in disseminating its best practices for a technology to a broad global audience, such as with a course on Android mobile development that Udacity has created with Google. At other times, a partner wants curricula targeted at meeting specific internal skills gaps that it might have. AT&T is working with Udacity, for example, on courses to upskill employees in such burgeoning areas as cloud engineering, big data and data science, software development, and web development.

All courses are open to the population at large. “We see ourselves as a new kind of university for twenty-first-century technical skills,” Shen says. “As the Internet of Things and big data and other currents converge, the reality is that

technology is changing very rapidly. It’s hard for traditional educators to keep up with that, and that’s the gap we want to fill.”

Udacity believes that an important tenet for education in this time of rapid change is that it be interactive and project-based. If you want a certificate from one of its online courses, you work with a coach on a project and get assessed and evaluated on that project. Course videos tend to be short, and the emphasis is on doing.

In Udacity courses, for example, students can find themselves building their first web crawler, their first social network, or their first mobile app within the Udacity environment. A MapReduce project involves having students work with their first big data project, performing mapper and reducer jobs on data sets so as to better analyze the data. The project-based, coach-based corporate training model has been successful for Udacity, says Shen, who indicates that the company is seeing completion rates of 60 to 70 percent, much better than with its original MOOCs. Student engagement and demand are better as well, Shen states.

Udacity also invests time in data analytics around its course offerings. The company has its own data scientists working with course developers, course engineers, and its coaching team to provide tools and data on better serving students. “The data scientist will see, for example, that students are spending a lot of time at ‘node 60’ of a course and not progressing forward,” says Shen. Armed with that information, Udacity will remedy any specific problem or perhaps introduce a new module to break the learning content up more smoothly. The IoE mechanism is strongly in evidence here: nodes on the Internet relay fine-grained data to people who can use it to make educational processes better.

One way that Udacity is aiming to be agile for those attempting to keep pace with transitions is by offering “nanodegrees,” which are six- to nine-month certification programs that demonstrate one’s acquisition of a particular skill set or readiness for a particular type of job. “These are very ‘stackable,’” says Shen, “and aimed at continuous learning, because we believe that learning is not something now where you can stand still.”

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## Xerox: Enabling the IoE Workforce with Learning at the Moment of Need

Discussion about agility and targeting the skills one needs leads to another important tenet for education in the digital age: that it come at the right time in the right form.

IoE is driving companies to embed just-in-time training directly into the connected devices that they create. An example is Xerox Corporation, which, with its “next-generation remote services,” builds contextual help guide information into its multifunction devices so that users can learn how to fix a specific problem immediately at the point of experiencing it. Beyond this capability, however, because the multifunction device is equipped with Voice over IP (VoIP), Xerox customers can also use the machine to reach 24-7 live helpdesk support. The helpdesk technician will be able to view exactly what is going wrong with the customer’s machine and walk the individual through correction procedures.

“The highest and best use of IoE in our view involves humans and devices working together. When we have the ability for devices to do machine-to-machine communication, that’s good; however, we feel that when there is also room for human analysis and review, interpretation of that information, and the ability to act upon that, that’s a big value,” says Sanjay Parker, Director of Thought Leadership, Xerox Learning Services. Xerox Learning Services provides customized and corporate learning solutions to execute business strategies, and operates as a subsidiary of Xerox.

For Xerox, the tech-to-user interaction available with its multifunction devices enables them for IoE by incorporating “just-in-time” learning. “When we talk about just-in-time learning,” says Parker, “we are acknowledging that very few people are ever going to take a course on a copier to learn how to use that copier. They’re going to want to go ahead and click buttons, and if they run into a problem, they want to see immediately how to get around that problem or do what they need. That’s where we create that learning content and put it around the machine itself, and make it easy to use and specific and engaging. It all gets pushed out to the device. And better to have it right there on the machine in a little screen rather than on a PC, so that while you’re there, you can learn what you need to do.”

Xerox’s effort in IoE-enabled training, where users of machines are connected to live tech support at the point where they are experiencing a problem, is also an example of learning by doing. Parker views it as an example of the “70-20-10 principle” of learning, where 70 percent of learning that truly sticks with you is the informal learning that takes place when you have a specific need or problem and go out in search of your answer, while only 20 percent comes from coaching or mentoring, and only 10 percent from taking formal classes and training.

## Employee-Created Videos: A Viral Learning Success at Xerox

Another IoE-enabled education tool at Xerox involves the ability to connect people by video over the Internet on a portal. John Leutner, head of global learning at Xerox, indicates that the company has used employee-created videos extensively on its Learning@Xerox portal to share success stories, insights, and lessons learned with fellow employees about effectively selling Xerox products and services.

While a simple, basic concept, the use of readily accessible employee videos to impart nuggets of learning around key aspects of the Xerox business has been immensely successful in terms of usage and higher levels of employee performance, according to Leutner. “We’re now seeing this collective knowledge sharing that’s happening organically, versus sending everyone off to a class,” he says.

It’s also another demonstration of the importance of learning at the moment of need. “At Xerox, we were loading people up on training—adding in this, this, and this—and then wondering why there was a breakdown in people being able to apply what they know,” Leutner states. Even though many of the videos come straight from employees and can sometimes have crude production values, their ability as learning devices to zero in on areas of importance in a fresh way gives them a relevance and timeliness that surpasses traditional training, he adds.

“Realizing that learning is part of the work, and not a separate event that you go to, is critical as we look at the future, because if you look at the high performers, the thing that stands out is their self-sufficiency. They individually ‘cracked the code’ to enable themselves to be self-sufficient. So, the

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question for a learning organization is, how do I build that level of self-sufficiency by providing the workforce the capability so that they don't necessarily have to go out and individually crack the code?" says Leutner.

## Stanford and Its MOOCs: Scaling Education for IoE

In the area of higher education, an investment in online teaching and learning continues by many institutions, including top universities such as Stanford and MIT, who helped pioneer the MOOC concept. In their ability to take advantage of the network infrastructure as a platform for offering high-bandwidth applications such as video conferencing, animations, and simulations to a worldwide audience of interconnected learners, who can share content with each other, online course modules and MOOCs are IoE-enabled endeavors.

Stanford University currently has more than 370 online offerings from all seven of its schools to support "blended" learning (the use of a combination of online delivery of course content with traditional in-classroom teaching), and makes over 50 MOOCs available to the public with titles ranging from "Mining Massive Datasets" and "Technology Entrepreneurship" to "Scaling Up Your Venture Without Screwing Up" and "OpenKnowledge: Changing the Global Course of Learning." Close to two million people have registered for the free public online courses taught by Stanford faculty via the NovoEd, Coursera, Udacity, Class2Go (Stanford's initial platform), and Stanford OpenEdX platforms. OpenEdX is the open-source release of the edX platform developed by the nonprofit organization edX, which was founded by Harvard University and MIT.

Stanford has recently used IoT instrumentation to address the challenge of how to offer lab work as part of science or engineering MOOCs. Professor Lambertus Hesselink in the Department of Electrical Engineering and his graduate students have devised a method for digitizing a physical experiment and delivering it as a virtual lab to the thousands of students enrolled in a MOOC. In addition, Professor Tiziana Vanorio in the Department of Geophysics has been working on a way for students to learn more readily how to use complex and expensive rock physics instrumentation through animations. She hopes to make the animations interactive so that students can take the instruments apart digitally to

understand how they operate. She also hopes to make these animations available online to other institutions who do not own this type of equipment.

Online courses and modules are also used at Stanford within the context of blended or "flipped" learning models, not just for MOOCs. Flipped learning is a form of blended learning in which instructors record their lecture material and provide it online for students to digest at their own pace. They then use classroom time for more dynamic learning, such as engaging with the students on homework and projects or discussing topics of concern or special importance. In this way, the classroom has been "flipped" from the more traditional model of having students sit passively in a lecture hall taking notes and then work more actively with the course content outside of class.

## Using Research Data from MOOCs at Stanford to Improve Teaching

Stanford is focusing on being research-driven in its approach to MOOCs and digital teaching and learning—directing its attention to how MOOC data collected from the Internet can be studied and used to understand better what engages learners so as to advance educational innovation and teaching practice. The sheer size of MOOCs makes them especially well-suited to serving as research labs for different teaching approaches and pedagogical techniques. While a classroom of 30 students will not yield statistically significant results as part of an experiment, a MOOC with 10,000 students will.

The platform supporting Stanford Online serves as one source of course data to improve teaching. In addition, the Office for the Vice Provost of Online Learning maintains a data portal, which offers access to raw data as it is being gathered from online course participants worldwide, and helps instructors and learning researchers make sense of it through analysis and visualization tools. The Lytics Lab is an educational research lab that focuses on data-driven design to improve online learning. Its research efforts include subjects such as mitigating attrition in MOOCs, leveraging the scale and diversity of online classes, and exploring how teams and peers help each other learn in MOOCs.

Stanford is also home to the Open Learning Initiative (OLI), which offers its own slate of free, open online courses that have been created by course development teams, including

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learning scientists who are developing and testing new theories about student learning. OLI courses provide students with targeted feedback and hints and also capture data about their course activity on the network and feed it to an instructor dashboard. The dashboard shows which concepts students are having trouble with so that the instructor can take more time to teach those concepts or tailor the instruction appropriately.

## MIT and the SPOC Alternative for the IoE Workforce

MIT and Harvard co-founded the edX consortium and online learning platform in 2012. Peter Hirst, Executive Director of Executive Education, MIT Sloan School of Management, describes edX as “an open-source technology platform for putting on MOOC courses as well as creating those kinds of courses.” Some edX courses have had 10,000 students enrolled at one time; millions of people have participated in edX since its inception. Hirst explains that while most enrollees are participating in and completing courses purely within the online MOOC context, the course content does exist as a resource for institutions, including MIT, who want to use it as “a tool for flipping the classroom.”

While MIT continues to commit to MOOCs, it has also started to explore the “small private online course,” or “SPOC” model, as well. Hirst explains that for executive development programs at Sloan, companies still want their most senior executives in face-to-face classrooms of 30 or 40, getting a personal and intensive experience with optimal knowledge transfer between participants. However, sometimes companies will want to extend the program to hundreds of individuals at the next levels in the management hierarchy beneath their senior executives. “That doesn’t scale for us in the physical classroom,” says Hirst, “and so the SPOC is a space where we can partner with our customers to explore new applications of our technologies that replicate the experience of these smaller, more senior classrooms for a larger group.”

The idea here, Hirst adds, is to be able to scale to something bigger than a traditional classroom (tens of students) but smaller than a MOOC (thousands or tens of thousands of students), something closer to hundreds of students. The SPOC would typically avail itself of the same online content as the MOOC, but, for a cost, it would also offer more instructor (or at least teaching assistant) engagement and support.

## Stanford Forays into Virtual Reality and Improving Learning

While companies and educational institutions at the forefront of digital learning such as Udacity, Xerox, Stanford, and MIT are focused these days on what they can discover from their learners’ behavior and performance in order to make learning better, they are also devoting attention to the technological potential that exists today within IoE and how it can be used to plug learners more dynamically into a networked learning experience. One of these areas is virtual reality.

Jeremy Bailenson, Associate Professor of Communication, who also heads up Stanford’s Virtual Human Interaction Lab, has initiated numerous projects to see how virtual reality affects the brain and how this information can be leveraged for learning. While constructing realistic immersive environments within virtual reality, in which participants can learn by doing, is extremely costly, Bailenson has been working on simpler uses of virtual reality that can enhance the learning experience.

One group of studies allows any teacher in a virtual classroom to exhibit “nonverbal superpowers.” For example, with “augmented gaze,” an algorithm is used to keep a teacher’s gaze upon the learner more of the time than could happen in a physical classroom with many students so that the learner stays engaged in the learning. With “digital chameleon,” or mimicry, the movements of the learner are subtly mimicked by the teacher to obtain more rapt attention and to gain social influence with the learner. Again, this teacher behavior would not be feasible in a physical classroom of numerous learners but lends itself well to the networked learning environment of a MOOC or other online course.

With facial identity capture, the instructor’s face is subtly morphed to absorb some of the features of the student so that the student can identify better with the instructor and the learning, and social influence and student trust can be gained by the instructor. This feature is particularly valuable in MOOCs, where the instructor is often speaking to students in completely different parts of the world.

The Virtual Human Interaction Lab has also worked with the concept of “stereotype threat.” In the real world, if a female engineering student walks into an engineering class where all the other students are male and the instructor is male, she might immediately feel the threat of being different from

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everyone else and this can influence learning. Virtual reality can change this dynamic by rebalancing the gender mix of people within the virtual classroom that the female student sees, creating a more reassuring environment. The same type of technique can be used around race.

## Virtual Reality Keeps People Connected at MIT

The MIT Sloan School of Management has put virtual-reality-assisted learning into play in the corporate sphere; an example is the use of virtual avatars as part of its Big Data program, “Big Data: Making Complex Things Simple.” It’s a two-day workshop focused on the management and strategy issues for a growing number of executives looking to maintain an edge on current and future opportunities related to applications of big data.

According to MIT Sloan’s Peter Hirst, the impending arrival of Hurricane Sandy to the northeastern United States during the autumn of 2012 created a last-minute situation where many people scheduled to travel to the in-person workshop were now reluctant about attending. MIT’s engineers had already been exploring the use of a virtual reality gaming platform as a business collaboration tool and had created a virtual environment from it. Faced with this new situation, they quickly worked on a method to bridge this virtual environment to the workshop’s live proceedings.

To make it work, a camera crew filmed everything taking place in the live classroom and streamed it into the virtual reality environment on a “virtual Jumbotron,” says Hirst. Inside the virtual environment, each attendee was represented as an avatar. In the physical classroom, a couple of live screens showed the in-person attendees what was going on in the virtual classroom.

Various special features added to the realistic effect. Avatars could walk up to a virtual floor mic to address the live class. The virtual classroom also used what Hirst calls “immersive 3D audio.” “Essentially, it means that the closer that you stand to someone, the louder you hear their voice,” says Hirst. “It enables you to have a cocktail party effect. You can turn your head to have a conversation with someone or move toward someone else for a conversation.” MIT’s engineering team also devised a way for live attendees to enter the virtual environment as avatars for further interaction.

Connecting people on the network in this way, while “a technological and human feat,” says Hirst, resulted in a very engaging and interactive educational experience. Virtual attendees expressed that they felt as if they were really there—much more than if they’d just been instructed to open their web browser and watch a video stream, he adds. While this was the first major application of this avatar-based virtual reality classroom, MIT Sloan now uses the platform in several of its blended and wholly online executive education courses.

Xerox is also exploring the possibilities for an enriched learning experience with virtual reality, specifically in terms of how it might use the Oculus Rift virtual reality headset, says Sanjay Parker. “Cost is a factor, but we are focused on experience. We’re finding with the Internet of Things and the explosion of bandwidth that we’re now able to enhance the experience and reduce the cost at the same time, which is a win-win for everyone,” he adds.

## Work with Younger, IoT-Friendly Learners at NYAS

While Udacity, Xerox, and MIT Sloan have been focused on ushering corporate learners into a world of increasingly digital learning, The New York Academy of Sciences (NYAS) has devoted much of its attention to students in grades K through 12. The rewards of working with this age group are inherent in their having grown up in a world with more and more connected devices.

Says Meghan Groome, Executive Director of Education and Public Programs, “There’s no need to explain to kids what the Internet of Things is. They get it; it’s their life. It’s us adults who need to have it explained. It would be great for the kids if their refrigerator talked to them and sent them a list. They would love to hack their refrigerator.”

Groome adds that while adults are focused on discovering what IoT technology is allowing them to accomplish to make their lives easier, kids see a world of connected devices that they can use to improve their community. Kids, according to Groome, are “global citizens” who like having a community, working with their friends, and improving the world. “What Internet of Things devices allow them to do is to use all of these interconnected pieces to essentially take a problem that they see in the community and solve it in a deeply personal way,” she says.

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Children participating in NYAS programs work on meaningful projects in ways incorporating IoT. For example, a group of fourth graders has “prototyped” a swallowable chip (with a battery fueled by stomach acid) to send information to them about whether their grandparents are getting enough food and nutrients. A group of seventh- and eighth-graders devastated at having lost their family photos to Hurricane Sandy has designed a waterproof keepsake box with a GPS tracker in it able to reunite them with cherished items. A 17-year-old has designed a tracking device that can be worn in a sock by his grandfather with Alzheimer’s disease to alert family members if he has wandered outside the radius of the home.

“And when you shift from the Internet of Things to the Internet of Everything,” says Groome, “one of the most valuable things I see is how the mobile phone is able to connect the kids to scientists all over the world. I can’t tell you how many times I’ve walked into a classroom, and there’s a mobile phone sitting in the middle of the table on speaker with 10 little people gathered around listening, completely wrapped up in what the shark biologist or cardiovascular surgeon is saying.” She adds that it is a lost learning opportunity that many schools do not currently allow children to bring their mobile phones into class.

Groome’s comments about children’s readiness for IoE have important implications not just for educational institutions but for the corporate arena as well. Says Learning@Cisco Director of Content Development, Drew Rosen, “As today’s youngsters enter the workforce, they are not going to want to learn in traditional ways, given that they’re already learning in nontraditional ways right now. If a company has a traditional corporate university or bricks-and-mortar classroom setup, the new employees might not thrive in that environment because that’s not how they’re learning now.”

## NYAS Turns to Cisco Collaborative Knowledge to Address STEM Skills Gap

In 2013, NYAS launched the Global STEM Alliance, an effort to scale STEM mentoring programs developed at NYAS and to galvanize support from industry, government, and nonprofits to work together to address the problem of a mounting global STEM skills gap. Through a partnership with Cisco, NYAS will aim to reach one million students in 100 countries by 2020.

In order to scale the STEM mentoring programs, NYAS is developing a comprehensive virtual learning platform to increase access to STEM programming and learning experiences all over the world. NYAS intends to utilize the Cisco Collaborative Knowledge suite of services to enable a truly interactive learning experience.

The Cisco Collaborative Knowledge offering is a collaboration and knowledge-sharing cloud-service solution. It features five components and can be deployed readily in an educational environment for keeping students and teachers connected over the network. A Mobile Sharing feature allows students to download learning material suggested by an instructor, read it on their phone, make notes about it, and share it with others on the Cisco Collaborative Knowledge platform. The Expert Discovery feature lets students find peers or instructors with a specific expertise who might be able to help them, and lets participants endorse each other as experts.

The Knowledge Center within Cisco Collaborative Knowledge is a library of valuable content to which an instructor can upload a syllabus, source materials, and extracurricular reading. The Learning Community feature allows for the creation of a social networking community, where a teacher might get a discussion going or students might talk about their homework or projects. Lastly, the Learning Management feature is a learning management system that stores available training, lets students track their progress and take assessments, and helps instructors build learning plans.

According to Celina Morgan-Standard, Senior Vice President of Global Business Development, NYAS intends to use the Cisco Collaborative Knowledge platform to enable rich, interactive learning experiences between mentees and NYAS’ network of more than 22,000 scientist members serving as mentors. It also plans to incorporate the Cisco Collaborative Knowledge content management and searching and tagging capabilities to leverage educational material developed at the Academy and create a deeper learning experience.

The first program that NYAS intends to move onto the virtual learning platform, says Morgan-Standard, is NeXXt Scholars, a one-on-one mentoring program in which STEM professional women act as mentors for primarily undergraduate Muslim women. Having the program supported by the Cisco Collaborative Knowledge platform capabilities means it can be delivered asynchronously, which will make



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it feasible for many more students and will eventually enable NYAS to scale the program to high school students as well.

Cisco TelePresence and Cisco WebEx are also part of the NYAS arsenal for facilitating training and sharing content over the network.

## Other Cisco Learning Solutions for the IoE Era

Cisco Connected Learning is another Cisco solution aimed at extending education beyond the walls of a physical classroom. It harnesses collaboration tools, Cisco WebEx, video, and mobile capability to help deliver flipped or blended educational experiences and “anytime, anywhere learning.” It helps prepare learners of all ages for IoE by facilitating learning societies that can connect on the web, in the cloud, or on their phones.

Networking advances are also making it easier to reach populations in remote areas with vital education. The Cisco Enabled Education Development CEED E/S 2700 series is a platform designed with that purpose in mind. It utilizes collaboration and live content video to create a real-time interactive environment between instructors and students who might be located far away from each other. Both parties can see each other, and raise and answer questions using the classroom equipment provided by Cisco. With this solution, the instructor can teach several classes in different locations at the same time.

JHPIEGO, an NGO subsidiary of Johns Hopkins University, has been using the Cisco Enabled Education Development CEED E/S 2700 solution to bring nurses’ training to Bihar, one of the poorest states in India. Through this technology deployment, JHPIEGO has been successful in overcoming issues of scale, quality of teaching, delivery in rural areas, and availability of teaching aids that can often burden skills providers and educators in developing countries.

## Building Talent for IoE

As IoE expands its reach during the coming years—connecting billions more devices and touching many different industries—a global talent shortage already in existence will continue to grow. According to the latest Bureau of Labor Statistics report, there are nine million people currently unemployed in the United States. Yet, a skills gap report published in March 2014

by human capital solutions leader CareerBuilder indicates that more than half (54 percent) of employers say they can’t find qualified candidates. Cisco recognizes this challenge and has been working with industry to solve it.

The Cisco education portfolio consists of more than 45 certifications and accompanying curricula that have helped the industry advance successfully through many transitions in the past, such as from the public switched telephone network (PSTN) to VoIP, and from Voice to Video and Collaboration. Focusing on job roles and their evolution, Cisco certifications help train and reskill an average of 400,000 people each year. During the past 21 years that its certification program has been in operation, 2.4 million individuals have become certified.

Cisco was the first in the industry to create social learning experiences for students, and today more than 800,000 professionals visit the Cisco Learning Network quarterly to learn, engage, and find experts. They use Cisco Learning Network as a way to understand the industry, get connected to jobs, and get access to peers who can help them discover their own path to success.

With IoE, businesses are now faced with yet another transition, one that promises not just greater connectivity but also tremendous productivity gains, process efficiencies, and business value. It is a promise that can be achieved only with a skilled and competent workforce.

In order to help create this workforce of the future for IoE, companies will need to reskill individuals who are already working in connection with industrial plants, utility networks, and transportation systems, and in crucial areas such as IT, networking, security, data analytics, network programmability, and business transformation. In addition, there will need to be upskilling around the convergence of IT and operational technology (OT) for individuals within industry and for those graduating from schools and colleges.

Cisco’s recently announced education program, the Cisco Industrial Networking Specialist certification, is a first step toward addressing the control engineer and industrial plant administrator job role. Thousands of control engineers working in industrial plants need to be reskilled in IT and networking today. The certification, which has been developed in partnership with industry, focuses on the foundational skills needed to deploy, operate, and manage industrial networks in a connected plant enterprise.

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Cisco also offers training and certification programs in security and cybersecurity, business transformation, and network programmability, all critical components of IoE.

## The Industry Talent Consortium

Cisco and the industry also recognize that the IoE talent gap needs a broader set of players coming together to solve specific challenges related to big data and analytics, security, network applications, and so on. Under the auspices of the Internet of Things World Forum, relevant participants have joined forces to form an Industry Talent Consortium that is tasked to address specific job roles and skills gaps.

The founding members of the consortium include representatives from academia (Stanford, MIT, and NYAS), who will help define what the key skills areas of focus are for IoE, that is, what to learn and how. Employers like General Electric and Rockwell Automation will provide the specific talent requirements they have as they look to hire in the IoT space. Change agents such as Cisco, Udacity, Knod, and Pearson will then provide educational curricula to help the individuals who have the background get reskilled or upskilled. And these individuals will then be connected to the employers who are looking to hire them.

The primary areas of focus for the Industry Talent Consortium in Phase 1 will be data sciences, cybersecurity, and industrial networking:

- **Data sciences:** According to CareerBuilder, demand for data scientists has increased 40 percent from April 2011 to March 2013.
- **Cybersecurity:** The 2014 Cisco Annual Security Report predicts a shortage of more than a million security professionals across the globe during the next five years. The consortium will help address this challenge by educating and certifying individuals using the Cisco Cybersecurity Specialist curriculum, which concentrates on the topics of event monitoring; security event, alarm, and traffic analysis; and incident response.
- **Industrial networking:** The skills shortage within connected manufacturing plants is also significant. Thousands of plant engineers need to be reskilled in IT and networking. Cisco and Rockwell Automation will jointly address the skills gap in the industrial networking space.

In the second phase, the Industry Talent Consortium will expand to identify and address other job roles such as application developers, process scientists, and cloud brokers in arenas such as utilities, oil and gas, mining, healthcare, and retail.

In addition, Cisco offers a global education initiative, the Cisco Networking Academy, which teaches students the skills needed to build, design, and maintain computer networks, aiming to improve their career prospects while filling the global demand for networking professionals. The program operates 9000 academies in 170 countries, and provides education to hundreds of thousands of students each year.

## A Network Infrastructure for IoE

For higher education to take full advantage of the promises awaiting it with IoE, there must be leadership from universities to invest in the necessary infrastructure, according to Cisco business development manager for higher education, Ian Temple. “Until we put into place the right infrastructure, a lot of our ideas are just ideas,” he says.

A university network infrastructure ready for IoE entails the following:

- Collaboration tools for students, faculty, and staff locally and globally, including high-end telepresence for more immersive experiences
- The necessary bandwidth in the network architectural design to accommodate extensive collaboration and communications
- High-definition synchronous and asynchronous video to broadcast outside experts
- Voice and unified messaging for centralized control of voice-mail systems and integration with email, web, and mobile clients
- Increased connectivity speed and wireless coverage across campus
- Improved delivery of a secure network, given that access must be granted to students, faculty, administration, guest researchers and instructors, visitors, and event attendees on all of their devices

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# The Internet of Everything: Fueling Educational Innovation

- Data centers that provide consistent uptime, especially given research that often involves enormous data sets requiring a large pipeline and high-performance computing resources to process them in a timely fashion
- Overall integration of network technologies for smoother, more efficient operation throughout the university system

Xerox's John Leutner sees similar infrastructure challenges at the corporate level as companies stretch to meet the requirements of IoE. Embracing the cloud infrastructure fully will be an important component in companies' ability to serve learning content quickly and manage it effectively, he adds.

## Connected and Learning for Life

As IoE offers more insertion points for technology into our lives, it is clear that learning and education will grow to become more of a lifelong process for all of us. In the face of rapid changes, people will not be able to sit complacent in the knowledge that they have acquired and expect it to remain relevant. People will find themselves needing to develop new skills more frequently as technology shifts, and, clearly, education has a continuing major role to play in staying up to date. Those institutions and companies that are looking ahead to maximizing the potential of IoE in the educational space offer us a promising glimpse of the various ways in which we can be part of the exciting changes ahead, staying connected within the digital landscape and reaping the benefits.

