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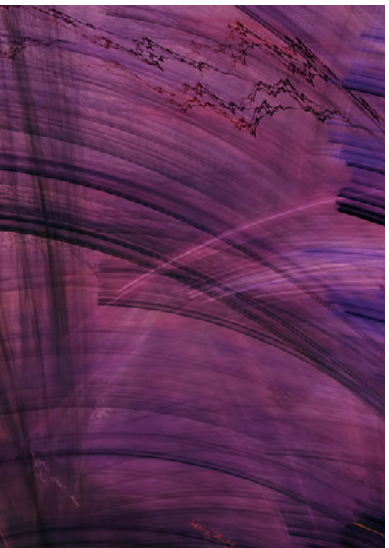

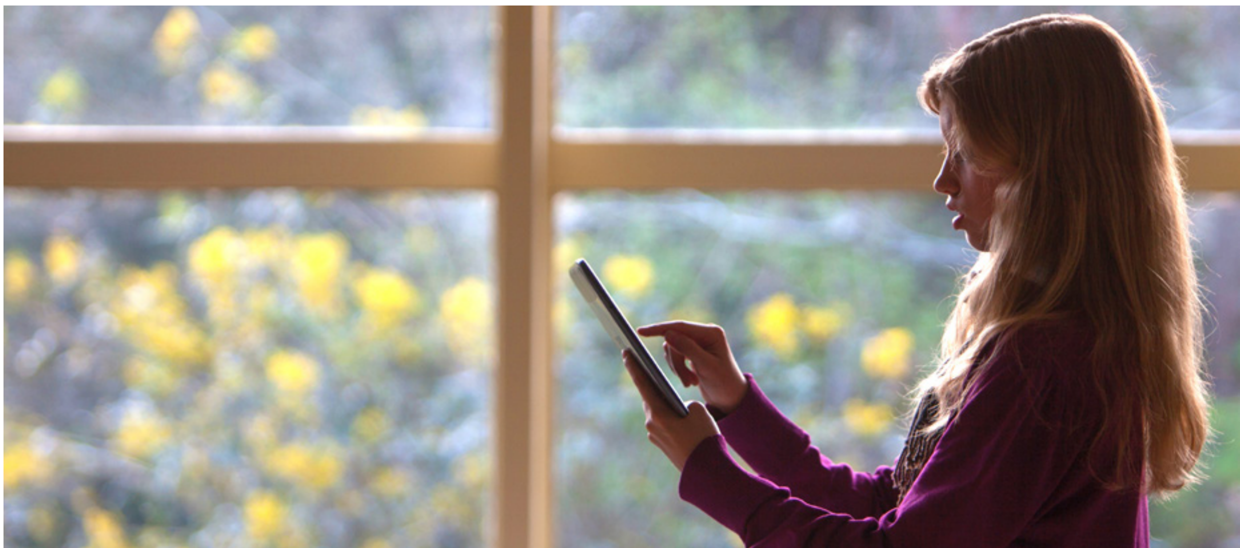

Internet of Things

October 2016 | Prepared by Clarity Innovations

Executive Summary

As technology continues to evolve, computers grow smaller and more power efficient. This means that computing devices can be embedded into all sorts of objects, from household items to clothing. For these computing devices to communicate, they must connect in some way. This connection could be to a database, a network, or other devices.

Internet of Things (IoT) technology in education represents an enormous opportunity for schools to collect valuable data and use this data to enhance the learning experience. The capabilities of "smart" objects – such as desks, light fixtures, or fitness bands — have the potential to support both teachers and students in meeting learning goals. IoT also has the potential to improve school operations overall by solving a wide array of challenges facing educational institutions, from logistics to administration to student life.

Logistically, wireless tagging technology can streamline the process of checking out books and other educational materials. In the area of administration, smart wristbands can automate the process of collecting attendance. Embedded with sensors and stored data, smart wristbands can improve student life by simplifying payment in the cafeteria and at vending machines, as well as motivating and rewarding physical activity.

Further, streamlined and optimized utilization of facilities can result in financial savings for budget-conscious schools. Automated monitoring of temperature in a cafeteria's food coolers reduces the need for regular human involvement. Schools can also achieve lower maintenance costs for heating and air conditioning systems by installing equipment with built-in wireless access. These systems can communicate remotely to an off-site service team about their status and exact nature of any performance issue. More information and advance notice can shorten repair calls and reduce the overall cost of maintenance.

The "Internet of Things" connotes the next step in the evolution of smart objects-interconnected things in which the line between the physical object and digital information about that object is blurred. A vision that began with high-tech tags for inventory has evolved and extended to include the collection and monitoring of an object's environment. In the current IoT vision, sensors give more and more things in our daily lives a "voice"; by capturing data, sensors enable things to become context-aware, providing more experiential information to help people and machines make relevant and valuable decisions. In the energy sector, the interconnected objects embedded with sensors have enabled the development of a "smart grid" to improve reliability, security, and efficiency of electricity transmission and distribution systems. In the construction and housing sector, "smart homes" and "smart buildings" integrate IoT technologies that increase efficiency, security, and comfort for inhabitants. "Smart cities" enable and enable a better quality of life. For their residents by using IoT technologies to monitor assets such as local departments' information systems, libraries, hospitals, water supply networks, waste management, and law enforcement.

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Introduction

People primarily use the Internet, specifically the World Wide Web, as a tool for communication and information gathering. Online activity mirrors much of what people do in physical space — chat, play games, share pictures and videos, and shop. In many ways, cyberspace exists as an extension of the meeting spaces familiar to people for centuries — the marketplace, town square, auditorium, library, and school. Transactions and interactions online primarily take place between people, and the information exchanged takes familiar forms such as currency, text, music, images, and video.

At the same time, Internet access, and especially wireless Internet connectivity, has elevated ordinary human communication abilities to superhuman levels. A climber atop Mount Everest can instantaneously share, on YouTube, what he or she hears and sees with millions of people simply by tapping a finger on a smartphone screen. School children in a classroom can use Google Hangouts to ask questions in real time to astronauts orbiting the Earth on the International Space Station. Inhabitants of a city affected by a devastating earthquake can use a phone to post a text message on Twitter so friends and family know that they are safe. The power to virtually inhabit two places at once, mediated by Internet-connected mobile devices, has become commonplace to billions of people. How people use their newly acquired "superpowers" has revolutionized everything from entertainment and commerce to health care and politics.

Increasingly, schools and classrooms provide wireless Internet access for mobile devices used by teachers, students, and staff. This wireless network supports the implementation of additional technologies that open up new possibilities for the teaching and learning experience on campus. Inspired by the high-tech upgrades to the data infrastructure in schools, researchers have set their sights on adding high-tech features to traditionally low-tech elements of a typical classroom, such as desks, doorways, and ceilings. For example, a team at Ireland's Cork Institute of Technology has developed a way to embed touch-sensing technologies and LED feedback displays into school desks. These same desks, connected to information and communications technology (ICT) on a campus, afford new pedagogies and interactions for students and teachers alike.[1]

Along with data connectivity, sensor technology can potentially enhance otherwise ordinary objects such that they can automatically gather information to share over data networks. Technological advances have led to the miniaturization of many sensors, as well as the lowering of their cost. Broadly defined, a sensor is an object designed to detect events or changes in the surrounding environment, then provide an output using electrical or optical signals. The increasing number of applications for sensors in everyday life has occurred at the same time as the development of wireless technology standards such as Bluetooth and Near Field Communication (NFC). Bluetooth is a wireless technology standard for using radio waves to exchange data over short distances. NFC is a set of short-range wireless technologies, typically between devices brought within about 4 cm (2 inches) of each other.

[1] http://www.tiptaptap.ie/

Together, these two developments have inspired visions of a network made up of smart objects, also known as the "Internet of Things" or IoT. In 1999, Kevin Ashton coined the term "Internet of Things" to describe an automated process of data passing to and from things using technology like radio-frequency identification (RFID). RFID tags allow objects to wirelessly and automatically communicate data. These tags have proved useful in a variety of applications, including:

- Inventory tracking
- Access control
- Contactless payment
- Sporting events timing
- Animal identification

More than simply communicating information, a smart object embedded with both wireless communication capabilities and a sensor could autonomously monitor and transmit data about the environment around it. As the cost and size of sensors decreases, this translates into an increase in the types of data that a smart object can collect and transmit. These sensors can take many forms and serve a myriad of purposes. Digital cameras represent just one type of sensor capable of detecting the electromagnetic spectrum. Other sensors exist that detect invisible light, from UV and infrared to microwaves and cosmic radiation. Just as a microphone detects the vibration of the air that people perceive as sound, other sensors can detect seismic activity, the beating of the human heart, or vibrations in industrial machinery.

The following table summarizes information about the communication and sensing capabilities of objects participating in an "Internet of Things" on a school campus. Along with capabilities, the table displays the use cases for the recording and transmitting of data to support learning goals and streamline typical processes familiar to students and staff of a school or district.

HOW DO "THINGS" COMMUNICATE?	WHAT INFORMATION DO "THINGS" COMMUNICATE?	WITH WHOM, OR WHAT, DO "THINGS" COMMUNICATE?
• A local area network, either through a wired or wireless connection • Radio communication, using Bluetooth or RFID • Near Field Communication (NFC) • Connection to 3G networks like those used by mobile phones	• Data from sensors (temperature, energy consumption, motion or proximity detection, etc.) • Video, audio, and images from cameras, microphones • Biometric data recorded by fitness trackers or other wearables • Educational content, to display on mobile devices, interactive whiteboards, etc. • Assessment data collected from students completing class work or exams	• Remote professionals (regarding maintenance or repair, campus safety and security) • Other things (mobile devices used by students and educators, interactive whiteboards, wearables such as fitness trackers, etc) • Learning Management Systems or Content Management Systems • Student Information Systems (for recording attendance) • Payment systems (for buying school lunch, using vending machines, etc) • Inventory tracking systems (checking out books and materials)

Exploring The History of The "Internet of Things"

To better visualize the future of the "Internet of Things" in schools, it may help to understand the history of the idea itself. Both the vision and the technologies that inspire it have evolved over the nearly two decades since its inception. Originally inspired by the early development of the Internet, the Internet of Things has come to mean far more than it did originally.

"A NETWORKED PHYSICAL WORLD"

In 2009, Kevin Ashton wrote an article for RFID Journal entitled "That 'Internet of Things' Thing." In the article, Ashton said that he was "probably the first person to say 'Internet of Things.'" He is "fairly sure" he originated the phrase as the title of a presentation he made at Procter & Gamble in 1999. The presentation linked the new idea of radio-frequency identification (RFID) to the "then-red-hot topic of the Internet."[2]

That same year, Ashton, along with Sanjay Sarma and David L. Brock, co-founded the Auto-ID Center at Massachusetts Institute of Technology (MIT). In a white paper written by Sarma, Brock, and Ashton, they explained why they founded the Center:

"The Auto-ID Center at the Massachusetts Institute of Technology is a new industry sponsored lab charged with researching and developing automated identification technologies and applications. The Center is creating the infrastructure, recommending the standards, and identifying the automated identification applications for a networked physical world."[3]

ELECTRONIC TAGS

The paper goes on to elaborate on the vision of a "networked physical world" as follows:

"The Auto-ID Center envisions a world in which all electronic devices are networked and every object, whether it is physical or electronic, is electronically tagged with information pertinent to that object. We envision the use of physical tags that allow remote, contactless interrogation of their contents; thus, enabling all physical objects to act as nodes in a networked physical world. The realization of our vision will yield a wide range of benefits in diverse areas including supply chain management and inventory control, product tracking and location identification, and human-computer and human-object interfaces."[4]

The "physical tag" referred to in the vision not only stores data; it also can communicate that data wirelessly with an external tag reader. The tag circuitry does not require the inclusion of a power source like a battery. Instead, the tag can obtain power wirelessly from the reader.

[2] Ashton, K.: That 'Internet of Things' Thing. RFID Journal, www.rfidjournal.com/article/print/4986 (2009)

[3] Sarma, S., Brock, D.L., Ashton, K.: The Networked Physical World. TR MIT-AUTOIDWH-001, MIT Auto-ID Center (2000)
[4] Ibid.

TRILLIONS OF TAGS

A Universal Product Code (UPC) identifies an object's type when scanned by a bar code reader. Every object of that type has an identical UPC, so a UPC tag reader cannot distinguish between two individual objects of the same type. As an alternative, Sarma, Brock, and Ashton proposed assigning a "wholly unique, searchable identification number to each physical object . . . an EPC, or Electronic Product Code."[5] The EPC would be a 96-bit number, allowing for the creation of trillions of unique tags. The EPC, therefore, could support the realization of the envisioned system necessary for a networked physical world. In their conclusion, the white paper authors state: "A networked physical world requires a system that includes all traded objects in the world. Such a system must scale to unprecedented proportions, quickly becoming the largest man-made system ever. For perspective, we expect such a system to ultimately handle more than one trillion (10^{12}) new unique objects annually."[6]

NOT JUST A "BAR CODE ON STEROIDS"

Fast-forward ten years to Ashton's article in RFID Journal. The originator of the phrase "Internet of Things" lays out a vision that extends the original goal of "automated identification using contactless tag technologies."[7] Ashton describes a problem, along with its solution: "people have limited time, attention and accuracy — all of which means they are not very good at capturing data about things in the real world. And that's a big deal. We're physical, and so is our environment. Our economy, society, and survival aren't based on ideas or information — they're based on things . . . yet today's information technology is so dependent on data originated by people that our computers know more about ideas than things . . . we need to empower computers with their own means of gathering information, so they can see, hear, and smell the world for themselves, in all its random glory. RFID and sensor technology enable computers to observe, identify and understand the world — without the limitations of human-entered data."[8]

Ashton also spells out the opportunity:

"If we had computers that knew everything there was to know about things — using data they gathered without any help from us — we would be able to track and count everything, and greatly reduce waste, loss and cost. We would know when things need replacing, repairing, or recalling, and whether they were fresh or past their best." [9]

"SMART" OBJECTS

The evolved vision of a "networked physical world" contains objects embedded with wireless communication technology combined with any number of sensors. These objects can transmit data about themselves and their environment, as well as the interaction of the two. What Ashton dreamed about in 2009 has increasingly become a reality. These "smart" objects have become what people commonly think of as the building blocks for the Internet of Things today. In addition to wireless communication technology and sensors, smart objects may also contain actuators that convert electrical signals into mechanical movement. This means that some smart objects

[5] Ibid.
[6] Ibid.
[7] Sarma, S., Brock, D.L., Ashton, K.: The Networked Physical World. TR MIT-AUTOIDWH-001, MIT Auto-ID Center (2000)
[8] Ashton, K.: That 'Internet of Things' Thing. RFID Journal, www.rfidjournal.com/article/print/4986 (2009)
[9] Ibid.

may be capable of manipulating their environment, not merely collecting information about it. The most well known “smart” device, the smartphone, exemplifies one more possible feature — a user interface. Apps on smartphones and other mobile devices can often serve as the user interface for a smart object connected wirelessly to the phone.

The Internet of Things Today

CAPABILITIES	**DESCRIPTION**
Communication and cooperation	Objects use wireless technology such as GSM (Global System for Mobile communication) and UMTS (Universal Mobile Telecommunications System), Wi-Fi, Bluetooth, Zigbee, etc to network with Internet resources or each other
Addressability	Objects can be located and addressed via discovery, look-up, or name services
Identification	Objects are uniquely identifiable
Sensing	Objects collect information about their surroundings
Actuation	Objects can manipulate their environment
Embedded information processing	Smart objects feature a processor or micro-controller, plus storage capacity
Localization	Smart things are aware of their physical location, or can be located, using GPS or the mobile phone network
User interfaces	Smart objects can communicate with people in an appropriate manner, either directly or indirectly (for example via smartphone)

source: http://vs.inf.ethz.ch/publ/papers/Internet-of-things.pdf

What Exactly Is An Internet of Things Smart School?

Many schools may already use RFID tags to keep track of library books, or other pieces of inventory checked in and out by teachers and students. Access cards for entering the school building also likely make use of RFID technology.

For examples of smart objects in school that could represent parts of an Internet of Things, consider the mobile devices and wearables carried by people on a campus. These devices collect GPS and accelerometer data, not to mention audio and video, when cameras and microphones are enabled. It’s not far-fetched to imagine a future when these same devices collect biometric data such as heart rate and even brain activity.

So, the “Internet of Things” has evolved as a term to encompass any object that can transmit data through IP networks. Typically, an adjective like “smart” or “intelligent” signifies that the object described has IoT functionality. Within the classroom, interactive whiteboards, laptops, and tablets all qualify for IoT membership.

Examples of IoT Technology Currently Used In Education

MULTI-TOUCH TABLES

The SMART Table® is an interactive table that supports up to 40 simultaneous touches, enabling collaboration on lessons for as many as eight students at a time. A teacher can send activities from his or her computer to the SMART Table, or share SMART Table content with the whole class via an interactive whiteboard.[10]

STUDENT ID CARDS

DataCard Corporation sells K-12 Student ID card systems that manage the checkout of books, supplies, and equipment; automate attendance tracking; integrate with existing student account databases; and control access to school facilities, restricted areas, and extracurricular events.[11]

BEACONS

Beacons are always on, broadcasting over Bluetooth. Any Bluetooth 4.0 device can be configured to act as a beacon, sending data to nearby mobile devices. Students and school staff need a mobile device with an installed app that listens for data from beacons.

In April 2016, Google added Ephemeral Identifiers, or EIDs, to Eddystone, their Bluetooth low-energy beacon format. EIDs allow for the signal to be only recognized by a controlled set of users, instead of the general public. This could enable a new set of beacon use cases where users can exchange information securely and privately.[12]

Some possible uses for beacons in schools include:

- Enabling precise delivery of learning materials to specific areas of a classroom
- Automating attendance taking
- Controlling access to schools without using ID bags and readers

Companies currently designing, manufacturing and selling beacons for use in schools include **Estimote**, **Aruba Networks**, **Kontakt.io**, **Gimbal**, and **Radius**.

SMART HVAC SYSTEM

Daikin's Rebel Rooftop Systems, integrated with Daikin Intelligent Equipment™, allows for monitoring and controlling the school building's environment 24/7 from anywhere in the world.[13] The intelligent gateway extracts a significant amount of data from the unit, then transports that to the cloud through a number of different

[10] https://education.smarttech.com/products/smart-table
[11] https://www.datacard.com/education/k-12-student-ids
[12] Nirdhar Khazanie, "Growing Eddystone with Ephemeral Identifiers: A Privacy Aware and Secure Open Beacon Format," Google Security Blog, April 14, 2016.
[13] http://lit.daikinapplied.com/bizlit/DocumentStorage/RooftopSystems/Brochures/Daikin_Rebel_Commerical_Packaged_Rooftop_Systems_-_ASP31-344_LR.pdf

mechanisms. It can send data, via 3G, to a service technician, so they can arrive on site with the right parts. The equipment can also automatically configure to a signal sent from a utility to use less power during peak times — equating to significant savings.[14]

SMART LIGHTING

Cisco's Digital Ceiling uses Power over Ethernet (POE) to enable each light fixture in a classroom to communicate with the school network. POE systems pass electric power along the same cables that carry data. Miami-Dade County Public Schools set up a proof of concept at the staff training center to explore future options available by moving lighting to the network. Some possible uses explored include:

- Adjusting to ambient lighting automatically throughout the school to closely mimic outdoor lighting patterns
- Using lighting colors to send signals across sites (green lighting could signal a new class period, red could indicate an alarm)
- Picking up signals from smart wristbands worn by students with light sensors, facilitating automatic attendance collection as they enter the classroom

WIRELESS TEMPERATURE MONITORS

Monnit Corporation has been in the sensor business since 2007. The company advertises low-cost, wireless temperature sensors to place inside of a school's cafeteria coolers. The sensor can send real time alerts via SMS text or email if the cooler's temperature falls above or below the optimal range. Some benefits of the technology include:

- Reducing food spoilage and waste
- Saving time and money by eliminating the need for manual checking
- Achieving and maintaining FDA safety standards[15]

Monnit also offers classroom sensors that remotely monitor both temperature and humidity levels.[16]

TELEPRESENCE ROBOTS

In several campuses around the United States, homebound or hospitalized students have used robots to remotely participate in classroom activities. A middle school student in Newport, Maine with a condition that hinders her mobility uses a robot to attend school, as does a 16-year-old in Sandy Creek Township, Pennsylvania. He was seriously hurt in a traffic crash, leaving him unable to physically return to class until his broken leg healed. Also, a kindergartner in Hoisington, Kansas uses a robot to go to school because he has a weakened immune system that prevents him from being around too many people.[17]

Each of these students relies on a Telepresence robot made by Double Robotics. The robot can raise and lower in height from 47 inches to 60 inches so that its screen and camera lines up with people either seated or standing.

[14] http://www.intel.com/content/www/us/en/internet-of-things/customer-stories/daikin-applied-transforms-hvac-systems.html
[15] http://www.monnit.com/solutions/school-cafeteria-cooler-temperature-monitoring
[16] http://www.monnit.com/blog/2016/08/the-importance-of-monitoring-classroom-temperatures/
[17] http://www.doublerobotics.com/education/

SMART SCHOOL BUSES

IC Bus, a subsidiary of Navistar, Inc, manufactures school buses that set the stage for a future in which remote users can pull data from a bus and use it to calibrate the bus' engine. The bus' OnCommand Connection stores data every 30 minutes, then provides a health report viewable on a smartphone app.[18]

APPLE TVs AND SMART TVs

Smart TVs connect to the Internet, allowing streaming of programs, videos, and apps. Apple TVs, paired with a projector or television screen, can also stream content from the Internet. In addition, a teacher or student can use an Apple TV to mirror an iPad screen.[19]

CONNECTED SPORTS EQUIPMENT

Wilson Sporting Goods recently announced a new football that contains a motion sensor capable of sending data wirelessly using Bluetooth. Data collected by the football includes velocity, distance, spin rate and spiral efficiency. The non-rechargeable battery built into the football gives it 500 hours of connected play, or the equivalent of about 200,000 throws. Wilson sees the smart football as a training tool that can change the way young quarterbacks improve their skills.[20]

Football players at York High in York, South Carolina have begun wearing helmets with embedded technology designed to assist in the process of identifying concussions. An extra set of padding in the helmet contains sensors that detect a heavy impact and send a signal to an athletic trainer or coach on the sidelines.[21]

Adidas now offers a smart soccer ball with an integrated sensor that detects speed, spin, strike, and flight path data. The ball instantly relays this data via Bluetooth to view on a smartphone. The companion smartphone app analyzes the data and displays feedback, as well as tracks progress. Unlike the Wilson connected football, the Adidas miCoach Smart Ball comes with a rechargeable battery and charging base.[22]

High school tennis players can now affix a Smart Tennis Sensor to the grip end of their rackets. The sensor, made by Sony, records shot data including ball speed, swing speed, ball spin, and ball impact spot and displays it in real time on a smartphone via Bluetooth.[23]

FACIAL RECOGNITION CAMERAS

Blue Line Security Solutions has installed a facial recognition system that allows doors to unlock automatically for students and staff at St. Mary's High School in St. Louis, MO. The system can also detect visitors who may be prohibited to enter the school, such as sex offenders, disgruntled employees, or relatives with restraining orders against them.[24]

[18] http://www.prnewswire.com/news-releases/ic-bus-announces-availability-of-over-the-air-programming-for-school-buses-300306273.html
[19] http://www.edudemic.com/5-ways-to-use-apple-tv-in-the-classroom/
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How IoT Can Transform Education

In 2013, Cisco published a white paper entitled "Education and the Internet of Everything."

The paper provided possible applications of "physical objects that can be connected to both the Internet and people via sensors." Some examples included:

- Security cameras and motion sensors to monitor facilities to keep students, teachers, and parents safe. Principals, security officers, and operations leads can remotely preconfigure this surveillance equipment to increase accuracy and timeliness of emergency responses.
- Sensor gloves that provide feedback to children learning sign language from a computer. The learner wears the glove while attempting to sign; the sensor information is fed back to the computer, which gives the learner feedback on his or her accuracy in signing.
- Headsets that help learners who have Attention Deficit Hyperactivity (ADHD) and/or are easily distracted. The headsets detect brain activity and reward learners when they demonstrate improved concentration.[25]

Of these ideas, only the first one that focuses on school safety has actually been realized in practice. The other ideas remain areas of research and development.

Along with researching ideas, some education thinkers have attempted to imagine how the classroom of the near future might look and function. Michael J. Timms directs the Division of Assessment and Psychometric Research at ACER, the Australian Council for Educational Research. He recently published a paper in the *International Journal of Artificial Intelligence in Education* entitled "Letting Artificial Intelligence in Education Out of the Box: Educational Cobots and Smart Classrooms." Timms believes that robots designed to support human teachers will appear in the classroom within the next 25 years. He calls these robots that work alongside humans, "cobots," a shortened form of the term "robot co-worker." These cobots would have embedded artificial intelligence, as well as be able to "move around the classroom as students are working on projects, recognizing the faces and voices of individual students, being able to point or gesture, and being capable of facial expressions." Apart from robots, Timms provides examples of how artificial intelligence might be deployed in the physical classroom "to create a 'smart classroom' that can support the students, the teacher, and . . . the educational cobots within it." [26]

Some features of the smart classroom of the future might include:

- "Sensorized" blocks for teaching base ten counting. Each block 'knows' its identity and where it is in relation to other blocks. The blocks could use flashing LED lights to communicate to a learner if they have made a correct pattern to represent a given number.
- A music score on a tablet could send signals to the guitar held by a learner, communicating what chord to play next. The guitar could indicate the finger positioning on the fretboard using LEDs.

[25] M. Selinger, A. Sepulveda, and J. Buchan, "Education and the Internet of Everything: How ubiquitous connectedness can help transform pedagogy," White Paper, Cisco, San Jose, CA, Oct. 2013.
[26] M. J. Timms, "Letting artificial intelligence in education out of the box: Educational cobots and smart classrooms," International Journal of Artificial Intelligence in Education, pp. 1–12, 2016.

- Sensors worn by students and embedded in the room itself could carry out classroom management tasks, as well as learning tasks. Specifically, badges worn by students could sense when other badge wearers are in range, as well as detect emotion from the affective tone of voice of the wearer. The badges could also track the location of the wearer or alert a teacher if a student leaves the classroom without permission, or if the vocal tone of a group of students indicates that they are off task.
- High definition cameras, combined with facial recognition technologies, could sense the emotional state of the learners. Data from these sensors could be used along with artificial intelligence technology to identify the features of a productive learning space. Such a system could provide feedback to beginning teachers about how to bring a class back to a productive state.
- Motion sensors and biometric sensors might gather information about student engagement as well as watch for off-task behavior.[27]

Similar to the ideas put forth in the Cisco white paper, the majority of Timms' ideas do not yet have real-world examples of implementation. However, the technology that would make these ideas workable does, for the most part, exist today.

[27] M. J. Timms, "Letting artificial intelligence in education out of the box: Educational cobots and smart classrooms," International Journal of Artificial Intelligence in Education, pp. 1–12, 2016.

Conclusion

As computing devices shrink and power efficiency increases, this results in an expansion of possible “things” that can communicate with one another. The Internet of Things, or IoT, has the potential to transform everyday life in all sectors of society, including schools. Students and teachers may soon see a range of benefits arising from new uses of the Internet networks already in place on their campuses. Additionally, school administrators, parents, and other stakeholders stand to gain from IoT technology applications.

Developments in the area of artificial intelligence, specifically, pose new opportunities for IoT applications in schools. The discussion of Internet of Things may often sound like settings for young adult science fiction stories, but it is rooted in science fact. What remains to be seen is the degree to which schools will incorporate emerging IoT technologies as quickly and enthusiastically as the sectors of business, commerce, medicine, manufacturing, and the like.

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