IoT and IoE Impacts on Education

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Abstract

Searching Google for “Internet of Things”, over 203 million entries were found. Searching Google for “Impacts of Internet of Things on E-Learning”, over 6.37 million entries were found. Searching Google for “Internet of Everything”, over 40 million entries were found. Searching Google for “Impacts of Internet of Everything on E-Learning”, over 6.7 million entries were found. Therefore, it can be said that both Internet of Things and Internet of Everything have significant impacts on E-Learning. This paper presents Introduction to IoT and IoE, the Impacts of IoT on Education, Ways IoT is Changing Education, Internet of Everything Impacts on Education, IoE Impacts on Educational Innovation, and Impacts of IoE on Jobs.

Keywords. IoT, IoE, E-Learning, Educational Innovation, Impacts of IoE on Jobs.

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1. Introduction

Searching Google for “Internet of Things”, over 203 million entries were found. For example, from Wikipedia [1] and publications by the authors of this paper [2 - 10], Internet of Things (IoT) is the network of all kinds of things embedded with sensors, electronics, software, and so on so forth, connected to the Internet, based on the International Telecommunication Union's Global Standards Initiative" [11].

From the document “That 'Internet of Things' Thing” [12], Kevin Ashton, who was the Executive Director of Auto-ID Center at Massachusetts Institute of Technology (MIT) in the United States said that he coined the term “Internet of Things” to use in the title of the presentation he made to Procter and Gamble (P&G) in the year 1999. Then in the year 2015, Newsweek named Kevin Ashton “Father of Internet of Things” [13] as shown in Figure 1. By the way, Srisakdi Charmonman, the senior author of this paper, was named Father of Thai IoT by the International Biographical Centre in Cambridge, England, in the year 2016, as shown in Figure 2.

Searching Google for “Internet of Everything”, over 40 million entries were found. For example, the document “Internet of Everything (IoE) Faq” [14] gave answers to nine frequently asked questions (FAQ). Cisco answers to the nine frequently asked questions are given below, either in full if they are short, or in summary if they long.

![Figure 1. Kevin Ashton Coined the Term IoT in 1999 and Called ‘Father of IoT’ in 2015.](image1.png)

![Figure 2. Srisakdi Charmonman named Father of Thai IoT in the year 2016.](image2.png)
1) **What is the Internet of Everything?** The Internet of Everything is the intelligent connection of people, process, data and things.

2) **Why is the Internet of Everything important?** The Internet of Everything brings together people, process, data, and things to make networked connections more relevant and valuable than ever before. IoE turns information into actions that create new capabilities, richer experiences and unprecedented economic opportunity for businesses, individuals and countries.

3) **How does the Internet of Everything relates to the Internet of Things?** The “Internet of Everything” builds on the foundation of the "Internet of Things" by adding network intelligence that allows convergence, orchestration and visibility across previously disparate systems.

4) **Why is the Internet of Everything happening now?** The explosion of new connections joining the Internet of Everything is driven by the development of IP-enabled devices, the increase in global broadband availability and the advent of IPv6.

5) **What risks and challenges should be considered in the Internet of Everything?** Some important considerations in the Internet of Everything include privacy, security, energy consumption, and network congestion.

6) **What role does the network play in the Internet of Everything?** The network plays a critical role in the Internet of Everything – it must provide an intelligent, manageable, secure infrastructure that can scale to support billions of context-aware devices.
7) How does the Internet of Everything relate to Cisco new brand campaign? The Internet of Everything represents the business opportunity that the Cisco new brand campaign addresses.

8) Is the Internet of Everything a Cisco architecture or trademark? The Internet of Everything does not describe a specific architecture and is not solely owned by Cisco.

9) What are the elements of the Internet of Everything? There are four elements, namely, people, process, things, and data. The answer will be given in more details in Section 4 “Internet of Everything and Education” of this paper).

   This paper presents Introduction to IoT and IoE, the Impacts of IoT on Education, Ways IoT is Changing Education, Internet of Everything Impacts on Education, IoE Impacts on Educational Innovation, and Impacts of IoE on Jobs.

2. The Impacts of IoT on Education

   Searching Google for “Impacts of IoT on Education”, about 952,000 entries were found. As an example, in the document “What will be the impact of IoT on education?” [15], it was stated that the use of the Internet of Things in education would increase dramatically and 4 explanations were given:

   1) IoT as a new tool to connect to students. In the past, teachers and students were not connected because the lack of engaging lesson plan, relevant discussions, fresh classroom projects and new teaching methods. IoT can now be used to allow students to watch lectures via live video feeds, recordings on YouTube or a similar venue at home, and discuss what they learned and engage in hands-on projects related to the lesson.

   2) There are many simple components of IoT. IoT provides smaller and more affordable wireless systems that consume less power and can be integrated into almost any type of device thru Wi-Fi, Bluetooth, Zigbee, NFC, RFID, and so on so forth. Some of this technology can add wireless sensor capabilities to any sort of device, such as FitBit wearable fitness trackers, books, fixed structures
and even people. IoT simplifies and automates access to essential information in any type of educational or real-world setting.

3) IoT has the ability to improve upon the learning experience. Students can bring wireless devices into the classroom or use them at home. The materials available for learning on mobile devices, such as e-books, may be more engaging and interactive. The advanced eLearning applications allow students to work at their own pace through a course, which increases both satisfaction and completion rates for the course. Teachers can provide one-to-one instruction and seamless student assessments.

4) Potential of IoT in Education. IoT would allow for better operational efficiency in every type of learning environment. Classroom discipline would be much more easily enforced with vibrations that are similar to a silent notification on a mobile phone. These devices could redirect a student’s attention, such as giving a warm-up exercise to do on their device. During examinations, a student’s identity could be verified through their brain waves tracked by a wearable.

### 3. Ways IoT is Changing Education

The document “5 Ways The Internet Of Things Is Changing The Game For Education And Learning” [16] proposed 5 points to be considered:

1) **Connect academies all over the map.** Some of the latest IoT features include digital highlighters, smart boards, and even smarter boards. Consider a scenario where students sitting in a classroom or at home can interact with their classmates, mentors, and educators scattered across the world. Now, let’s suppose the lesson of the day is focused on sea life. To give students a really exciting – and highly educational – experience, the teacher decides to access live information generated through sensors and live feeds monitoring a particular body of water.

2) **Conserve and sustain to survive and flourish.** With the aid of the IoT, a variety of options are possible in terms of environmental and energy conservation, ecosystem regulation, traffic, and transport, to name a few, that can help schools build up their budgets and offer better learning opportunities.
3) **Provide safe and secure learning environment.** With empowered sensors, RFIDs, cameras, and connected devices, monitoring and surveillance of entire buildings is possible. Instant notifications, alerts, and configured actions would be a significant addition to the safety and security of schools and other educational institutions.

4) **Grant parity for all.** IoT provides connected world of everything to offer students who need modified learning plans and exceptions. There are already a number of devices, tools, and apps that create appropriate learning experiences while bringing them on par with the rest of the class.

5) **Turn learners into creators.** IoT promotes the way for students to be creative. The predictions regarding the enormous number of connected communication and decision-making devices provide an excellent opportunity for students to understand, build, and control such systems themselves.

### 4. Internet of Everything Impacts on Education

The document “Education and Internet of Everything – Cisco” [17] stated that there would be four elements from IoE to have impacts on education. The four elements are people, process, things, and data.

1) **People** will continue to connect through devices, like smartphones, PCs and tablets, as well as through social networks, such as Facebook and LinkedIn. As the Internet of Everything emerges, the interaction of people on the Internet will evolve. For example, it may become common to wear sensors on our skin or in our clothes that collect and transmit data to healthcare providers. Some analysts even suggest that people may become individual nodes that produce a constant stream of static data.

2) **Process:** This includes evolving technology, business, organizational and other processes that will be needed in order to manage and, to a large extent, automate the explosive growth in connections—and the resultant accumulation, analysis and communication of data—that will be inevitable in the Internet of Everything. Processes will also play an important role in how each of these entities—people, data, and things—interact with each other within the Internet of Everything to deliver societal benefits and economic value.

3) **Things:** This element includes many physical items like sensors, meters, actuators, and other types of devices that can be attached to any object, that are
or will be capable of connecting to the network and sharing information. These things will sense and deliver more data, respond to control inputs, and provide more information to help people and machines make decisions. Examples of “things” in the Internet of Everything include smart meters that communicate energy consumption, assembly line robots that automate factory floor operations, and smart transportation systems that adapt to traffic conditions.

4) Data: Today, devices typically gather data and stream it over the Internet to a central source, where it is analyzed and processed. Such data is expected to surpass today’s largest social media data set by another order of magnitude. Much of this data has very transient value. In fact, its value vanishes almost as quickly as it is created. As a result, not all generated data can be or should be stored. As the capabilities of things connected to the Internet continue to advance, they will become more intelligent and overcome the limits of traditional batch-oriented data analysis by combining data into more useful information. Rather than just reporting raw data, connected things will soon send higher-level information and insights back to machines, computers, and people in real time for further evaluation and decision making. The intelligent network touches everything—and is the only place where it’s possible to build the scalable intelligence required to meet and utilize this new wave of ‘data in motion’. This transformation made possible by the emergence of the Internet of Everything is important because it will enable faster, more intelligent decision making by both people and machines, as well as more effective control over our environment.”

5. IoE Impacts on Educational Innovation

The document “The Internet of Everything: Fueling Educational Innovation”[18] stated that IoE would definitely have impacts on education innovation. The innovation is mainly about critical skills in the knowledge economy, and the top ten skills for the IoE workforce. By the way “The knowledge economy is the use of knowledge to generate tangible and intangible values. Technology and in particular knowledge technology help to transform a part of human knowledge to machines.” [19].

5.1) The innovation about critical skills in the knowledge economy includes three types of skills. They are 21\textsuperscript{st} Century Skills, Global leadership skills, and Entrepreneurial skills.

5.1.1) 21\textsuperscript{st} Century Skills.

(1) Critical thinking

(2) Collaboration
(3) Communication

(4) Creativity

(5) Problem solving

(6) ICT proficiency

5.1.2) Global leadership skills
(1) Global mindset

(2) Languages proficiency

(3) Cultural awareness

(4) Team player

(5) Professionalism

(6) Work ethics

5.1.3) Entrepreneurial skills.
(1) Opportunity recognition

(2) Self-direction

(3) Persuasion

(4) Planning skills

(5) Risk taking

(6) Resourcefulness

5.2) The top ten skills for the IoE workforce.
  5.2.1) Sense making

  5.2.2) Social intelligence

  5.2.3) Novel and adaptive thinking

  5.2.4) Cross-cultural competency

  5.2.5) Computational thinking

  5.2.6) New-media literacy
5.2.7) Transdisciplinarity

5.2.8) Design mindset

5.2.9) Cognitive load management

5.2.10) Virtual collaboration

6. Impacts of IoE on Jobs

One of the main purposes of education is to prepare the graduates to have good jobs. One of the good jobs is technology-related job. The document “The Internet of Everything Will Impact Everything, Including Your Next Tech Job” [20] stated that “IoE is having enormous impact on business. Accenture made a survey of 1,400 business leaders which concluded that IoE would be a net creator of jobs but IoE would also create a major revolution in the way we work, dramatically changing jobs at different level within the enterprises”. Five points were discussed:

1) THE TECHNOLOGY OF IOE. Before we delve into the impact IoE will have on enterprise jobs, we first must familiarize ourselves with exactly what IoE is. IoE expands on the concept of the “Internet of Things” in that it connects not just physical devices but quite literally everything by getting them all on the network. It moves beyond being a major buzzword and technology trend by connecting devices to one another and the Internet, and offers higher computing power. This connection goes beyond basic M2M communications, and it is the interconnection of devices that leads to automation and advanced “smart” applications. IoE works to connect more devices onto the network, stretching out the edges of the network and expanding the roster of what can be connected. IoE has a major play in all industries, from retail to telecommunications to banking and financial services.

2) THE DEMANDS OF IOE. IoE does put quite a few demands on the network that have not previously been there in order to be implemented correctly and maximize business potential. Decisions must be made from both a technology and enterprise side – the team implementing the on-the-ground technology must be very candid with what will be needed from the business side, such as extra funding, additional staff, planned network downtime or limited access. The management of the IoE implementation process and the demands placed on network administrators alone opens up the possibility of more Technology Implementation Manager roles. These Technology
Implementation Managers would act as the liaison between the IT team and the C-Suite, and will provide education on what options are out there for IoE implementation, conduct vendor and partner research and handle the Requests for Proposals and make sure the business goals and initiatives for IoE implementation are outlined, with a detailed plan of how they will be met. Once the project is off the ground and the vendor is brought on board, this manager will be the day-to-day contact for the vendor and will also their role as the liaison between IT and the C-Suite.

3) IMPACT ON THE SYSTEMS ADMINISTRATOR. IoE will have a very real impact on jobs at every level. Entry-level employees are entering the workforce at a great time, as they are better able to adapt to changing industry standards and expectations. They also came of age with the Internet, which changes their relationship with connected devices. They are used to having information they need right at their fingertips and rely more heavily on electronics to provide them with the information they are looking for. Coming in at an entry level, they may have even taken courses on Open Source or IoE, and be able to use this knowledge and skill set in their day-to-day tasks. For IT professionals of this level, IoE will mean that the boundaries of the network and system will expand and shift, and System Administrators will need to keep up with these shifts and have tricks in their toolbox to accommodate those before they move up to impact other levels of the network. The increases in devices on the network will place tons of strain on the network and create the need for increased bandwidth. It will also mean that Systems Administrators will no longer just be in charge of the network – they will have to be prepared to manage the connectivity of actual devices, while being prepared to manage the edges of the networks first, working their way in.

4) IMPACT ON THE CHIEFS. IoE will drastically change the way companies do business for the better. For members of the Chiefs, especially the Chief Operations Officer and Chief Innovations Officer, IoE will cause them to be on the lookout for additional opportunities it will create. For example, the COO must have a deep understand of what needs to be changed from an operational standpoint for IoE to be successfully integrated into day-to-day business. The COO must look at ways in which IoE will have the most impact specific to the company and industry – should IoE mainly be used to boost the customer experience, or the sales team? How disruptive will connected devices be, does there need to be a campaign around the benefits of disruption? For the Chief Financial Officer, IoE will be all about return on investment. They must ask themselves how the revenue model will change with IoE introduced and
incorporated, and whether or not funding streams need to be altered and the extent to which board members must have buy-in.

**5) IMPACT ON OVERALL JOB GROWTH.** It is no secret that IoE will have an immensely positive impact on the overall job creation and growth in many industries. The Jobs Report for December 2014 reported that 252,000 US jobs were created in December alone, and the unemployment rate dropped to 5.6%. IoE will only add to these numbers, as it will require companies to grow and expand their skill-set to hire professionals who possess the skills needed to properly implement the technology. All of this job growth will also boost the gross domestic product of twenty of the world’s largest economies by 2030 by an additional $14 trillion. IoE will also open the doors for more corporate training sessions, creating an additional set of jobs – IoE trainers. And, in order for IoE to be implemented, we can expect to see IoE-specific engineers, IT personnel and the creation of entire vendors that are just focused on advancing IoE. IoE is shifting the industry, both from a technology standpoint and within the enterprise. It is not just creating more robust and innovative technologies, it is also creating an entirely new field of jobs that have never been seen before. It is opening up doors for even more job development and growth in technology fields in all industries, and is allowing for the cross-pollination of the Chiefs and IT teams.

**7. Concluding Remarks**

Searching Google for “Internet of Things”, over 203 million entries were found. Internet of Things (IoT) is the network of all kinds of things embedded with sensors, electronics, software, and so on so forth, connected to the Internet. The Internet of Everything (IoE) is the intelligent connection of people, process, data and things. Both IoT and IoE are getting more and more popular in all fields including education. This paper presented Introduction to IoT and IoE, the Impacts of IoT on Education, Ways IoT is Changing Education, IoE Impacts on Education, IoE Impacts on Educational Innovation, and Impacts of IoE on Jobs. However, new papers on IoT and IoE are appearing very often. Therefore, all parties concerned should search Google from time to time to study and decide whether or not to use the new information for the benefits of themselves, their organizations and their countries.
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(In the order of citation similar to the case of footnotes)

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