THE EVOLVING CHALLENGES OF INTERNET OF EVERYTHING: ENHANCING STUDENT PERFORMANCE AND EMPLOYABILITY IN HIGHER EDUCATION

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Abstract

The Internet of Everything (IoE) is the essential prerequisite for the creation of virtual communities and ecosystems of institutions, communities and smart objects. IoE is built on the connections among people, processes, data and things.

IoE are explicitly linked to global higher education (HE) and betterment to economic development, new research and innovation. Significant numbers of learning activities are moving to individualized proliferation of ebooks, e-readers, etextbooks, elearning and e-everything where transition to "hybrid" classes that combine online learning components with less-frequent on-campus, in-person class learning becomes more and more the norm. Through mass adoption of IoE is expected to witness a shift in expert resources use in HE that allows more people to gain access to education, regardless of their learning background.

IoE adaptation in HE and the ubiquitous connectedness will transform the pedagogy towards one that empowers a new generation of digital citizens who understand the technologies that underpin IoE, but the impact of widespread adoption, and the right application of the information need yet to be understood.

This article endeavours to discuss the evolving challenges of IoE adaptation in the HE including (1) access to right content and information and availability of materials on any device, at any time, (2) customization of curriculum to enable high/active engagement, interaction and attendance, and (3) to reduce the skills mismatch between what the labour force can do and what employers need as indicators of success for IoE adoption in HE.

To transform information into processes and products is necessary to gain from the sharing and use of knowledge. We analyze how an Internet of Everything that filter, select and distinguish relevant information to tailored student need enhances performance.

Keywords: Internet of Everything (IoE), ebooks, e-readers, etextbooks, elearning, e-everything, curriculum, employability, digital citizens.

1 INTRODUCTION

Around the world, cities, state and governments, as well as other public-sector organizations, are leading the way in bringing the Internet of Everything to life [1]. The Internet of Everything (IoE) brings challenges and opportunities to higher education. In this current era the wealth of data and the development of new knowledge is challenging institutions to rethink teaching and learning in a global market [2].

The unprecedented growth of ubiquitous computing, is evolving IoE capabilities in higher education. Greater connectivity and technological advancement have enriched and expanded in higher education sector to fulfilling its promise to the students for personal growth and discovery, satisfying career possibilities, and potential financial success. At the same time, the changing operating environment associated with the IoE represents considerable opportunity to the attack surface and threat environment of the Internet and Internet-connected HE systems. As more people adopt new technologies for learning, they will thrive in the emerging world of the IoE, the networked connection of people, process, data, and things which is the basis for the Internet of Learning Things [4].

Cisco believes that the IoE is the next step in the evolution of smart objects, and its interconnected things add network of networks where billions, or even trillions, of connections create unprecedented opportunities [2]. The IoE adaptation and emerging technologies for learning creates classrooms which are more “open” through voice, video, and text-based collaboration, and teachers now have a wide range of multimodal resources at their disposal to enhance learning experience.

This paper presents and discusses the potential of IoE and challenges it presents to formal higher education, including:

- How to get the most value from the combination of people, process, data and things to the higher education system and seizing the potential of IoE in education
- The potential benefits of Bring Your Own Device (BYOD), Big Data and wearable technologies integrate with IoE
- How educators can influence policy makers to help customization of curriculum to enable active engagement and interaction of information by shaping IoE and maximize its gains in higher education

In the future, learning will become substantially more important to society. This means that we need to re-engineer the whole approach to learning. Most important is the right content, and information and availability of materials on any device, at any time. So it is imperious for students to continue to acquire the knowledge and skills they need to grow. It is also critical for higher education institutions to evaluate their output (graduates employability) within vested industry, to empower of societal and technological changes, and to take advantage of them in a transformational industry that solve the world’s biggest problems.

2 SIGNIFICANT CHALLENGES IMPEDING IoE ADOPTION IN HIGHER EDUCATION

Educational “Climate Change” is creating an endless demand for new forms of learning. New technologies such as cloud computing, mobile learning, learning analytics, open content, 3D printing, virtual and remote laboratories, games and gamification, tablet computing, and wearable technology is instilling a new digital culture and develop an IoE society [3]. Globalization and new patterns of learning methods are increasing the demand for specialist skills and knowledge. But to be “knowledgeable” will no longer be good enough: a new set of 21st century technology adaptation, confidently credential, will also be essential to flourish. Many more people than ever before need to have advanced capabilities for critical thinking, collaboration, and problem-solving.

2.1 Long-Term Trends: Driving IoE adoption in higher education for next five years

2.1.1 Advancing Cultures of Change and Innovation

Cisco predicts that worldwide, IoE in education has a 10-year net present value of US$175 billion, which will be delivered through streamlined and personalized instruction [12]. In many ways, internet and network technologies that students use in their daily lives extend to learning. It is clear that smart devices could play a major role in teaching and learning, therefor institutions have been updating their infrastructures to accommodate this smart devices programs. In this sense, it has become the responsibility of universities to adopt environments that accelerate student learning and creativity.

Rapid growth in learning management systems such as Blackboard and Moodle is generating immense amounts of structured and unstructured data such as audio and video content. Digital classrooms equipped with lecture capture systems and web streaming allow students to access instructional materials on-demand whenever necessary and this puts pressure on HE to have relevant infrastructure.

2.1.2 Driving to Virtual Reality and Improving Learning

The higher educational institutions which are experiencing new digital learning systems are focused these days on what they can discover from their learners' behaviour and performance in order to improve learning system. 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. There are several ways of using virtual reality (VR) in the classroom: one method is using desktop set up in which the student explores a virtual environment using a computer, keyboard and mouse. More advanced VR set up is fully immersive and requires the student to wear a head mounted display (HMD) and data glove for interaction within a virtual environment. This environment may take the form of a series of large screens or a complete CAVE VR system [5]. The fully immersive set up will include a tracking system which is included in the HMD that records and analyses the student's movements in a virtual space. The VR system can be used in many areas of the curriculum. This includes maths, English, science, history, geography, languages and newer subjects such as design technology.

This IoE technology adaptation will transform the students who respond to better computer generated learning than traditional methods of teaching. VR learning is an ideal way of engaging students with a particular subject in a manner they are comfortable with. The VR technology can be used in many different ways for the education, an example is the use of virtual avatars as a part of Big Data program in upcoming "Big Data 4Dx" program [6]. The Big Data 4Dx program is a web-based, immersive collaborative environment. Students participating in the online format will interact in a virtual room with faculty and other students via personalized avatars [7].

3 HOW THE IoE TECHNOLOGY TRANSFORM PEDAGOGY

Technology is just one of many disruptive influences in education today. Arrival of this emerging technologies together with combining machine-to-machine (M2M), person-to-machine (P2M), and person-to-person (P2P) connections creates new capabilities, richer experiences, and incredible economic opportunity. CISCO has identified this integrated architectures that connect people, process, data, and things and designed high-performance end-to-end coverage systems which are intelligent and proactive in the IoE era [8].

Research shows that learners are also becoming more adept to using social networks such as YouTube and Facebook as to text message; post videos, blogs, and images; and collaborate and socialize regardless of time or place [9]. IoE brings an advanced technology that enables education to move from a knowledge-transfer model to a collaborative, active, self-directed, and engaging model that helps students increase their knowledge and develop the skills needed to succeed in the "Learning Society" and increase the employability [10]. In the area of computer science, the challenge is in developing new forms of innovative curriculum that reflects the radical changes in computing technology. In response, the Open University in the United Kingdom revamped its undergraduate computer science curriculum and now offers an introductory course, "My Digital Life", designed around Internet of Things (IoT) block concepts [11]. The course starts with a block concerned with students' needs to consume, process and publish information. It introduces students to the concepts of data and

information and how these are created, distributed and stored. These block expands user view to encompass the devices students use on a day-to-day basis; from the familiar personal computer to smart phones, games consoles and television smart boxes. In this course students have to create six different blocks and takes the widest possible view of computing technology and demonstrates how that ubiquitous computing would prove to be attractive to students. Social awareness and interactivity on lectures with a large audience can be improved by allowing students to use hand-held devices and wireless communication to interact with the lecturer and with other students. One example of the interactions enabled by the system is a feedback mechanism allowing the students to interact with the lecturer, exchange information about intendent to interactivity and difficulty of a lecture [13].

4 KEY FACTORS FOR SUCCESSFUL IMPLEMENTATION OF IoE IN HIGHER EDUCATION

Higher education institutions that are implementing successful change are focused on critical areas of modernizing teaching and learning culture by adaptation of an IoE, and how to scale and propagate change across multiple, often divided, areas within their institutions. Also, these institutions could use the IoE technology to manage each area more effectively. The IoE plays a critical role within each of the selected areas, and if used in a forward thinking manner, it can help to accelerate innovation and change.

4.1 The four pillar IoE network connection in higher education: People, Process, Data, and Internet of Things (IoT)

IoE in higher education is in the incipient stages, but some institutions are leading the way in showing how IoE can be used effectively to transform pedagogy [8]. Fig.1 presents the four pillar structure of IoE and their impact on higher education and how some of the practices currently being planned or adopted need support, build and scale up.

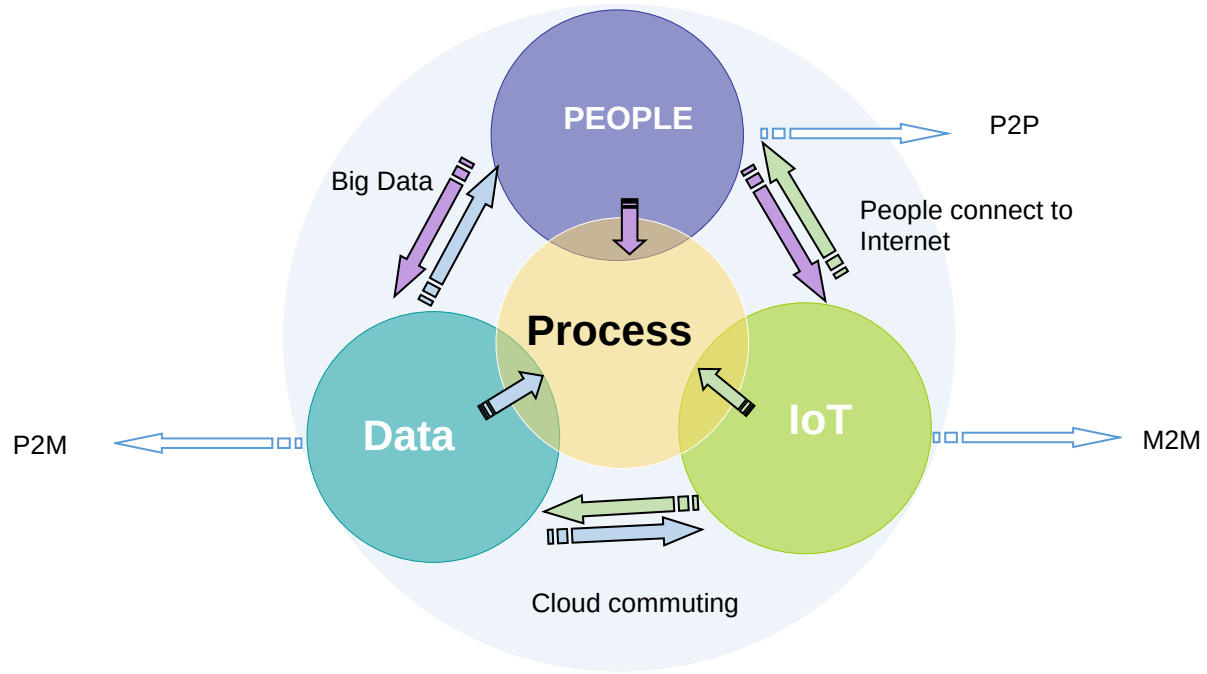

Fig.1: Four pillar network connection of Internet of Everything (IoE) in higher education system, Person to Person (P2P), Person to Machine (P2M) and machine to Machine (M2M).

4.1.1 People

Today, majority of the students in HE connect to the Internet using multiple devices and social networks. The education sector must understand how people connect to the Internet to increase their learning and apply their knowledge. Two distinct models guide current efforts to make use of the IoE in higher education. The first one seeks to improve existing forms and structures of instructions to create effective digital curricula that can be used in both formal and informal learning; what makes students interested is that they transcend conventional ideas and learning activities to create something that is new, meaningful [14]. This model emphasizes building an advance interactive curricula. Second model is more radical, it envisions the IoE as instrumental to a fundamental change in the processes and organizational structure of teaching and learning. According to this view, the IoE can transform HE into student-centered learning rather than institution and faculty-centered instruction. It can allow institutions to leapfrog existing academic structures and establish direct links to students. This will encourage new collaborative arrangements between academic institutions and entrepreneurs to permit these partnerships to extend their reach nationally and internationally. Also, IoE will help connect learners who are home-bound but capable of learning and participate in classroom courses [2]. IoE technologies is seen to support minorities and disabled learners' by offering access to high-quality learning and peer-to-peer interaction, which will improve their opportunities for greater success in life.

4.1.2 Data

The implications of this in HE are enormous [2]. For example, learners could also access data from research initiatives, monitor programs on diverse subjects (e.g. climate change, astronomy, etc.), or watch animals in their natural habitats via live webcams then collect data from wireless integrated network sensors [15] and subsequently feed that information to other programs for analysis, improving the accuracy of their research. Students involved in HE research and working with and manipulating real data, could also contribute to data banks by sharing datasets with others around the world. This will enhance and extend students' learning experience, authenticating their research through active engagement with other researchers. IoE can also enable students to track and analyse their own data for adopting healthier behaviours. IoE takes data-driven decision making in HE one step further, encouraging innovation that motivates and excites learners, turning passive learning into active learning, informing educators about students' lifestyles, and helping teachers develop better curriculum and assessment structures.

4.1.3 Internet of Things (IoT)

Things are machine to machine (M2M) connections that can be connected to both the Internet and people via sensors. The unprecedented growth of ubiquitous computing, evolving IoT capabilities, and technologies such as cloud computing, and big data and analytics will improve the core values of teaching and the curricula with new digital culture and develop an IoT-centric society. The IoT drives digital momentum into higher education with ever-increasing online degree options and unified access to instructional content in both structured and unstructured formats. Many universities are using hybrid cloud as their enterprise architecture for hosting machine-to-machine or IoT applications [16]. The combination of millennial generation or generation Y [17], the most tech-savvy students [18] in the history of higher education, as well as the rise of smart mobile computing, has opened up new methods of leveraging enterprise architecture, virtual classroom environment, and research computing.

Currently, on average, students have at least three different devices (BYOD) that connect to the institution network and the cloud offers seamless connections and services to core information technology services. The IoT applications used to integrate mobile learning applications and radical apps can help students take advantage of learning resources, manage assignments and work on projects. Academics also can use these apps to teach highly specialized concepts, scientific simulations and complex physical and social topics. The link between real objects (things) and web-based information are significant steps in HE that will create deeper understanding across curriculums.

4.1.4 Process

Process plays an important role in how people, data, and IoT work together to deliver value in the connected world of IoE. Reliable connections are the backbone of the system to deliver right information to the right person, at the right time, in an appropriate way with the correct process. Such

information will also increase student retention and the application of new knowledge, which is vital for future success in both employability and society. Improving the applications of students' personalized feedback and performance could increase the learners' achievements. For example, a learner studying CISCO network architectures could observe his or her ranking in real time against all learners studying the same level of the course. The process could eliminate traditional examinations used to measure and compare learners' performance and achievement. The model of measurement could be accurate at any moment in time, providing ongoing, targeted, and personalized feedback on what a learner must do to improve his or her understanding and performance.

5 IoE IN EDUCATION: ELEMENTS OF THE INNOVATIVE PEDAGOGICAL MODEL

Once identified the implications for people, data, process and IoT are inter related to each of challenges detailed in the section 4. The model proposed in this article (Fig. 2) takes into consideration a number of factors that derive from the four pillar structure when more students adopt new technologies for learning. The model's 16 factors support thrive in the emerging world of the Internet of Everything (IoE) by networking connection of people, process, data, and IoT. This is becoming important in HE system. The innovative model has a process approach for innovative pedagogical practices that are related to People, Process, Data and IoT that underpin the six trends and challenges of IoE adaptation in HE system.

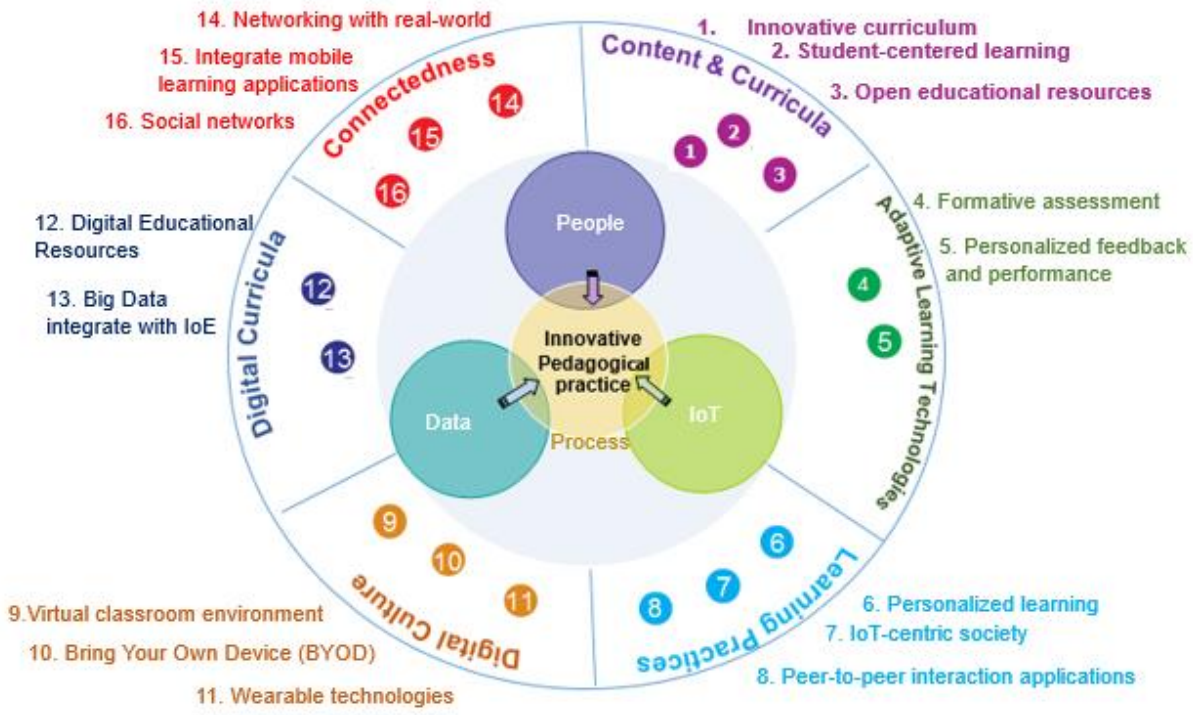

Figure 2. Elements of the innovative pedagogical model with IoE adaptation.

The six technologies and their elements are discussed under section 4.1 as part of the four pillar model. These pillars emphasize of what the technology is and why it is relevant to teaching, learning, or research in the HE system. The innovative model proposed here is rooted in the methods used across all the research conducted within the new IoE adaptation. Reliability, responsiveness and inclusiveness of emerging technologies are examined for possible inclusions in the six trends and challenges of innovative model.

6 CONCLUTIONS

There is tremendous values in IoE adaptation across the higher education system. The IoE empowers the global higher education system to be more relevant, engaging and as a result to motivate learners, and to enable faster time to success. In the near future, most higher-education institutions will use the IoE technologies incrementally to improve administrative processes, on-campus instruction, and distance learning [14]. Novel digital culture will create Internet-based, virtual universities that will provide the lowest-cost degree options to encourage more off-campus learning and subsequently widening participation to education.

However, to capitalize the benefits from connecting people, process, data, and IoT, reliable connectivity and continuous access is a must. Students will find themselves needing to develop new skills more frequently as technology shifts, and clearly higher education institutions have a continuing major role to play in supporting students in staying up to date. Also this revolutionary internet based system to be accepted, both policymakers and educators must be well-prepared not only to exploit, but also to understand potential cyber risks. Higher education institutions that are looking ahead to maximizing the potential of IoE in the educational offer will need to put in place relevant policies and control instruments that ensure a secure integrated system for the benefit of their students.

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