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INTERNET OF EVERYTHING AND ITS EFFECTS ON EDUCATION

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Abstract: *The first to decades of the 21st century have seen an unprecedented increase of devices connected to the internet and the data aggregated from those connected devices. One of the areas affected by this process is the field of education where we have seen the rise of distant learning, smart classrooms and performance tracking to name a few. This paper outlines some of the main aspects of this evolution through the notions of Internet of Things and Internet of Everything. The focus is on the possibilities that the collected data presents to stakeholders, educational institutions and students alike and the effects it has on the shaping of the educational process as well as the challenges that they face.*

Keywords: *Internet of Everything, Internet of Things, education, pedagogy, security*

INTRODUCTION

For the last 50 years, the internet has slowly become ubiquitous for global digital connectivity. Without going into much detail we can outline milestones like the rise of the World Wide Web (WWW) in the 1990's and the evolution of the phone into a handheld computer in the 2000's. During each of these stages, the rise of connectivity could be described as revolutionary. According to estimates from 2018 there are now 50 billion connected devices (Davis, 2018). These are of course not only consumer devices like smart phones, computers or television sets but also industrial devices, connected medical equipment and transportation vehicles etc. A large proportion of ordinary objects can now be connected via different sensors to form what is known as the Internet of Things (IoT). Kevin Ashton coined the phrase in 1999 and since then, it has evolved from its purely industrial meaning and stock control to encompassing almost every aspect of our lives (Ashton, 2009). Nowadays the understanding of IoT has evolved to include all devices that can capture data electronically and have the ability to transfer this data over the Internet or to a device connected to the Internet. When we add all the people connected with their devices to all the connected objects (or things) and all the data generated and stored us can begin to conceptualise what is known as Internet of Everything (IoE). Studied mostly in the field of computer sciences, the global connectivity has an effect on every aspect of human existence. The rise of the social media, the undermining of the political system, and the shift in attitude towards climate change, to name a few, can be all attributed to some extent to a more connected world. Education is one of the areas where IoE has a significant impact and which can benefit immensely from harnessing the opportunities that the connectivity and data analysis provide for progression. In this paper we will focus on those opportunities and will outline some of the barriers that can have an impact on them. Given the size limitations of the paper, we will offer an overview, which can be used as a starting point for further research. The subject falls in line with the PhD research of the author.

EXPOSITION

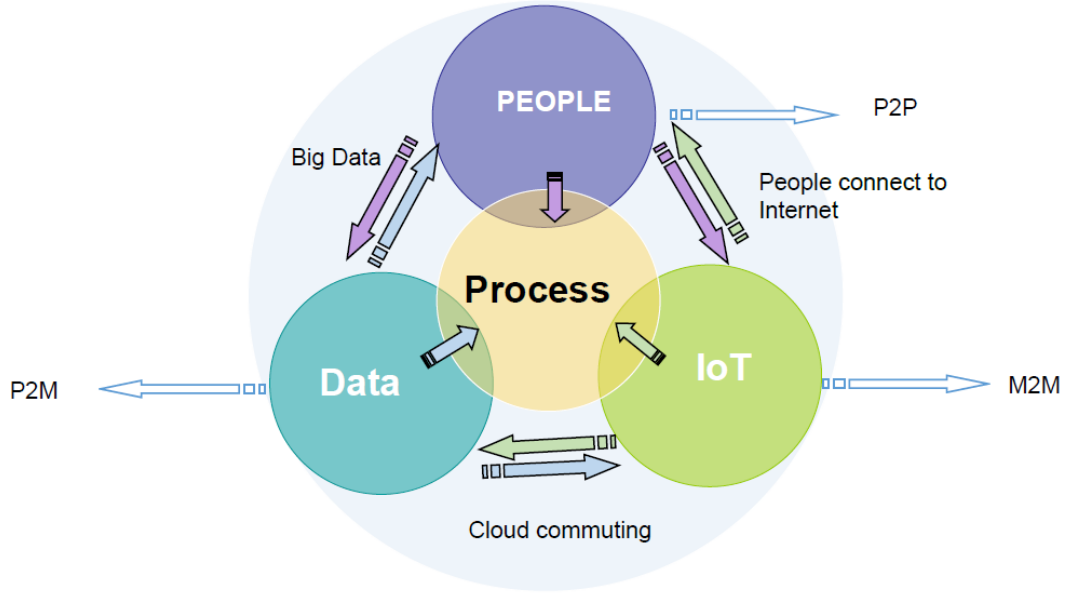

Figure 1. Four pillar network connection of Internet of Everything (IoE) in higher education system, Person to Person (P2P), Person to Machine (P2M) and machine to Machine (M2M) (Bandara & Ioras, 2016)

In 2013 the networking giant CISCO defines four pillars of IoE in higher Education: people, process, data and things (Selinger, et al., 2013). Figure 1 shows how those pillars are interconnected within an ecosystem. It is important to note that the process is in the centre – all the nodes have an impact on the process, which in turn governs the whole system. This creates a model that is constantly evolving and self-regulating. This model can also be extended to every other level of education. Because of the interconnectivity, it is difficult to look at each of the elements separately. For example, every student would be able to compare his or hers results real time with all other students doing the same subject at the same level. This could eliminate examinations and can provide accurate assessment as well as personalised feedback at any time in a way that is meaningful for the student (Selinger, Sepulveda, & Buchan, 2013). This example relies on devices (things) to facilitate feedback based on collected data, which is tailored to the student (person). The process governs the way this is happening in not only terms how this actually happens but also the moral and ethical aspects of how data is collected, processed, stored and analysed for the purpose of education.

Collecting data related to education is not a new concept. Student performance in learning systems has always been graded in quantitative terms; the grades are used to justify certification of educational achievements, which in terms can offer further opportunities for education or professional development. Every contemporary education system tracks the student from the moment the individual enters the system at a very early age until the person leaves the system. With the mostly compulsory character of education until a certain level in most countries, this means that the collected data encompasses extremely large proportion of the world population. Alongside grades, indicators like personal absences, dropout rates and teacher performance are painting the picture that should provide educational institutions with insights in order to drive positive change. One of the main barriers is the fact that individual institutions (schools, universities, etc.) are not willing to work with this data, which is gathered only for compliance purposes (Voorhees & Cooper, 2014). In that sense by opening the education ecosystem towards an ever-increasing volume of data is a great challenge that would require the combined and conscious efforts of all stakeholders. According to Wong, et al. (2019) "by utilising learning analytics to examine the trace data, patterns related to learning processes can be identified to

deepen our understanding of how students learn and add to the development of learning theories. In turn, this will help guide the design of instructional materials to support and enhance learning." (p.4)

The rise of the Massive Open Online Courses (MOOCs) is a direct consequence of the connectivity empowering distance learning. Harvard University alone provides access to over 2500 online courses from 140 educational institutions on its platform edX (www.edx.org). Most of the courses are relatively short, self-paced and free, requiring a small fee if one would like to receive a certificate upon completion. The Open University (www.openuniversity.edu) in comparison offers full-scale university level courses with corresponding length, learning materials and tutor support however it comes at prices comparable to physically attending university in the United Kingdom. This university history is as long as the internet itself but the spread of the latter has allowed the courses to reach students from 157 different countries. Distance learning made possible to provide personalised and adaptive learning through the use of pedagogy aided by technology. Using real time data from monitoring the student performance, teacher strategies can be adjusted to suit the pace and the performance of the learner (Peng, Ma, & Spector, 2019).

Such observations are also relevant when it comes to the classic brick and mortar learning environment. The connected "things" and devices have the potential to completely alter the educational process. The technological penetration at school is currently at an enhanced classroom level with the aid of mobile devices like laptops and tablets, digital white boards and wall projectors. On the software side of things, digital school diaries are gathering the manually input student absences and grades, while platforms like Moodle (www.moodle.org) are allowing an interactive way of performing part of the teaching/learning from a distance. None of these collects any more meaningful data than the traditional methods however they are all a step in the right direction. Technologically, to be part of the IoE environment a classroom needs to have a variety of connected devices that can both gather, submit and visualise information related to the educational process. The nature of the connected IoT devices will dynamically aid the improvement of the learning circumstance for the benefit of everyone involved in the process – learners, teachers, administrators and decision makers (Veeramanickam & Mohanapriya, 2016). One of the terms used to describe a connected learning environment is Smart classroom. Bagheri & Movahed describe it as "an intelligent environment equipped with different kinds of hardware and software modules. Video projectors, cameras, sensors and face recognition algorithms are examples of modules that monitor different parameters of the physical environment." (Bagheri & Movahed 2016, p.71)

This concept will be able to fulfil its potential only if the data collected from the connected sensors is used to analyse and enhance the learning experience. In other areas like finance and information technologies, for example the large amount of data collected is used to outline patterns in order to prevent fraud, to enhance the user's experience and even to predict, and influence future behaviour. The ultimate goal in this direction when it comes to education is to create a Smart learning environment (SLE) - physical space enhanced with digital and context-specific components (sensors and actuators, for instance) that facilitate better and faster learning. According to Freigang (2016), SLE "allows for hybrid learning approaches that switch between formal and informal settings, independent and class learning, varying learning times and places, and analogue and digital learning formats. These learning scenarios pave the way for hybrid synergies between the physical and digital world. Smart learning environments also adapt themselves to learners' needs by taking information from the environment, processing it, and using it to initiate appropriate steps such as recommendations."

All of the above enhancements to the educational setting do come with serious potential downsides and risks. One of the biggest risks like with any connected technology is the privacy. While IoE offers accelerated sharing, communication and interaction, the context awareness of the technology means that ability to control the flow of data and to establish who know what about us

is extremely compromised (McRae, Ellis, & Kent, 2018). Educational institutions need to plan carefully the implementation of any connected devices or services, as they are directly responsible for ensuring the security and wellbeing of their students. As stated by Aldowah, Rehman, Ghazal, & Umar (2017), "IoT applications must engage the future workforce morally and ethically to address cyber security issues as society depends more on IoT applications. Therefore, a collaborative method to safety and security will be required to develop solutions in effective and appropriate way to face IoT security challenges. Furthermore, the full potential of the IoT depends on strategies that consider people's privacy" (p.7). This does not only extend to cyber-attacks or improper handling of personal information but also questions the way institutions handling student records. The ethical dimensions of learning analytics open the door for a number of debates in fields like surveillance studies, Big Data, governmentality and privacy. None of these debates is limited to only one field and they often overlap with each other. (Bandara & Ioras, 2016)

CONCLUSION

The Internet of Everything offers to revolutionise a conservative field like education by providing it with the means to collect and analyse data in order to create an enhanced learning experience tailored to the individual learner. While this is making headway in the distance learning delivered over the internet, it is not getting that much traction in the traditional educational setting. Alongside other factors, this requires huge amount of resources, which are not always evenly distributed among mostly publicly funded educational institutions. This is why private giants like Google can fund advances like Artificial Intelligence (AI) and Deep Learning, which are both very closely related to the IoE while at school the technological advancement is limited to digital diaries and whiteboards. To work on such projects though, apart from financial resources, a very large amount of data is needed, which is simply not available to the educational providers. To collect such amounts of data any institution needs to implement smart environments and s multitude of sensors tracking student performance, which in turn raises question over the ethical side of collecting information and the security risks of storing and analysing it.

The answer to that challenge would be to unite the efforts or educational institutions, business and government in order to facilitate the implementation of IoE in education, while offering a guarantee that personal data will be protected and used in an ethical way. This can only be achieved through a transparent public debate and very well defined rules especially taking into account the inherited mistrust towards surveillance by the government or exploiting personal details by the businesses.

REFERENCES

Aldowah, H., Rehman, S. U., Ghazal, S., & Umar, I. N. (2017). Internet of Things in Higher Education: A Study on Future Learning. *Journal of Physics: Conference Series. 892.* Langkawi: IOP Publishing. doi:doi :10.1088/1742-6596/892/1/012017.

Ashton, K. (2009, June 22). *RFID Journal.* Retrieved 04 15, 2020, from That 'Internet of Things' Thing: http://www.rfidjournal.com/articles/view?4986.

Bagheri, M., & Movahed, S. H. (2016). The Effect of the Internet of Things (IoT) on Education Business Model. *12th International Conference on Signal-Image Technology & Internet-Based Systems (SITIS)* (pp. 435-441). Naples: IEEE.

Bandara, I., & Ioras, F. (2016). The Evolving Challenges of Internet of Everything: Enhancing Student Performance and Employability in Higher Education. *INTED2016 10th annual International Technology, Education and Development Conference.* Valencia: IATED Academy.

Davis, G. (2018). 2020: Life with 50 Billion Connected Devices. *2018 IEEE International Conference on Consumer Electronics (ICCE).* Las Vegas: IEEE.

Freigang, S. (2016, - -). *IoT in education by designing smart learning environments.* Retrieved 04 20, 2020, from Bosch Connected World Blog: https://blog.bosch-si.com/future-of-work/iot-in-education-by-designing-smart-learning-environments/.

McRae, L., Ellis, K., & Kent, M. (2018). *Internet of Things (IoT): Education and Technology, The relationship between education and technology for students with disabilities.* Bentley, Western Australia: Curtin University.

Peng, H., Ma, S., & Spector, J. M. (2019). Personalized Adaptive Learning: An Emerging Pedagogical Approach Enabled by a Smart Learning Environment. In *Foundations and Trends in Smart Learning. Lecture Notes in Educational Technology* (pp. 171-176). Singapore: Springer.

Selinger, M., Sepulveda, A., & Buchan, J. (2013). *Education and the Internet of Everything: How ubiquitous.* Cisco Consulting Services and Cisco EMEAR Education Team.

Veeramanickam, M., & Mohanapriya, M. (2016). IOT enabled Futurus Smart Campus with effective E-Learning : i-Campus. *GSTF Journal of Engineering Technology (JET), 3*, 81-87.

Voorhees , R., & Cooper, J. D. (2014). Opportunities and Barriers to Effective Planning in Higher Education: Data Sources and Techniques. In M. E. Menon, D. G. Terkla, & P. Gibbs (Eds.), *Using Data to Improve Higher Education: Research, Policy and Practice* (Vol. Volume 29, pp. 25-38). Rotterdam: Sense Publishers.

Wong, J., Baars, M., de Koning, B. B., van der Zee, T., Davis, D., Khalil, M., ... Paas, F. (2019). Educational Theories and Learning Analytics: From Data to Knowledge. In *Utilizing Learning Analytics to Support Study Success* (pp. 3-25). Cham: Springer.

