The Eurasia Proceedings of
Educational & Social Sciences (EPESS)
ISSN: 2587-1730

The Eurasia Proceedings of Educational & Social Sciences (EPESS), 2018

Volume 11, Pages 30-35

ICONSE 2018: International Conference on Science and Education

Introducing the Internet of Things to Computer Science Students

Elena KRELJA KURELOVIC
Polytechnic of Rijeka

Jasminka TOMLJANOVIC
Polytechnic of Rijeka

Dario KUKULJAN
Juraj Dobrila University of Pula

Abstract: The aim of this paper is to show the importance of integrating the Internet of Things (IoT) into the curriculum, especially for computer science students. The Internet of Things is a new trend in the development of the Internet, where focus is on interaction between objects, i.e. "things". The IoT has become very widespread and the number of smart devices is increasing on a daily basis, thus we are talking about smart wearables, smart home, smart city, smart cars, smart healthcare, smart agriculture, etc. Therefore, it is important to familiarize computer science students with the IoT concept by examining literature and participating in practical projects which prepare them for future jobs. This paper describes the learning model with IoT projects as a part of course curriculum, for a 1st year Computer science students of the Polytechnic of Rijeka. The working hypothesis is that students show better results on the course with IoT projects in curriculum than in previous years with traditional teaching methods. The most significant goal of such a project is to reduce the educational gap between the skills demanded by the labor market and the practical knowledge of the future workforce in the IT field.

Keywords: Internet of things, Smart home, M2M, STEM, Education

Introduction

Due to the increasing availability of broadband and wireless Internet, the number of smartphone users and the development of cloud technology, and to the decrease in prices of electronics, a lot of "smart" devices are appearing. In 1999, Kevin Ashton laid the foundations for the IoT concept, explaining that things we use in our daily lives, if they have identifiers and the possibility to connect to the Internet, they can communicate mutually and could be controlled from anywhere. The Internet of Things (IoT) is a concept where all "things" or objects have a representation and a presence on the Internet. Smartphones, smartwatches and fitness bands (Wearable technology), which use sensors to track physical activity and pulse, thus enabling users to improve their health are being more and more used. Smart houses/buildings, smart cities, autonomous i.e. smart cars and vehicles, smart healthcare, smart agriculture are some of the areas in which the IoT is being used. The predictions of Internet of Things development indicates that numerous companies worldwide will have implemented the IoT by 2020, in order to improve their business activities, more than 65%, according to Gartner, and over 20 billion smart devices will have been connected globally (Banerjee, 2016; Hung, 2017). It is evident that we are heading towards the digital transformation in all sectors, referred to as "4th industrial revolution". Therefore, it is important to familiarize computer science students with the IoT, in theory and practice, during their studies in order to prepare them for the labor market. The main research question in this paper is will the students show greater interest in the course and better results when the IoT is included in the curriculum.

The Basics of the Internet of Things

The term Internet of Things "generally refers to scenarios where network connectivity and computing capability extends to objects, sensors and everyday items not normally considered computers, allowing these devices to generate, exchange and consume data with minimal human intervention" (Internet Society, 2015). Google defines the IoT as a "network of everyday items with embedded computers that can connect directly or indirectly to the Internet" (Asseo et al, 2016). In such a network every object has its own unique identifier. The term "thing" refers to objects made by humans (measuring instruments, watches, clothes, consumer electronics, cars, houses, farms, industrial robots, etc.), as well as natural objects (plants, animals, people). For example, "The Cow Tracking Project" has attached various sensors to cows to collect data regarding their health, eating patterns, behavior within the herd; with all the information being sent in real time to a local server (Plavljanic, 2016). Due to the fact that everything can be connected, Cisco uses the terms "Internet of Everything", IoE (Evans, 2012). "Smart things" offer an insight into data that until now has been hard to obtain, and they bring new value through the interpretation of collected data and better decision-making. The connection of a device to an engine or a database puts data in context to other information and that is truly the value of the IoT (Asseo et al, 2016). Exchanging, analysis and processing of the collected data are at the foundation of the Internet of Things, which is referred to as "new connectivity". There are 3 types of connectivity: person to person, person to machine, machine to machine. The IoT concept should increase the data flow between devices and computers and between people and computers (Plavljanic, 2016).

M2M communication

Machine-to-Machine (M2M) is automated communication (without human intervention) between machines, devices and objects. "Connected devices" is one of the features of the Internet of Things. The Internet of Things is bridging the physical and virtual worlds, in which M2M communications represent the baseline communication that enables the interactions between things and applications in the cloud (Internet Society, 2015). The Internet of Things generally refers to Machine-to-Machine communications involving network-based remote sensors and actuators (Asseo et al, 2016). The devices connected to the IoT use wireless technology to communicate: RFID (Radio Frequency Identification), NFC (Near Field Communication), Wi-Fi, LTE, and so on. Every device has its own unique IP address (to identify each thing) and it shares information with other connected devices and applications in real time or at defined time intervals.

Smart Home

One area of application of the Internet of Things is "Smart Home". The term "smart home" means there are different things inside a home that are computer-controlled and connected, with advanced processes of automation and optimization, e.g. energy consumption in order to increase comfort and security in the home. The smart home system consists of interconnected network of sensors and "things" like heating/cooling, lighting, alarm system, home appliances and devices, electric blinds/shutters, garage doors, water/gas valves, remote controls, communication devices and microcontrollers (figure 1). All objects are connected into a network, and each object has its own unique IP address so it can be controlled and managed from different positions and it can communicate with other objects in the network. The network itself can be wired, wireless, or an existing power-line can be used. The smart home system can be controlled and managed in different ways; most often via smartphones, remote controls, computers, or touchscreens. According to analysis, world market for smart home appliances will grow to $ 400 billion by 2030. (Kearney, 2017).

Figure 1. Example of a Smart Home (Horvat, 2017)

The Internet of Things as a part of teaching

The Internet of Things can be integrated into lesson plans and activities in the classroom at all levels. This paper presents the experience acquired in teaching an introduction to the Internet of Things as a part of the course named "System and Information" to 1st year computer science students at the Polytechnic of Rijeka. Main goal was to motivate students to become more prepared for future jobs in the IT field and interested in STEM.

The Internet of Things can improve education in different ways: as a technological tool to enhance academic infrastructure and classrooms (smart boards, mobile devices, e-books, student ID cards with RFID tags, etc.), or as a subject or a course to teach fundamental concepts of computer science. As a teaching subject, the IoT can be a stimulating topic to attract students to computer science studies and it is a platform for teaching computer science concepts (Gul et al., 2017). Asseo et al. (2016, pp. 23) consider it is important to "Take advantage of the opportunity and responsibility to teach students how to design IoT products and systems. Incorporate new subjects in order to provide the skills that are necessary in an IoT business world, where analysis of big data from IoT sensors will take on a major role. Most important, inspire creativity to apply the IoT to new businesses and concepts, and instill a vision of where the IoT can lead."

Teaching Methods

In presented case study, familiarizing students with the Internet of Things concept, its possibilities and applications, consisted of theoretical and practical lessons. The teaching methods that emphasized collaborative and active learning, problem-solving and critical thinking were used. After 2 introductory lessons, students divided into teams (3-4 persons) and chose a topic they would study in detail, research and then present to others and prepare questions for discussion. The following topics are proposed: Communication Models in IoT, Smart Wearables, Smart Home, Smart City, Smart Cars/Vehicles, Smart Healthcare, Smart Agriculture, Security and Privacy Issues in IoT.

In practical classes, students worked in groups to develop IoT based projects with LittleBits Smart Home Kit. The set consists of 14 electronic components (input sensors, CloudBit module with Wi-Fi, output modules like LED, MP3 player, IR transmitter etc.), which can be put together with built-in magnets (like Legos), that enables the creation IoT projects without soldering. The numerous possible combinations of these components engage students in active inquiry and problem-solving and make the whole process of learning-by-doing more interesting. Created projects can be managed via apps on a smartphone, tablet, or computer, from anywhere. Finished projects can be triggered by web services like e-mail/Gmail, Calendar, Facebook, or SMS, using IFTTT service (If-This-Then-That). Students learned about the IoT concept, home automation and network control. LittleBits Smart Home Kit supports trends in modern education: STEAM programs, the Maker Movement, project-based learning, collaborative learning, 21st-century skills and creative thinking (LittleBits Educator's Guide). "Point-and-click control software (e.g., IFTTT, https://ifttt.com/) can easily configure sensors and actuators to create do-it-yourself, highly optimized custom-control systems. All of these IoT examples can ultimately enhance the learning experience for students and teachers, offering improved engagement and collaboration." (Asseo et al, 2016).

Students' IoT Projects

CloudBit module, which can send a signal from LittleBits circuit to the Internet, or can receive a signal from an event on the Internet and send it to LittleBits circuit, was added to the projects the students had been familiarized with. Prior to first use, students had to setup the CloudBit module and connect it to a Wi-Fi (https://www.littlebits.com/cloudstart). Some of the IoT projects made by students included: turning on/off lights controlled by a light sensor, measuring of room temperature (figure 2) via computer app or smartphone app (figure 3), turning on/off cooling fan when the room temperature is above 24°C (with IR transmitter behind CloudBit like on figure 2), turning on/off water heater when CloudBit receives an email automated by IFTTT web service (figure 4), receiving an email if the noise level (sound trigger + threshold before CloudBit) in the room is too high, the alarm clock (MP3 player module) which is triggered by a Google Calendar event.

Figure 2. Temperature measurement via Internet

Figure 3. LittleBits Cloud Control with smartphone, receiving a signal

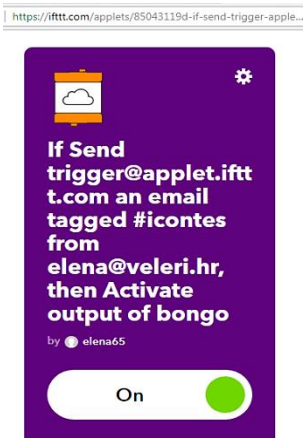

Figure 4. Automation of LittleBits project with IFTTT

Results and Discussion

After listening to lectures, giving presentations and doing practical assignments regarding the Internet of Things, students acquired practical and theoretical skills and knowledge and were able to apply critical thinking skills and discuss the topic. Students became more engaged and learned more, and the pass rate on the course increased by 8% compared to the previous two years with traditional teaching (figure 5). Although they were satisfied with the acquired skills and knowledge, they have recognized some problems with IoT. Some students expressed concerns about IoT security issues and the privacy protection of users. However, as future IT specialists, they are aware that IoT will create many new jobs and professions.

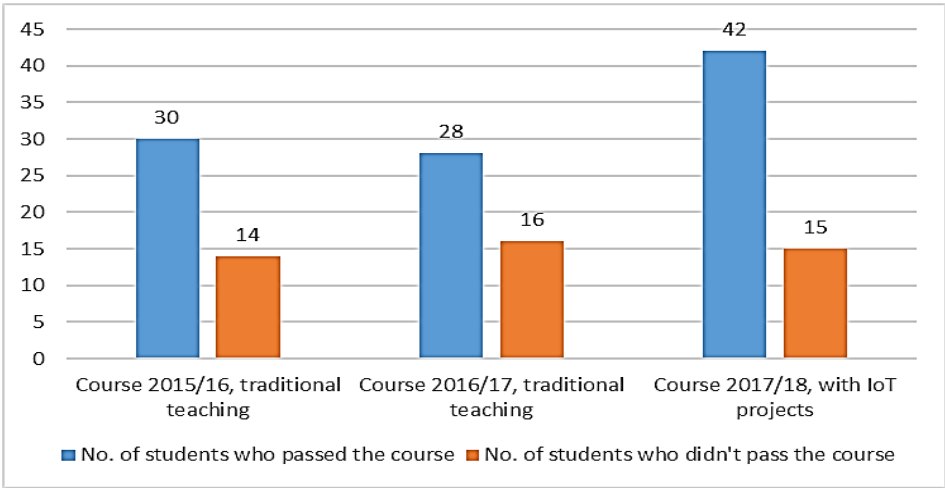

Figure 5. Pass rate on the course "System and information" with and without IoT in curriculum

Considering that computer science students have courses in programming during their studies, LittleBits Smart Home Kit has shown certain limitations. The authors believe that this particular set is more suitable for younger age groups, eg. primary and secondary school students. Therefore, in the following academic year, Arduino RFID Starter Kit is planned to be used in order for students to get acquainted with the method of contactless communication and automatic identification, which can be applied to register students' attendance.

Conclusıon

The number of connected objects is continuously increasing, which means that the IoT has a significant influence on the economy, industry and also education. The Internet of Things changes our habits. For example, the way we look after ourselves and our health, the way we manage our home, order, buy and pay, communicate, gather information and make decisions; it also helps optimize our everyday processes. Implementing the IoT into teaching with practical lessons requires a lot of preparation for both, teachers and students, but benefits are bigger than obstacles. Students have gained knowledge and practical experience which help them to understand the IoT concept and how "smart" things work. Teachers who want to include the IoT in their lesson plans must make sure they have all necessary IT equipment, with emphasis on a robust network bandwidth and reliable Wi-Fi, as well as choose teaching strategies that support the use of IoT in the classroom. However, if we want to prepare students for the demands of the labor market, it is necessary to include and integrate such topics and content into the computer science curriculum.

References

Asseo, I., Johnson, M., Nilsson, B., Neti, C., Costello, TJ. (2016, July/August). The Internet of Things: Riding the Wave in Higher Education. *Educause*. 51(4). Retrieved from https://er.educause.edu/~/media/files/articles/2016/6/erm1641.pdf

Banerjee, P. (2016). IoT Report. Retrieved from http://www2.schneider-electric.com/documents/presentation/en/local/2016/04/998-19699217_IoT_Report_2016_v2.pdf

Evans, D. (2012). The Internet of Everything. Cisco Internet Business Solution Group (IBSG). Retrieved from https://www.cisco.com/c/dam/global/en_my/assets/ciscoinnovate/pdfs/IoE.pdf

Gul, S., Asif, M., Ahmad, S., Yasir, M., Majid, M., Malik, S.A. (2017, May). A Survy on Role of Internet of Things in Education. *IJCSNS International Journal of Computer Science and Network Security*. 17(5). Retrieved from http://paper.ijcsns.org/07_book/201705/20170520.pdf

Horvat, I. (2017). Embedded računala i Internet stvari (IoT). *Ucionica.net*. Retrieved from https://www.ucionica.net/racunala/embedded-racunala-i-internet-stvari-iot-4038/

Hung, M. (2017). Leading the IoT. Gartner Inc. Retrieved from https://www.gartner.com/imagesrv/books/iot/iotEbook_digital.pdf

Internet Society. (2015). The Internet of Things: An Overview, Understanding the Issues and Challenges of a More Connected World. Retrieved from https://www.internetsociety.org/wp-content/uploads/2017/08/ISOC-IoT-Overview-20151221-en.pdf

Kearney, A.T. (2017). The Battle for the Smart Home: Open to All. Retrieved from https://iotnews.asia/wp-content/uploads/2017/01/The-Battle-for-the-Smart-Home-Open-to-All.pdf

LittleBits Educator's Guide. Retrieved from http://e.littlebits.com/lndownload-teachers-guide-welcome

Plavljanic, B. (2016). Internet of Things (IoT). *PC Chip*. Retrieved from https://pcchip.hr/internet/internet-things-iot/

Author Information

Elena Krelja Kurelovic
Polytechnic of Rijeka
Trpimirova 2/V, Rijeka,
Croatia
Contact e-mail: elena@veleri.hr

Jasminka Tomljanovic
Polytechnic of Rijeka
Trpimirova 2/V, Rijeka,
Croatia

Dario Kukuljan
Juraj Dobrila University of Pula
Zagrebacka 30, Pula,
Croatia