

THE IoT IN EDUCATION AND TEACHING

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Abstract: There are numerous innovations, requirements and challenges that the education sector faces nowadays. Schools and faculties are ever more utilizing the so-called. "smart systems" with improvements in the field of IT and control systems, known as the Internet of Things (IoT) concept. The IoT refers to the interconnected objects, such as machines, mobile or stationary devices, sensors, computers, cell phones, controllers, etc. As such it provides a lot of opportunities and inventive options to the education system at different levels of functioning. Innovative technologies have transformed education and schooling and led to the use of tablets and smartphones in the classroom, intelligent modules and devices, interactive on-line processes and learning support systems. The possibilities of multifunctional boards and panels in the classroom, tuning ambient parameters, or monitoring people can help out professors and students in meeting the basic learning goals, which are defined by the regulatory standards and their outcomes. The implementation of IoT in education is also an opportunity for educational institutions to improve the entire teaching process by collecting and utilizing various valuable data. The same technology can also enhance joint operations by addressing a wide range of tasks faced by educational institutions, from organization, logistics, administration, statistics, to the customized requirements of students and professors. The flexible IoT integrates efficiently and converges well with smart learning technologies, optimizing existing processes and significantly reducing overall operating costs.

Key Words: IoT, education, teaching, electronic devices, automatic control.

1. INTRODUCTION

The Internet of Things (IoT) represents the network connecting people, processes, data and objects. The IoT connects millions of objects, like traffic signalization and lighting, parking service, hospital and biomedical equipment, household appliances, production lines, agricultural machinery, etc. These objects are equipped with sensors, processors and communication devices, all with the need to exchange important data over the internet, in order to achieve better functionalities, provide higher quality of service or improved user experience.

It was estimated that in 2020 almost 22 billion devices would be active and networked and approximately 12 billion of these will be IoT connections, surpassing non-IoT connections. It is expected that by 2025 nearly 30 billion IoT connections will be in the global network. [1]

The IoT can be described as globally networked infrastructure, connecting physical and virtual objects by using collected data and communication capabilities. The requirements for the IoT are security, privacy, trust. [2]

The IoT is an extremely large platform that uses different types of technical devices. Each device on the IoT has its own unique identifier (UID), embedded hardware and software, equipping it to receive, process and send information without human intervention. The IoT can refer to any device connected to computer network in order to collect, process and send information in various manners, for example, through sensors and processors. [3]

As in many other sectors the IoT have a significant influence on education. From the so-called "flipped classrooms", on-line courses, to integrated mobile technologies, network convergence, the IoT-enabled connectivity continues to supplement instructional approaches. The IoT can improve certain functions of the various education systems starting from the security of equipment, staff and students, through the use of smart cameras, indoor climate control, to the smart lighting systems that are providing better and more energy efficient lighting.

The IoT is modifying the education system, it brings a lot of added value to the physical teaching environment as well as to the structured learning approach. Smart schools have facilities to operate in an innovative regime with highly personalized learning methods. The technology that underpins this can use Wi-Fi and networks in order to send and receive appropriate materials for instructions and learning. [4]

2. THE IoT AND CONTEMPORARY EDUCATION ENVIRONMENT

In the recent years the intensive development of inventive technologies has changed the world of education dramatically. However, these progressions are negligible compared to those that are happening in the education system due to the appearance of the IoT applications. The IoT is a complex and rapidly growing network, which consist of connected objects of different types. Because of their ubiquitous nature, educational institutions are striving to incorporate IoT technologies into teaching and learning activities in more extent then ever before.

Teachers, researchers and students are now having opportunity to lead the discovery, development and design of IoT systems, devices, applications and services.

The IoT in education may be implemented through flipped classrooms, Augmented Reality (AR) and Virtual Reality (VR), smart boards, or to provide access control monitoring and safe learning and working spaces. According to some research reports the IoT market to rise from \$4.8 billion in 2018. to 11.3 billion by 2023 will be expected. [5, 6]

IoT technologies have steered education towards strengthened digital learning, updating campuses and classrooms for the better user experience. It implements advances in electronics, enabling the development of smaller, reduced also in power consumption, and most importantly less expensive wireless systems, that can be integrated in almost any type of device. Wi-Fi networks in schools and departments must be scalable to handle the rapidly-growing number of smart devices connected to them. Incorporating the IoT into the curriculum by introducing experimenting with devices, like Arduino and Raspberry Pi, helps teach engineering and math, electronics and programming, but even more importantly inspires indispensable creativity. IoT-enabled classroom can utilize part of a colleges existing technology investment to help automate adequately and simplify common classroom tasks, improving both on-line and face-to-face learning. [7]

Education will be furthermore affected by the IoT as schools are using connected devices more effectively. The IoT technologies continue to enter the education sector, as students, educators and administrators collaborate more closely and obtain relevant insights from the collected, analyzed and applied data. These technologies will provide: data collection, personalized learning, more human-to-machine interaction, security (figure 1). [8]



Figure 1. The IoT in Education [8]

Students are becoming increasingly adept at using popular social networks, like YouTube, Facebook, Twitter, instant messaging, posting videos, or snapshots, while collaborating and socializing anywhere, anytime. There is also the use of software applications to create educational content or to interact with such content. Nowadays more and more classrooms are becoming “open” through implementation of video, voice or text messaging, while multimedia resources of various teaching modes are available to improve overall teaching process. [9]

The IoT has huge potential in education. However, for successful implementation it is necessary to address: 1. Security; 2. Data integrity; and 3. Education policy. The successful implementation of the IoT in education will depend upon the same three key factors. ICTs are becoming an indispensable part of education system in order to prepare students for jobs available today, as well as in the future; and educators and students alike must continuously improve skills and competencies over time to keep up with the fast technological changes. [9, 10]

While IoT technology is proliferating, especially in mobile devices, most education institutions around the world still have to integrate it actively in the whole learning process. A great number of institutions have still not reached each other and interconnected. Technology must be adopted in a massive way, so that the IoT can be fully realized and engaged in a more authentic and relevant education beyond the classroom. [5]

Technologies necessary for the development of the Internet of intelligent devices are: computer networks and protocols, sensor networks, M2M communication, mobile technologies, cloud computing, big data. The IoT links people, processes, devices and data altogether. It augments the quantity and value of the collected information, allowing the stakeholders in educational sector to turn data into valuable information as never before. With the introducing of mobile technologies, the educational institutions now can keep track of overall education resources. The implication of the IoT will help the overall resource deliveries in an innovative manner to the participants. This insight provides stakeholders with a real-time information of students, staff and other resources. It helps in decision making, automatic execution and providing security features.

But extensive use of ICT and the IoT can increase energy consumption and produce more electronic waste or environment pollution. So wise choice should be that green versions of both listed are derived and then applied. [11]

There is no doubt that the enhanced IoT-supported educational environment required a higher degree of collaboration among various relevant institutions, staff members and students. Only with full engagement of all

stakeholders to cooperate and collaborate, the idea of the completely redesigned education sector, technology supported, enhanced and economically, ecologically and socio-culturally sustainable, would be possible. Because of that, the power of collaborations between people and technologies in modernization of the education, the realizing fully IoT-based educational practices and the environment conditions, are subjects in the main focus. [12]

3. INTEGRATION OF THE IOT SYSTEMS AND THE SMART LEARNING TECHNOLOGIES

The IoT has integrated in the learning and teaching overall. Smart Learning Environments (SLEs) are equipped with digital components, that create better, more efficient and flexible learning process (figure 2). SLEs create a synergy between physical and digital realities, allowing students to absorb information from their experience, and making opportunities for seamless transitions between a variety of learning approaches. SLEs also adapt themselves to learners' needs and allow hybrid learning approaches. SLEs provide individual or group learning, formal or informal settings, analog or digital formats, etc. The IoT can track whether homework was done and collect data about time required for student to complete assignments. This data can help teachers assess whether their methods are effective and proper, which students need additional help, what are the learning outcomes. [13]

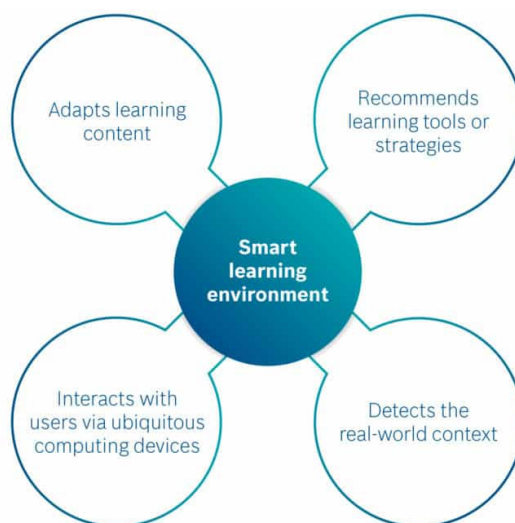


Figure 2. Scheme of the smart learning environment [13]

The essential factors which drive rapid adoption of the IoT in education system are following, according to [6]:

- Easy availability and affordability of cloud services are important tasks in the increased popularity of the IoT;
- Highly customized apps tailor-made to educational institutions requirements can be developed quickly;
- Unlimited storage with 'pay per use' ensures that storing, analyzing and accessing data is easier and cheaper.

The role of education became more significant in the past years, partly due to the emerging and expansion of sophisticated innovative technologies. The human- or student-centered design is transforming education enabling that the learning process of different students when needed can be completed in various ways. Additionally, learning material becomes concentrated and more personalized. Both are provided through SLEs. An important element of the IoT is integrating technology into everyday items to make them "smart". [13]

The IoT has important functions for the improving education system at all levels, ie. in kindergarten, school, college, academy, university. Students are increasingly moving from printed books to tablets and laptops. With all necessary information readily available, students now learn at their own pace, and have almost identical experience working from home or in the classroom. In a way, this trend provides students with more benefits, on the other hand the learning process is more efficient for professors. Progress in connectivity technology means that teachers do not have to review tests (written works) or to perform other routine tasks manually. Instead, teachers can now focus on the real, customized lesson that matters more to students. Devices connected to the cloud enable professors to collect data on their students, and afterwards assess who needs more attention or support. Statistics like this one also allow professors to adequately modify curriculum for future lessons. [9]

The quality of learning process for students can be enhanced through monitoring and analyzing continually the tasks, exercises and activities, implementing information sensing devices and processing platforms to provide feedback about entire learning process. Using wide area broadband network, with locally smart nodes or intelligent objects, the IoT has the potential to allow expansions and improvements to essential utilities in various fields. These can be done by introducing a certain ecosystem for the application deployments. The functions of the IoT are designed to provide and form the smart educational operations and processes, as in making activities more efficient and getting professional decisions more effective. [13]

4. CONCLUSION

The IoT makes significant impact on the education sector. It has strong connections with many aspects of contemporary education system, where these technologies show irreplaceable potential. Through enabling smart classrooms, schools, and universities, the IoT creates a completely new type of interaction between teachers and students, devices and environment. Learning and teaching processes become faster, easier, more immersive, interactive, cooperative, flexible, collaborative and available on-demand, anywhere and anytime.

The IoT can support different classroom concepts and activities through the use of new learning resources and flexible learning methods; enhance organization's and management efficiency, high-level control procedures, reduce maintenance costs and similar. The IoT and software development tools can significantly improve educational experiences and make operations easier, for all stakeholders: students, educators, administrators, management, parents. With help and support of the certain IoT systems teachers tasks and goals remain to assist students as needed to navigate throughout interactive exercises where they learn by doing, and not solely by passive observing.

Options for enhancing learning practices are explored by using IoT systems, as well as the potential of these to contribute to achieve economically, socially and environmentally sustainable educational surroundings. The smart classroom equipments enable users to develop skills, adapt and use contemporary technologies in a learning process, which then produce elevated learning outcomes. The IoT is a specific technology in which objects equipped with sensors, actuators, and processors communicate with each other to serve relevant multifunctional purposes.

Moreover, in the case of emergency situations (floods, earthquakes, pandemics, etc.), learning takes different organization and operation forms. When teaching inside educational institutions is interrupted and online learning remains as only resource, the potential of the IoT comes to the fore. However it is necessary to prepare relevant knowledge sources, use existing platforms and to develop appropriate databases for online learning as an alternative teaching option. Thereby teachers, researchers and students are in active positions to lead the discovery and development of the IoT systems, devices, applications and services.

The IoT supports educational institutions to transform the whole learning ecosystem in order to perform important tasks, such as subject tracking, data analytics, classroom management, personalized learning, providing mobile learning control systems, proper assesment. The most crucial factors for the further IoT implementation in education and teaching are insuring existing resources to be optimally used and making necessary innovative technologies, both accessible and easy to use.

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