

Can we make Schools and Universities smarter with the Internet of Things?

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Abstract – Schools and universities stand up to the challenge the Internet of Things, which has the potential to significantly change teaching and learning. The learning and administrative processes and the relationships between all participants in education may benefit from the Internet of Things since the linked physical devices ensure connectivity of people and ensure their activity. The implementation of the Internet of Things in education, unlike other spheres, has a very important and difficult task. The Internet of Thing has to guarantee the creation of an environment that supports the acquisition of knowledge in a new, natural and effective way, consistent with the new realities and learners' expectations.

The questions of how and in what direction the Internet of Things will lead to changes in educational activities and processes have many answers and need discussions and debates.

The objective of the current work is to answer these questions by presenting the concept the Internet of Things and consider its possible applications in education.

Keywords – Internet of Things; education; smart devices

1. Introduction

Innovative technologies, used in education, help to transform learning process from a model of knowledge transfer to a model based on interaction, collaboration and active participation of learners. The Internet is a natural environment of the contemporary innovative technologies.

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The Internet connects people through the tools of Web 2.0, giving the m various channels for connection and interaction. The *Internet of Things* is a concept that focuses on connectivity of physical objects that people use and how the y can facilitate everyday life. The idea of a network of interconnected physical devices actually connects people more comprehensively and naturally to their surroundings and allows more efficient exchange of information between devices and people.

The questions of how and in what direction the *Internet of Things* will lead to changes in educational activities and processes have many answers and need discussions and debates.

The objective of the current work is to answer these questions by presenting the concept the *Internet of Things* and consider its possible applications in education.

The *Internet of Things* has the potential to significantly change the educational process and the relationships of participants. The *Internet of Things* may affect the teaching and learning processes, including the approaches of creation of knowledge and its dissemination. The learning process may be directed entirely to the participants' needs by physically connected devices. The *Internet of Things* allows achievement of what is often a matter of controversy – the availability of more technical devices and accompanying technologies helps transform learning in more human-oriented process [1].

Contrary to everyday life, where people use smart devices to facilitate and accomplish their activities more effectively, implementation of the *Internet of Things* in education has much more important and difficult task. The purpose of using the *Internet of Things* in education is to create an environment that supports the acquisition of knowledge in a new, natural and efficient manner consistent with the learners' needs and expectations.

2. The concept of the *Internet of Things*

The global system of connected computer networks Internet is an indispensable part of people's

lives and connects and provides users with a huge variety of information resources and services. In its development the Internet evolves and transforms from repository of static documents into the vast world of connected users, devices and applications.

The evolution of the Internet goes through: Internet of Content - publishing and sharing mainly static content; the Internet of Services - Web 2.0 or opportunities for collaboration and interaction between users, which results in creating dynamic content, the Internet of People - opportunities for connecting users via social media [2]. The *Internet of Things* is seen as the next step in the evolution of the Internet. The new stage is characterized by the communication between devices (machines) which provides opportunities for generating and collecting huge amount of data. Data is processed, analysed and transformed into information, knowledge and wisdom, which can be disseminated [3]. The *Internet of Things* allows all these activities and the processes of making decisions, based on collected and analysed data, to be accelerated and automated.

In all previous phases in the Internet evolution main subjects that create and use the generated data and information are people. The active participants in the the *Internet of Things* are devices (things) that generate and use data [4].

According to Gartner IT Glossary [5] the *Internet of Things* is a concept for a network of physical objects that have embedded electronic devices for communication and interaction with each other or with their surroundings. They exchange data during the process of interaction. The physical devices react autonomously to the real world events and can influence it by initiating processes that can run other actions with or without direct human intervention [6, 7].

The concept of the *Internet of Things* can reorganize economic and social processes and substantially change and improve people's lifestyle. The *Internet of Things* may make the functioning of surrounding devices in favour of people's needs and preferences excluding the need for their direct participation in the activities and operations.

The connected devices, data and information generated in their interaction, are a prerequisite for new services and applications that the devices themselves individually can not provide. As a result, the physical and the digital world merge, people are more closely related to their surroundings and communication with it is facilitated.

3. Internet of Things and Education

The forecast of Gartner, Inc. is that by 2020 the number of connected devices will reach 25 billion [8]. Certainly, according to this prognosis the concept of the *Internet of Things* will influence all spheres of public life, including education.

The *Internet of Things* is becoming more popular in different areas of social and economic sphere. New concepts such as Smart Cities, Smart Environment and Smart Homes are stepping in and using [9]. The creation of **Smart Cities** allows opportunities for Smart Parking; tracking and monitoring of sensitive equipment, structures and objects; traffic tracking and optimization; Smart Roads that ensure safe movement adapted to climatic conditions; Smart Lighting with intelligent street lighting, etc. **Smart Environment** includes environmental monitoring which results in preventing fires and air pollution, pre-registration and reducing the damage from landslides, floods, avalanches, earthquakes, etc. **Smart Homes** offer remote control appliances that provide optimal living environment, etc. The *Internet of Things* is used to automate a number of industrial and manufacturing processes, in management, marketing and logistics, in agricultural production, animal breeding, identification of objects or people and others.

The relationship between business and education, the need for lifelong learning at all levels of management in business organizations, the widespread of e-learning and distance learning are prerequisites for the gradual introduction of the *Internet of Things* in the field of education. The ideas of building **Smart Schools** and **Smart Universities** come to the fore. They transcend notions about the traditional interactive classrooms.

The *Internet of Things* is used by more and more educational institutions to provide the infrastructure, the physical environment, where the learning process is performed. Various smart devices manage and ensure the necessary conditions for the creation of an optimal learning environment: a control of airflow, an optimization of the air quality, temperature and humidity. The *Internet of Things* allows the making of optimal conditions for learning activities and the achievement of efficient spending of the financial funds for provision and maintenance of the physical infrastructure. Educational institutions can also ensure a higher degree of physical security in buildings using smart devices.

The questions what and how the *Internet of Things* will lead to changes in educational activities and in education in general are still open and unresolved. The possible directions for change are expressed in [1, 10, 11, 12].

Students are much more engaged in the learning process and they can perceive and learn using all their senses.

The *Internet of Things* provides opportunities for conversion of users' various personal devices into tools for implementation of training as part of their daily activities. Smart devices provide easy and quick access to the educational environment and available learning resources and activities. Smart objects become tools that help implement effective learning process and offer new learning experiences.

All available users' devices are connected and can be identified, interact and communicate with each other and with their surroundings. They can link their owners with environment and all other participants which results in higher degree of involvement and participation in occurring activities and processes. Connected devices transform learning from passive to active. The easy, almost unlimited access, to all relevant information and knowledge that can be generated in real time, increases the commitment of the learners to both formal as well as informal training. The connection with experts in a given field and the opportunities for sharing available information and knowledge stimulate the activity of learners in education as well as in science research process. The smart devices allow learners to be witnesses and direct participants in research activities, especially in disciplines that require data collection and analysis from the environment.

Opportunities for realization of personalized and based on interaction models of education.

Reporting the learners' achievements and tracking their progress by using smart devices are more effectively. Using different personal devices in the learning process allows fast and accurate development of a learner profile. The collected data can be stored and analysed in order to retrieve the necessary information about the specific way each learner acquires knowledge and skills. Learner profiles are a prerequisite for the realization of personalized learning. Learners can follow their own individual personalized training plan tailored to their needs and expectations. Personalization can be done automatically based on the constructed learner's profile, his level of knowledge and achievements, the pace of learning and specific needs by obtaining assignments and materials that are specifically designed for him.

Stimulating learners' creativity.

The *Internet of Things* provides learners opportunities to learn new technologies and apply them later in their professional development. Learners can experimentalise with different tools and devices, creating unconventional connectivity in

order to collect data, monitor events, getting the sound and artistic effects. Using the sets of the *Internet of Things* devices and sensors, specifically designed for training [13], has not only cognitive but also constructive purpose. Learners are discoverers of the new features and functionalities of connected things and can create new networks of devices that perform various tasks.

Automating many administrative activities.

Connected devices can improve the speed and save time to carry out some routine daily activities - for example, tracking learners' attendance in classroom. The smart devices register and collect data and replace teachers in carrying out routine administrative actions that take time, enabling them to focus on the process of training. Carrying out the routine activities in the classroom without the direct participation of teachers does not always mean better and more effective learning [14]. The collected data should be stored, processed and analysed, provided and shared with the right people at the right place and time and used to achieve the learning objectives.

Reporting the students' cognitive activities

Some authors believe that smart devices, which measure brain waves (Brain Sensing Devices), could be successfully used in the learning process. Brain Sensing Devices record electrical signals to measure human brain activity. The main purpose of such devices is to assist the process of meditation and relaxation, but they could be used effectively during the learning process. The learner's activity during the training process can be registered. Teachers can monitor students and their mental activity and react adequately depending on the data, which devices display. Brain Sensing Devices can collect data and inform teachers when some learners have difficulties when they are solving a problem or a task. The collected data can be processed and turned into real time indicators that help achieve effective learning process. The problems are solved before they take hold. This is a significant advantage of using the *Internet of Things* in learning process compared to the traditional education, where gaps and difficulties in mastering the educational content are established during the examination activities. Timely detection of gaps in knowledge allows overcoming them easily.

Providing an appropriate learning environment for learners with special educational needs

The *Internet of Things* creates a user friendly environment for people with disabilities and helps for their social integration. The smart devices and applications facilitate the management and performance of their daily activities making them

more self-sufficient and independent. The smart devices for remote control of home equipment, parking, which can be activated and managed by touch, gestures or voice, sensor indicators for orientation, text-to-speech modules, Radio-frequency Identification (RFI) and others, can be used for creating a learning environment for learners with special educational needs [15, 16]. Tracking the indicators of the connected devices by learners' parents ensures their protectivity and is a prerequisite for more effective and real time feedback with the educational institution.

Creating an interactive innovative learning environment

The *Internet of Things* can help creating an interactive and innovative learning environment that corresponds to the new pedagogical paradigms and changed needs and expectations of teachers and learners. A dynamic educational process can be realized via the *Internet of Things*. Dynamic events could happen during classes. They can be generated by the data collecting and processing from smart devices and connected to ongoing activities.

The teachers' role in this new innovative learning environment is changed. Teachers may focus on the teaching process, not on the accompanying regular administrative actions. The *Internet of Things* is very helpful for teachers when they work with large groups of learners. They can provide personalized learning, individual approach to each learner. Teachers can use various techniques and approaches tailored to the learners' specific needs and features.

Teachers have to take many decisions related to the learners. The decisions based to collected data from the smart devices can be automated via the *Internet of Things*.

The *Internet of Things* offers teachers tools for easy and fast creation of content that can be immediately shared with other participants in the educational process. The learning activities in the classroom can be recorded and saved automatically and made available to all learners. The collaboration is supported by the interconnected devices, such as the interactive whiteboards, which are intensively used in classrooms. Each participant in the learning process can be actively involved in the learning activities and contribute to the creation of educational materials. The learners can participate in the classroom activities by their personal devices and their actions can be displayed on the board and registered by all other connected devices in real time. Each learner has an access to content, which is created and displayed, can use and store it according to his preferences at any moment.

The *Internet of Things* has many benefits, but there are some problems that arise with their wider

acceptance: an incompatibility of connected devices due to the lack of the international standards for compatibility; security and privacy problems; job losses due to the automation of operations; human dependence on technology and others.

Although the *Internet of Things* still enter the various spheres of public life, the experts predict the new stage in the evolution of the Internet – the Internet of Everythings. The Internet of Everythings brings together people, processes, data and things and allows the construction of a world that will enable data and people connectivity [12].

4. Conclusion

The central role and place in education, unlike other areas of public life, is assigned to people, no matter of their roles: teachers or students. Undoubtedly, the smart devices can contribute and support the effective learning process. The conception of the *Internet of Things* concept creates prerequisites for building interactive and innovative learning environment where the events and activities take place dynamically and learners' needs are the leading engine of the training process. The set of smart technical tools allows personalized and human oriented training. Each participant can work, create and improve his knowledge and skills in such an environment.

The *Internet of Things* is entering with slow but promising pace in educational institutions in different ways (see Figure 1.). Some educational institutions focus on using the *Internet of Things* to create the necessary physical infrastructure for implementing the learning process: ensuring secure, reliable and cost-effective infrastructure. This is the first step in the *Internet of Things* use and they become an integral and necessary part of education. Other educational organizations offer basic knowledge and skills in the field of the *Internet of Things* and train learners to use this modern concept in their careers.

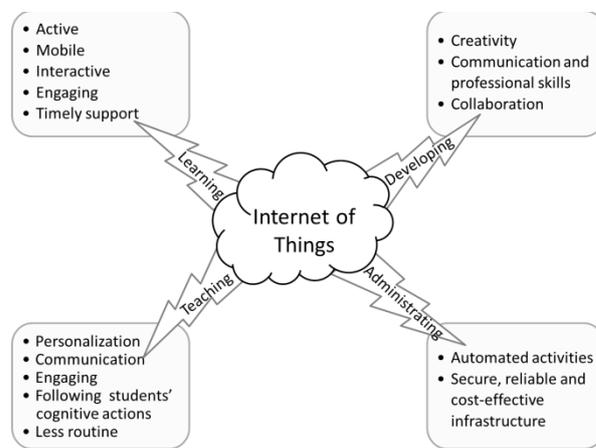


Figure 1. The main processes facilitated by the Internet of Things.

More important direction for the *Internet of Things* implementation in education should be a creation of dynamic and interactive learning environment where teachers, students and devices are connected, communicate and interact with each other. The innovative learning environment allows control of the information flows, timely receipt and use of the generated information. The ideas for personalized and individual training consistent with the learners' needs and preferences can be accomplished in a new and more effective way in a learning environment based-on the *Internet of Things*.

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