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A Survey on IoT in Education

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Abstract: The Internet of Things (IoT) has a major potential and already started to improve the human life in all sectors: smart cities, smart environment, smart water, smart metering, security and emergency, retail, logistics, industrial control, agriculture, home automation, eHealth and education. For example, in the construction and housing sector, smart buildings may integrate IoT technologies to increase efficiency, security, and comfort for inhabitants. In industry, smart wristbands may automate clocking in and out to precisely record the amount of time spent at work. In smart cities, the IoT technologies may be used to monitor parking spaces availability in the city, to monitor sound in different city areas in real time, to create intelligent and weather adaptive lighting in street lights etc.
In education, the IoT technologies represent a great opportunity for schools and may be used in various ways: to collect and use data to enhance the learning experience, to support the meeting of the learning goals, to improve the overall school operations etc. Since IoT field is expected to grow significantly in the next years, it is a must to prepare young generations for these changes.
The article presents a survey undertaken with university students enrolled in technical specializations, concerning their perspective on different aspects related to IoT technologies, their knowledge and their willingness to learn about the topic.

Keywords: *Internet of Things; education; smart gadgets; 3D printing; Erasmus+ project.*

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1. Introduction

The concept of *Internet of Things* (*IoT*) was stated in late '90s, but over the years, *IoT* have been introduced in various way in our lives (e.g. smart services, smart wearable devices, solutions for smart homes and cities etc.). According to the International Data Corporation study (Lund, Turner, MacGillivray, & Morales, 2014), at the end of 2013 there were 9.1 billion installed *IoT units*, with IP connectivity and communicating without human interaction. More, this is expected to reach 22.2 billion units in this year and grow to 28.1 billion units in 2020. Considering this expected growth, it is clear that educational institutions have to prepare the young students, - starting at very early ages - for those changes, by teaching them related aspects connected to *IoT*, providing them with the skills that would help them understand those changes and face them with joy and enthusiasm.

As (Krotov, 2017) clearly pointed out, "*Internet of Things (loT) is an emerging phenomenon*" and therefore "is a lack of holistic understanding of what loT is". Although there are several opportunities for children to learn about *IoT*, such as *IoT contests*, *clubs or seminars such us hackathons* (Byrne, O'Sullivan, & Sullivan, 2017), in schools, students do not systematically learn about *IoT* (Lechelt, Rogers, Marquardt, & Shum, 2016). Moreover, according to EC "*Opening up education through new technologies*" (2018), 37% of the EU workforce has low digital skills, or even none. It is also important to mention that less than half of children attending schools are beneficiaries of highly equipped digitally tools. Unfortunately, only 20-25% of them are taught by teachers who are confident on using technology in the classroom.

One of the channels that can promote *IoT* in the educational system is offered by the European projects. Together with the exploitation of digital technology, such projects design educational tools and organize formal and non-formal activities, proposing modern and innovative pedagogical demarches with a strong impact on developing students' motivation and creativity. In this context, the project "*IoT in education - We are the makers!*" (code 2017-1-DE03-KA201-035615), funded by the European Commission under the program *Erasmus+ Strategic Partnerships*, started in September 2017, aiming to analyze the school topics where *IoT* technologies and skills can be enhanced, and to provide teachers and students with new educational auxiliaries (mainly manuals), offering in a pedagogical way a kit in which *IoT* is programmed, but also transposed in a manufacturing process. There are two possible approaches on introducing IoT in education: teaching IoT concepts and using IoT in subjects (Gaggl, 2011). The project "*IoT in education - We are the makers!*" aims to implement both approaches.

In this project, it is expected to design new learning and teaching methodology, where high school students will be involved in using *3D printers* and *programmable breadboards* to design, manufacture and program intelligent objects. The project is implemented by a partnership of educational/professional institutions from 6 countries: Germany, Denmark, Greece, Italy, Romania and France.

2. Survey method and participants profile

In the beginning of the above-mentioned project, the Romanian team involved in the project implementation, intended to evaluate the level of knowledge of the Romanian students, about *IoT* and *3D printing*, but also their willingness to learn about those technologies. For collecting the data, it was created a questionnaire with 33 questions: 5 related to their profile and 28 about IoT and 3D printing.

The objectives of the survey were: (1) to find out if students learned about IoT technologies and 3D printing before becoming university students (2) if they ever used or build an IoT device, (3) if they ever used a 3D modelling software and/or a 3D printer and (4) to evaluate their willingness to learn about IoT and 3d printing.

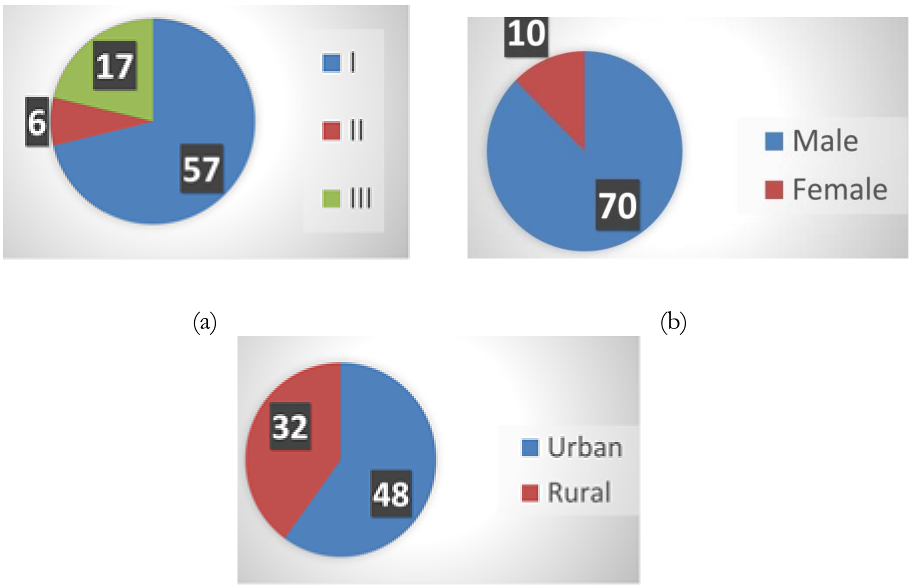
The project team wanted also to find out where the students had (if they had) the opportunity to learn/use those technologies.

In order to meet those objectives, the first intention was to apply the questionnaire to students enrolled in engineering studies, in the 1st year of study. However, in order to proceed to further comparisons, in the surveyed group students from 2nd and 3rd years of study were also included. The questionnaire was delivered on-line in a Moodle platform, constituting also a part of the initial evaluation of students' knowledge in the course dedicated to *Computer Programming Languages*. In addition, students enrolled in engineering studies who did not work in the Moodle platform, were asked to fill the hard-copy of the questionnaire, in the frame of the *Computer Assisted Instruction* course, part of their pedagogical preparation. 80 responses were collected between October - November 2017: 63 as on-line form and 17 on paper.

Considering the engineering study programmes most suitable for the survey aim (e.g. the students who attend the study programmes are more likely with a technical background, so the chance to learned before about IoT technologies is higher), there have been selected all the students enrolled in 2 engineering study programmes, who attended those two courses mentioned above and wanted to participate to the study: 38 students in

Automatic Control and Applied Informatics (*ACAI*) and 42 in *Applied Electronics and Telecommunications* (*AET*). Figure 1a illustrates the composition of the surveyed group of students considering their year of study: 57 students were in the 1st year (28 - ACAI, 29 - AET), 6 in the 2nd year (3 - ACAI, 3 - AET) and 17 in the 3rd year (7 - ACAI, 10 - AET). It is known that less women than men are following engineering studies (according to Women's Engineering Society only 11% of the engineering workforce is female). To this survey, 10 females and 70 males participated (Figure 1b). Concerning their place of living, 48 are coming from the urban areas and 32 from rural areas (Figure 1c).

Most of the participants are under 20 years old - 48 students, 18 students are with the age between 21 and 25, 5 students between 26-30, another 5 between 31-35, 1 between 36-40 and 3 over 40.



(a) (b)

(c)

Fig. 1. Surveyed group of students' profile: a) year of study, b) gender, c) rural/urban

3. Results and discussions

The surveyed participants were asked if they knew the concepts of *Internet of Things* (*IoT*) and *smart objects/devices*. Only 50 students from the total of 80 responded they have knowledge about the concept of *IoT* and 68 are familiarized with the concept of *smart objects/devices*. It was also performed an analysis of their answers, per age and per year of study, but the answers did not lead to a valuable conclusion (the proportion of the students who said they know/do not know the concepts are approximately similar in each analyzed category). After those questions, the students were introduced to the traditional and new definitions of *Internet of Things* and *smart objects/devices*, as stated by Fortino & Trunfio in 2014:

(a) *IoT* represents "*a world-wide network of interconnected heterogeneous objects uniquely addressable, based on standard communication protocols*";

(b) *IoT* is seen as "*a loosely coupled, decentralized system of cooperating smart objects*";

(c) *Smart object* is "*an autonomous, physical digital object augmented with sensing/actuating, processing, storing, and networking capabilities*".

The participants were asked if they knew the concepts of gyroscope, accelerometer, tilt sensor, light sensor and magnetometer. Their responses are illustrated in Figure 2. The most known concept is the *light sensor* and the less known is the *magnetometer*. In a way, this comes normal, due to the fact that such concepts are not learnt in secondary school during the Physics classes.

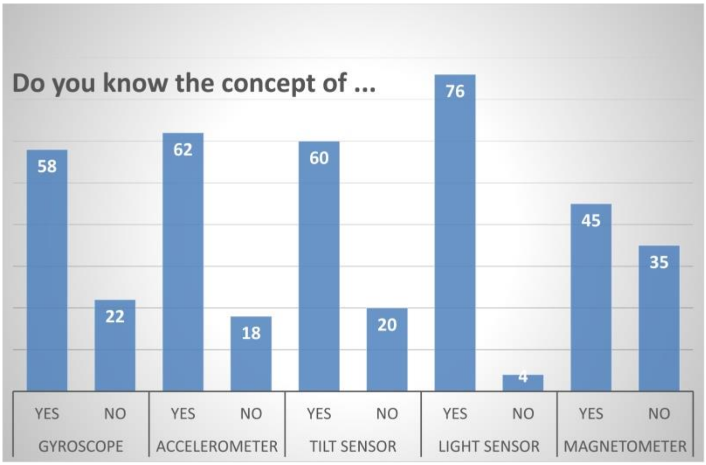


Fig. 2. Different concepts knowledge - results

The next question aimed to show if students knew how those sensors are working. Except for the *light sensor*, the students responded in a higher number that they do not know the processes, but in case of *gyroscope*, *accelerometer* and *tilt sensors* the numbers of those who responded *No* is just slight bigger than who responded *Yes*. In the case of *magnetometer*, two thirds responded *No* and for the *light sensor* 61 students responded *Yes* and just 19 responded *No*. Therefore, the most known sensor seemed to be the light sensor and the less known the magnetometer.

Being asked if they used smart things/devices in their ordinary life (considering the received definition), 60 students responded *affirmative* and 20 responded *negative*. Questionable answers were received when the students had to write which smart things/devices did they use: 35 mentioned *smartphone*, 23 - *computer/laptop*, 11 - *tablet*, 7 *smart TV*, 6 - *smartwatch*, 3 - *game console*, 2 - *vacuum cleaner*, 2 - *heating system*, 2 - *car*. The question was why only 35 students from the total of 80 stipulated the smartphone, but only 7 mentioned smart TV. By observing and also working with most of the respondents, we can say that at least - related to the usage of smartphones -, the number is not reflecting the reality. Two possible reasons for those unrealistic numbers may be the followings: (1) being a question with free answer, not all the students who use a smartphone (or any other smart device) filled in the answer; (2) for some respondents, the concept of smart things may still be unclear, even they received the definition and several explanations.

Another interesting aspect in this study - coming in accordance with the project activities - was related to the usage of *3D printers*. Only 11 students out of a total of 80 used a 3D printer: 3 of them are students in the first year of study and used a 3D printer in the high school, and the rest of 8 students - in the 3rd year of study - used a 3D printer at the faculty. The first year of study students who used a 3D printer are coming from the same high school - the 3D printer was received by the institution in the frame of a national robotics championship - *BRD First Tech Challenge Romania* (https://natieprineducatie.ro/). It is important to note that no students owned a 3D printer.

Trying to find out if the Romanian schools (except universities) own 3D printers or not, several conclusions resulted:

(a) no data was recorded concerning investments made by the Romanian National Ministry of Education;

(b) in the frame of the *BRD First Tech Challenge Romania*, 48 schools received 3D printers (Dorobanțu, 2016);

(c) in the frame of *3DUTECH* project that started in October 2017, 8 schools are about to receive 3D printers (ECDL, 2017). Therefore, the massive amount of the Romanian schools does not own a 3D printer.

The next question for the students was if they ever used a *programable board*. Only 17 students responded *yes* - 6 in the first year of study and 10 in the third year of study. Five of those students used a programable board at home, 10 at faculty, and only 2 at high school. Being asked if they had the knowledge to program a programmable board, only 14 responded *yes*, but, very encouraging is that 73 students out of 80 strongly agreed to acquire this knowledge as soon as possible. Also, 71 students would like to learn how to use a 3D printer.

Related to *3D modeling*, 28 students declared they have the knowledge to use a 3D modeling software and 71 students would like to learn (more) about. Being asked if they had the knowledge to create an *intelligent object*, 11 students answered affirmative and 74 students would like to learn to create an intelligent object by adding to a 3D object a programmable component.

4. Conclusions

The Romanian engineering education started to provide to students the necessary skills to code programable boards, to create intelligent objects, and in some branches, to use 3D printers. However, before being enrolled in academic studies, the students have the opportunity to gain such skills only in isolated cases. Since the *IoT* impact is expected to increase, the actual challenge is to teach as many students as possible on what *IoT* can add to their life and future profession. Here, not only the students who wish to become engineers are considered, taking into account that lower and mainly upper secondary school must introduce related *IoT* content in formal and non-formal education activities. More, transferring *IoT* basic skills to students, starting from early ages, they will have a considerable help to be competitive in the labour market.

It is obvious that the results presented in this article show that *IoT* and *3D printing* technologies are still in the beginning, in the Romanian education, but small steps for promoting such technologies are recorded in the last recent years. On the other hand, it is really encouraging to see that most of the students who participated to the described survey showed openness and desire to learn about those topics. By sure, the actual voice of young generation is in-line with the surveyed students' answers, who want to know more about this emerging technology which will become an important part of our everyday life very soon.

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The authors of this paper stipulate, on their own responsibility, that the subjects who participated in the research have been informed related to the voluntary nature of their participation, the understanding of the received information and the fact that the withdrawal from the research process can be done at any time without any negative consequences on participants. The whole research respected the actual ethical standards and the participants expressed their consent to participate in the undertaken research.

The contribution of the authors is equal.

References

Byrne, J., O'Sullivan, K., & Sullivan, K. (2017). An IoT and Wearable Technology Hackathon for Promoting Careers in Computer Science. *IEEE Transactions on Education, 60*(1), 50-58.

Commission, E. (2018). *Opening up education through new technologies*. Retrieved from European Commission, Education and Training: https://ec.europa.eu/education/policy/strategic-framework/education-technology_en

Dorobantu, B. (2016, December 5). *Video ZF Live. Dana Războiu, preşedinta Asociaţiei Naţie prin Educaţie: 50 de echipe de elevi pasionaţi de robotică au primit kituri şi echipamente în valoare de 280.000 de euro pentru a construi roboţi*. Retrieved from http://www.zf.ro/: http://www.zf.ro/business-hi-tech/video-zf-live-dana-razboiu-presedinta-asociatiei-natie-educatie-50-echipe-elevi-pasionati-robotica-au-primit-kituri-echipamente-valoare-280-000-euro-construi-roboti-16009941

ECDL. (2017, October). *Lansare proiect imprimante 3D pentru şcolile din România. 3DUTECH - Modelează viitorul. Printează-l 3D!* Retrieved from https://www.ecdl.ro/: https://www.ecdl.ro/en/news-article/lansare-proiect-imprimante-3d-pentru-scolile-din-romania.-3dutech-modeleaza-viitorul.-printeaza-l-3d_677.html

Fortino, G., & Trunfio, P. (2014). *Internet of Things Based on Smart Objects.* (G. Fortino, & P. Trunfio, Eds.) Springer.

Gaggl, L. (2011). *Education and the Internet of Things.* Retrieved from: http://www.brightcookie.com/wp-content/uploads/2011/11/IoT_in_Education-3.pdf

Krotov, V. (2017). The Internet of Things and new business opportunities. *Business Horizons, 60*(6), 831-841.

Lechelt, Z., Rogers, Y., Marquardt, N., & Shum, V. (2016). ConnectUs: A New Toolkit for Teaching about the Internet of Things. *CHI'16 Extended Abstracts* (pp. 3711-3714). San Jose, CA, USA: ACM.

Lund, D., Turner, V., MacGillivray, C., & Morales, M. (2014). *Worldwide and Regional Internet of Things (IoT) 2014-2020 Forecast: A Virtuous Circle of Proven Value and Demand*. Framingham: International Data Corporation (IDC).