Review article

IOT CONCEPT APPLICATION IN EDUCATIONAL SECTOR USING COLLABORATION

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Abstract. *Since its appearance, the Internet of Things (IoT) shows the potential to radically transform numerous areas of our everyday lives. Education, as one of the most important concerns and investments of a new world, didn't remain immune to novel technology advancements. With the IoT vision, not just computers, tablets and smartphones, but almost every other device becomes connected to the Internet, completely changing the traditional model of education. This paper analyzes manners to achieving enhanced educational practices using novel Information and Communication Technologies (ICTs), particularly IoT, as well as the potential of these approaches to contribute in achieving economically, socially and environmentally sustainable educational environment. Alongside technology, enhanced IoT-supported educational environment demands a higher degree of collaboration among institutions, staff members, and students. Only with full engagement of all stakeholders and their willingness to cooperate and collaborate, the idea of the completely redesigned education sector, technology supported, enhanced and economically, ecologically and socio-culturally sustainable is possible. Therefore, the power of collaboration, people, and technology in the modernization of the education sector and the realizing fully IoT-supported collaborative educational practices and the environment is the subject of discussion.*

Key words: *education, collaboration, Internet of Things, sustainability*

1. INTRODUCTION

The education can be defined as a way of making people better informed and wiser through acquiring knowledge and skills. As such, human pose awareness of responsibility and capability to significantly contribute to the world progress. In other words, the education outcome – research, invention, innovation and adaptation enhance the processes of

recognizing and dealing with the challenges and solving the problems of the world. Hence, the education is the most effective mean of making the world better, safer and more sustainable place to live, what makes it the best investment (UNESCO, 1997).

The role of education in all spheres of life and society progress implies the demand for continuous betterment of education sector. The technology progress has a profound effect on education, remarkably transforming the manners of teaching and learning on a worldwide scale (Advanced MP Technology, n.d). The technology utilized in education makes the educational activities more effective, student-focused and issue-focused (Gupta and Fisher, 2012).

In recent years novel Information and Communication Technology (ICT) solutions completely change the traditional educational process leading to the significantly improved modern and quality education systems at various levels of learning. There are currently seven categories of technologies, tools, and strategies that revolutionize the education sector: consumer technologies, digital strategies, enabling technologies, Internet technologies, learning technologies, social media technologies and visualization technologies (Johnson et al., 2015). As a part of Internet technology, the Internet of Things (IoT) has enabled that every device/'thing' becomes connected to the Internet opening a whole world of potentially remarkable improvements in all spheres of life. In other words, the IoT inclusion in the educational environment successfully overcome the gap between the traditional education system and modern education system requirements by transforming traditional classrooms separated by location and time into the connected classroom unified by the Internet and communication tools. Hence, the educational practice has been dramatically influenced by the IoT advances. This technology progress has significantly improved the delivery method of courses' content as well as the content of the delivery, by adding more resources and tools to the classroom, physically or online, and making the learning more dynamic and interactive (Advanced MP Technology, n.d.; Vujović and Maksimović, 2015). Therefore, the IoT brings completely new levels of connectivity and advanced learning approaches in the educational practices. However, the IoT also brings certain challenges and concerns, mostly privacy and security issues regarding students' personal and grade information (Advanced MP Technology, n.d.).

The important aspect of the IoT utilization in educational institutions is its potential, not just to raise the quality of education, but also to realize economically, socially and environmentally sustainable education sector (Fig. 1) (Maksimović, 2017a).

UNESCO has identified a number of the principles and values that underlie education for sustainable development (Blewit, 2010). Hence, the education for sustainable development:

- considers the well-being of the environment, society, and economic system;
- is interdisciplinary, engages formal, non-formal and informal education and encourages lifelong learning;
- is culturally appropriate and addresses content, context, global issues and local priorities and consequently have international effects and consequences;
- establishes civil capacity for community-based decision-making, social tolerance, environmental protection, adjustable workforce and quality of life; and
- satisfies the demands of the evolving nature of the sustainability concept.

Nevertheless, the education for sustainable development and integrating aspects of sustainability cannot be realized without techniques that promote participatory learning and higher order thinking skills (Blewitt, 2010). Hence, the students, teachers and other staff members must embrace new ways of teaching and learning in order to acquire new

skills and be able to re-regulate their mutual relationships (Wals and Jickling, 2002). This is not possible without collaboration among all stakeholders.

Collaboration has become a trend of the 21st Century (Laal et al, 2013). Alongside the collaboration between students and teachers that significantly improve teaching practice and learning experience, the collaboration among faculties, top management, teachers, students and administrative staff also enables the implementation of green technologies, particularly Green IoT (G-IoT), in the education sector. The G-IoT can be fully implemented in educational institutions what leads to the optimal utilization of resources, minimizing generation of waste, and maximizing recycling and reuse of ICT equipment, improving the design of the school and university buildings by designing ICT-intense "smart" buildings, saving natural resources, etc. Therefore, even technology has become the enabler of modern education, the high-quality education in sustainable and eco-friendly educational environment is possible only if a high-level of collaboration exists among all stakeholders in the education sector.

Fig. 1 The smart IoT educational environment (Maksimović, 2017a)

Hence, this paper represents an effort to summarize the IoT influence on the education sector. Evidently, the IoT can show its tremendous potential to completely revolutionize education only if all parties act together in realizing the goal of modern and sustainable education sector. In order to get as much as possible insights on this subject, the paper is organized as follows. The IoT and collaboration symbiotic approach in improving learning and teaching is presented in Section 2. Section 3 is devoted to the influence of IoT and collaboration symbiosis on the realization of intelligent and sustainable educational environment. Finally, Section 4 contains concluding remarks.

2. THE IoT AND COLLABORATION SYMBIOTIC APPROACH IN IMPROVING QUALITY OF EDUCATIONAL ACTIVITIES

The technology as a central enabler of education in the 21st Century can be practiced in various ways in order to revolutionize education sector (National Research Council, 2000):

- making more interesting subjects based on real-world problems;
- providing novel manners to enhance learning;
- improving feedback, reflection, and revision;
- enabling teachers' numerous opportunities to improve their skills; and
- connecting all interested parties with the intent to improve education sector.

The manners listed above for improving education sector are significantly strengthening by a phenomenon known as the Internet of Things (IoT). The IoT is based on connection of devices other than standard products. These devices/'things' are Internet capable and controlled, able to interact autonomously not only with users, but with other devices, and generate the valuable data on a daily basis. The data generated by IoT can be easily collected, quantified, stored and processed achieving in this way valuable insight and knowledge (Morphus, 2016). Alongside the numerous IoT applications and benefits in all aspects of our lives, the IoT holds the potential to empower educational practices and environment, through the enhanced knowledge obtaining and delivering in a virtual, shared, and intelligent teaching and learning environment (Vujović and Maksimović, 2015). In other words, the IoT enables dramatic transformation in educational technology and go further than online tutorials and virtual classrooms. Common presence of Internet-capable technology and smart devices (e.g., tablets, smart boards, etc.) in the classrooms makes lessons and discussions livelier and more interesting. Massive open online courses, online software and education applications make the students co-creators and active participants in obtaining their knowledge and experience (Brandt, 2016). The IoT helps educators to make their work more efficient and convenient, through the automation of numerous tasks and easier obtaining insights into student data. Since the IoT holds the potential to transform our society, economy and all aspects of people's lives, its essence lies in the power of connection and collaboration. Therefore, the rapid development and adoption of the IoT requires the unprecedented collaboration. Consequently, the creation and improvement of IoT-supported education also relies on a joint effort of all stakeholders. The engagement of all players in understanding the shared tasks and sharing knowledge, efforts and resources in the problem solving and learning is mandatory towards the fruition of the smart and sustainable education vision (Bentley and Cazaly, 2015; Cress, 2016). However, the collaboration is not simply learning or working together. To name some process a collaborative one, following basic elements must be fulfilled: positive interdependence, considerable interaction, individual accountability and personal duty, social skills, and group self-evaluating (Johnson et al., 1990). According to Bentley and Cazaly (2015), three key benefits of collaboration in education are:

1. efficient coordination of shared activities alongside reduced costs and bureaucratic procedures;
2. authentic and sustained engagement in the process; and
3. flexible and differentiated support, according to teachers and students' specific goals and needs.

Nevertheless, the technology progress makes collaboration easier, significantly improving the ways of sharing information and practices. The IoT offers cheap, affordable and instantaneous tools for knowledge and process sharing enabling to all stakeholders easier and faster collaboration possibilities.

Hence, the IoT and collaboration symbiotic approach possesses the potential to dramatically impact educational practice in the following two manners:

- improvement of learning issues,
- improving teacher's role and skills.

2.1. Improvement of learning issues

The IoT inclusion in education enables the students to become active participants accessing to their courses or laboratory exercises at any time, from anywhere they can log on, and choose the adequate manners to generate, obtain, manipulate, or display information. Alongside access to courses tailored according to student needs and preferences, students are able to choose the pace of work, to repeat the material that is not sufficiently clear and return to learning and working, to independently progress in mastering teaching material, and to track and evaluate their own progress. The accessibility of novel technology and equipment at any given time motivates students to work independently as well as to collaborate online with other students or teachers, developing own understandings and problem-solving skills (Stošić, 2015). With the help of IoT, Wireless Sensor Networks (WSN), Radio-Frequency IDentification (RFID) chips and Cloud-based applications, students have the ability to study numerous real-world problems, measure various data in real-time and analyze it, thus obtaining clearer insights into the subject of interest what successfully improves their learning experience (Ralhan, 2017). The novel devices implemented in the classroom, such as interactive boards and digital highlighters (Fig. 2), drastically simplify the learning experience and enhance the collaboration among students, teachers, mentors and colleagues across the world (Maksimović, 2017b).
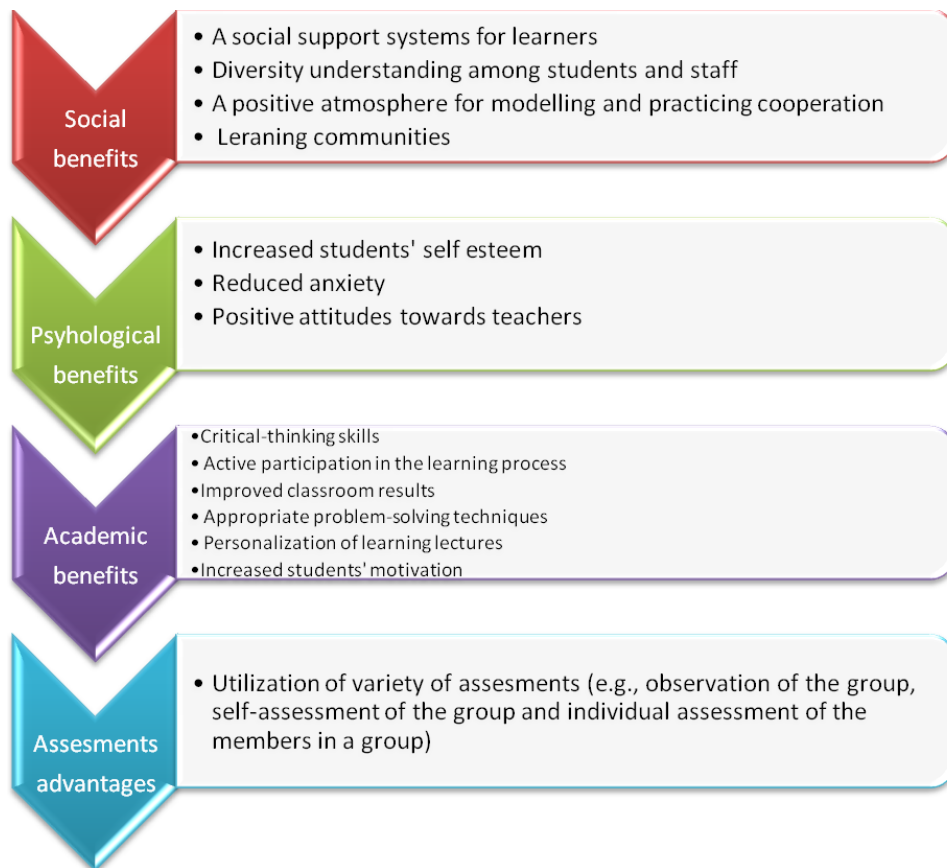

Fig. 2 The smart and interactive classroom (Maksimović, 2017b).

Plauska and Damaševičius (2014) have proposed the IoT-supported collaborative learning environment that enhances students' motivation and learning outcome based on the utilization of the robot as a mobile physical smart learning object and service. However, collaborating around a large number of IoT devices is a task with outstanding potential, but also complex and voluminous task (Skarpline, 2017). Through the collaboration in the Cloud, groups of students easier collect and analyze data together, while the interaction with educators can pass seamlessly through these same channels (Klostermann, 2016). Cloud-based software solutions enable the involvement and connection of a large number of people through the data integration, capturing and sharing knowledge (Skarpline, 2017). Simply saying, the idea of collaborative learning is in students joined work in resolving a problem, completing a project or creating a product. Instead of competing with each other, student through the collaboration achieve higher motivation, better and deeper understanding of content through co-assembling knowledge and meaning, improve self-esteem, development of teamwork, communication and critical thinking skills, and consequently increase their overall achievement in grades (Workshop, n.d.). The case studies, student-moderated discussions, debates, collaborative writing, demonstrations, and presentation are some of the activities or assignments well suited for collaborative learning. Hence, the benefits that are associated with the concept of collaborative learning are numerous and can be summarized as shown in Fig. 3. (Johnson and Johnson, 1989; Panitz, 1999, Laal et al., 2012).

The collaborative activities will bring benefits only if the right communication medium is chosen for the collaboration (Vujović et al., 2014). The IoT can be understood as the adequate tool for easier and faster means to share and present data in a convenient fashion, not just among students, but also among students and various objects and physical environments via sensors. Real-time communication enabled by the IoT significantly enhances the all collaborative activities. Furthermore, the potential of the IoT to make learning easier, faster, safer and cost-effective can be realized with the use of various special devices. Such devices are very useful for millions of students with special needs, enabling them to work and collaborate with others satisfying their social needs at the same time. For example, a special card can be applied to students with vision impairments so instantly they have been checked the enlargement of the fonts on computers is being executed. The utilization of mobile apps helps students with reading-related disabilities to read and understand the materials. In that respect is also a voice recognition app that assists students with writing difficulty finish papers. Furthermore, the IoT-enabled communication technology extends classrooms enabling students with special needs to access resources globally (Advanced MP Technology, n.d.). The security and safety can be achieved through utilization of digitized wristbands and identity cards that help educational establishment to track students, staff, and visitors. For instance, with the help of wearable, students' attendance, movement as well as health can be monitored while tracking of GPS-enabled bus system enhances the student safety (Ralhan, 2017).

In summary, the IoT enables improvement of learning issues in better, cheaper, faster and more sustainable directions.

Social benefits
- A social support systems for learners
- Diversity understanding among students and staff
- A positive atmosphere for modelling and practicing cooperation
- Leraning communities

Psyhological benefits
- Increased students' self esteem
- Reduced anxiety
- Positive attitudes towards teachers

Academic benefits
- Critical-thinking skills
- Active participation in the learning process
- Improved classroom results
- Appropriate problem-solving techniques
- Personalization of learning lectures
- Increased students' motivation

Assesments advantages
- Utilization of variety of assesments (e.g., observation of the group, self-assessment of the group and individual assessment of the members in a group)

Fig. 3 The collaborative learning benefits

2.2. Improving teacher's role and skills

The inclusion of IoT technology in teaching helps teachers to produce more efficient learning methods, creating high-quality and engaging lessons and moving more quickly through the material. Defining project goals and making personalized courses, applying novel ways of communicating and presenting information through appropriate guidance and support, and the students' evaluation through online assessment tools, significantly enhance educational processes. Hence, the teacher's role is running from a lecturer to a facilitator (Fig. 4).

As has been already stated, the technology employed in education enables students to better receive information in a visual, auditory and kinesthetic means. At the same time, with the aid of technology in teaching, the teacher interaction with the students is significantly improved (Stošić, 2015). Student-teacher collaboration has never been easier than nowadays when numerous online collaboration tools exist. There are numerous collaboration software solutions used from both learners and educators for communication and project management (Bika, n.d.; Pappas, 2014; Thomson, 2014). Using communication media enabled by IoT and the adequate collaboration tools, students can easily and quickly communicate with their

colleagues or teachers. Which of the collaboration tools will be chosen depends on the services they offer and user needs. The commonality for all the collaborative software is that it must permit users to operate seamlessly across platforms, devices, and locations, to simplify and make collaboration more intuitive (Skarpline, 2017). The teacher usually uploads an assignment that the students must complete working together. With the help of the technology and collaboration tools, students can share experiences, feedback, and opinions in real-time with their colleagues. At the same time, students are encouraged to work together, what create possibilities to profit from the knowledge and accomplishments of their colleagues. However, it is important to highlight that in this process, the teacher is just a facilitator of the learning process, not an active participant. The teacher's role is to create a project, conduct the discussion, to create questions that will motivate students to discuss and to ensure that the whole process goes smoothly and at a productive rate (Pappas, 2014). With the power of IoT, collaboration tools, and their powerful data-driven report system, the teachers and administration have insights on students' performance in a real-time and gather the student feedback in order to ameliorate the course and methods.
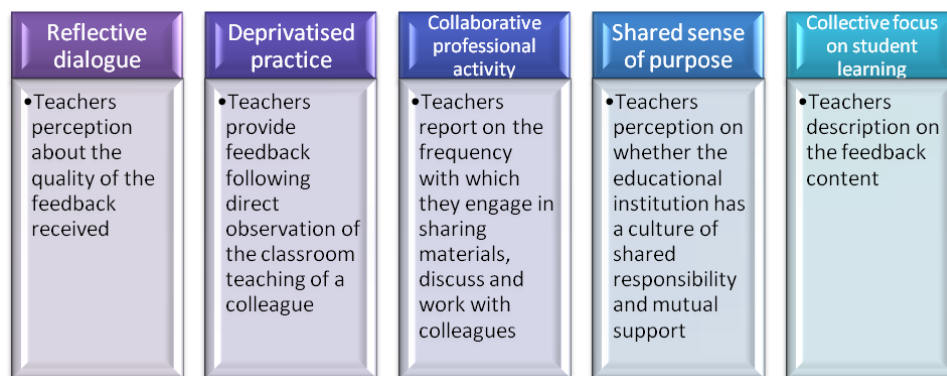

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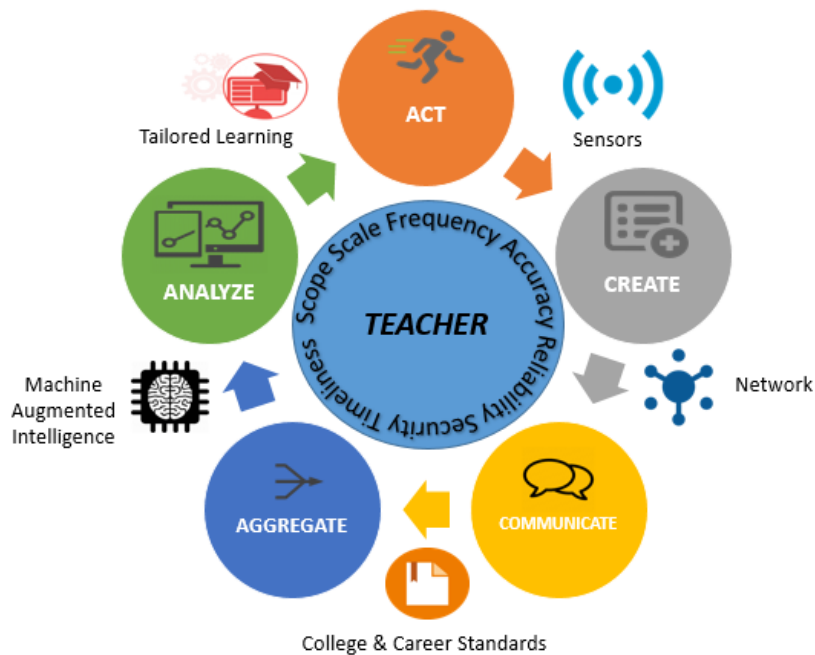
Fig. 4 IoT-enabled teaching

Going further with the teachers' collaboration contributes to the teacher's improvement and the student's achievement (Ronfeldt et al, 2015). Hence, increased collaboration with other teachers enables educators to join forces in planning, designing, modifying or evaluating teaching programs and strategies as well as to obtain valuable insights into learning outcomes. The collaboration among teachers may be informal or professional as a part of professional learning communities (AITSL, n.d.). The development of professional learning communities

appears as one of the most effective means to improve student achievement by improving teacher practices (teaching pedagogy, content knowledge, and instruction delivery) (Fig. 5) (Gomendio, 2009; Lintor, 2014). All teachers' activities and their collaboration with students, other teachers, institutions, and parents improve their expertise, experience and performances in general, what significantly contribute to the improved educational outcome. Thus, the inclusion of technology in education institutions, practicing it in collaborative processes with the aim to induce modifications in educational and other work practice promises to contribute to increased performances, enhanced communication and work procedures, and satisfactions of all stakeholders.

Reflective dialogue	Deprivatised practice	Collaborative professional activity	Shared sense of purpose	Collective focus on student learning
•Teachers perception about the quality of the feedback received	•Teachers provide feedback following direct observation of the classroom teaching of a colleague	•Teachers report on the frequency with which they engage in sharing materials, discuss and work with colleagues	•Teachers perception on whether the educational institution has a culture of shared responsibility and mutual support	•Teachers description on the feedback content

Fig. 5 Professional learning communities' factors

Performing collaboration processes among teachers require time for planning and scheduled co-teaching what can be very challengeable. Hence, it is mandatory to clearly define the roles of collaborators, the goals they need to fulfill and clear timeline. The IoT inclusion in the educational environment enables improved access to educational resources, easier and faster knowledge obtaining process and information sharing. In other words, the virtualization techniques, Edge/Fog/Cloud computing, and Big data analytics, alongside teleconferencing, video conferencing, web conferencing and online collaboration tools lead to the better information insights and enhanced and more sustainable collaboration among teachers ensuring that everything flows as smoothly as possible. Therefore, the IoT empowers the collaboration among teachers and at the same time significantly contribute to cost savings. However, collaborating in the educational environment doesn't end at the level of educators (Loop, n.d.). The collaboration among schools, faculties, and universities are of crucial interest in the process of improving education sector. Furthermore, the partnership and collaboration among educational institutions and students, other community organizations, and the government is the only way to revolutionize public education systems ((Bentley and Cazaly, 2015; Loop, n.d.). At the same time, the collaboration among higher education community and industries can significantly influence the development of the technologies, business models and ethics (O'Brien, 2016). Nonetheless, the promoting high-quality collaboration across all levels is a better way to improve student achievement and enhance whole education sector than promoting collaboration at any single level (Ronfeldt et al., 2015).

3. THE IMPROVEMENTS OF EDUCATIONAL ENVIRONMENT
WITH THE HELP OF IoT AND COLLABORATIVE ACTIONS

The benefits of IoT and collaboration symbiotic approach in the education sector are not just connected to enhance learning. In addition, working together with the utilization of novel ICTs increases safety and security, enhances access to a variety of information and ensures the ability to monitor resource utilization and consumption contributing to increased energy efficiency and cost savings (Brandt, 2016). Since the goal of modern society is to be sustainable as much as possible, a change in thinking and a collective intention for a sustainable future is required (Brodie, 2010). To accomplish the goal of improved and sustainable education at all levels requires the awareness, knowledge, technology, skills and involvement of all stakeholders.

The utilization of the IoT in buildings enables implementation of sustainability principles in all their operations. There are numerous ways to include sustainability practices in an educational institution. The utilization of smart IoT devices, like smart HVAC (Heating, Ventilation, and Air Conditioning), electric lightning, temperature sensors, night cooling systems, attendance tracking, wireless door locks and other smart building technology (Fig. 1), significantly contribute to enhanced security, safety, cost savings, but at the same time increase the teachers' operation practice, consequently raising the quality of the education (Maksimović, 2017a). Even numerous challenges across an education sector can be overcome with the help of the IoT, there are also 'hidden' and mostly underestimated environmental, and, sometimes, social costs. With the ICT expansion, the production and disposal of large quantities of everyday used smart devices are being followed with increased utilization of numerous resources (mostly raw and non-renewable), various released pollutants and escalating volumes of waste, and sometimes involvement in dangerous working activities (Brodie, 2010; Maksimović, 2017a; Maksimović, 2017b). Therefore, the goal is to maximize benefits of the IoT alongside minimized harmful effects on the human health and the environment. This is the reason why society is moving towards a greener future by modeling green principles in every facet of their operations.

Green ICTs and Green IoT (G-IoT) which encompass environmentally aware production, using and disposal of ICT equipment and solutions, hold the potential to significantly contribute to the sustainable education sector through the following activities (NCB, n.d.; James and Hopkinson, 2008; Brodie, 2010; Suryawanshi and Narkhede, 2014; Bagheri and Haghighi Movahed, 2015; Asseo, 2016; Maksimović, 2017a):

- the employment of equipment with reduced energy requirements and minimized harmful impacts on the surroundings (e.g., efficient hard drives, thin client devices, multifunctional equipment (printer, copier, scanner, fax), cheap sensors, smart power systems and alternative renewable energy sources);
- the inclusion of the equipment' operating activities that leads to reduced energy use and increases cost savings (e.g., utilization of distributed computing, processing, communication and storage and/or outsourced/shared service solutions, storage consolidations and optimization, virtualization of server resources, turning ICT equipment off when they are not utilized, enabling and using the standby/sleep mode and power management settings, reducing the brightness settings on monitors, avoiding screensavers, sharing printers and maximizing print substitution, using reusable devices);
- enablement of remote access to diverse kind of equipment;

- the realization of working activities through virtual meetings and learning sessions (e.g., e-learning approach, teleconferencing, video conferencing, web conferencing and online collaboration tools);
- the minimization of waste generation through as much as possible increased recycling and reuse of ICT equipment;
- the use of smart building technology which facilitates the improvement of the design and operation of educational institutional buildings (e.g., smart building design enables monitoring and management of resource consumption, monitoring, and surveillance of entire buildings, enabling in such way a secure and safe educational environment);
- increase G-IoT practice awareness and engagement of all stakeholders of the education sector, from students and teachers to an administration, educational institution, top management people, industry, and government.

Evidently, moving towards the greener future opens a whole new world of potentially remarkable improvements in education what makes all these activities mandatory in order to make education sector more intelligent and sustainable than ever before. The G-IoT and smart technology are able to produce a modern, more energy-efficient and cost-effective education sector only if the high-level of the collaboration of all participants, processes, data and things exists.

4. CONCLUDING REMARKS

The IoT is seen as a tool for transforming almost all aspects of our lives. The education sector didn't remain immune to technology advancements and with the help of IoT becomes innovative and efficient than ever before. Hence, the implementation of the IoT devices and technologies for education purposes becomes the hot topic among numerous researchers which explore novel methods for learning, teaching and managing the whole education sector.

One of the main IoT characteristic is the possibility of IoT-enabled devices to interconnect and communicate without any direct human intervention. Even the collaboration among devices is a huge advance, the IoT technology itself is not enough to dramatically revolutionize the education sector. The creation of a virtual, shared, intelligent, safe, secure and sustainable education sector is possible only with the existence of high level of collaboration among devices, processes, data and people based on the IoT utilization. In other words, the fast development of IoT and its symbiosis with the collaborative approaches promises more intelligent and sustainable manners for significantly improved all aspects of the education sector. Therefore, the IoT and collaboration symbiotic approach is a scaffold and a tool for enhancing education sector, spreading out a whole universe of potentially remarkable improvements.

We are already witnessing the benefits brought by novel technology advancements and collaborating approach. The IoT enables the inclusion of numerous IoT-enabled devices in educational institutions, such as a smart table, interactive whiteboard, 3D printers, smart document camera, Internet-connected laboratory equipment, etc., that enables a completely revolutionized learning and teaching practice. With the help of IoT-enabled devices and technology, students can access their courses at any time, from anywhere at the most appropriate manner for them as long as they have an Internet connection. Alongside access to massive open online courses, students are able to access to laboratory equipment at their institution, to perform experiments, obtain data, analyze it and via collaboration tools share

the information and knowledge and discuss with other colleagues or ask the teacher for additional explanation. In this manner, students are able to determine the rate and time of their work, to access to additional resources they might need and through flexibility and autonomy to learn they become active participants in obtaining their knowledge and skills. From the other side, educators with the help of IoT have an ability to significantly improve their teaching skills, adjusting their activities and highly interactive learning environments according to student needs and preferences. The improved methods of students work evaluation and progress tracking as well as collaborating with other teachers enhance the instructional strategies needed to be performed in order to improve educational activities. Furthermore, the teachers' collaboration with the colleagues, administration, top management people, universities, parents, and governments is required in the process of planning, developing and implementing novel technological advancements in the education sector. At the same time, this collaboration has potential to result in the realization of novel technological solutions and collaboration approaches.

Alongside significantly improved learning and teaching methods, IoT-enabled devices implemented in an educational institution like various sensors for temperature monitoring, lighting control and fire detection, smart HVAC system, security cameras and surveillance systems, wireless door locks, wearables for student tracking and monitoring health status, enable gathering numerous diverse data on which basis adequate decisions and managing actions are being performed. The implementation of techniques and devices with reduced energy consumption, teleconferencing, and virtual meetings, as well as increasing awareness of all participants in education sector regarding environmental protection consequently lead to the sustainable educational institution. Hence, smart sensors, Big data analytics, and Edge/Fog/Cloud-based computing are the main building blocks of the educational institution that helps to monitor and manage resource consumption as well as to successfully deal with security and safety issues. It can be expected that the further technology development will lead to the omnipresence of green products, green communications and green processing, that will consequently lead to the realization of smart and sustainable education sector. The G-IoT will significantly contribute to this vision by designing, producing, using and disposing of ICT equipment and solutions in an eco-friendly manner.

In summary, the technology and the common participation and collaboration of all stakeholders are mandatory in the process of creating intelligent and sustainable education sector. The IoT is already integrated into the education sector, but its full potential is yet to come. On that point are numerous challenges, mostly regarding personal data privacy and security issues that must be successfully overcome. Utilization of the IoT devices and technologies and collaboration among people, devices, processes and data, will bring numerous benefits in all aspects of the education sector. Based on a large amount of various gathered data, the IoT may enable the creation of recommender systems that will automatically suggest the actions to be executed in order to create as much as possible better and sustainable educational environment and activities. However, the IoT and collaboration symbiotic approach is necessary for the processes of increasing students' performances and accountability, enhancing collaboration at all levels, creating connected, secure, safe, convenient, cost-effective and ecologically and socio-culturally sustainable educational environment.

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PRIMJENA KONCEPTA INTERNETA STVARI
U SEKTORU OBRAZOVANJA KROZ SARADNJU

Od svoje pojave Internet stvari pokazuje potencijal da radikalno transformiše brojne oblasti svakodnevnog života. Obrazovanje, kao jedan od najvažnijih aspekata i investicija modernog doba, nije ostalo imuno na pojavu i razvoj savremenih tehnologija. Vizija Interneta stvari omogućava da se, ne samo računari, tableti i pametni telefoni, već skoro svaki drugi uređaj poveže sa Internetom, na taj način potpuno mijenjajući tradicionalni model obrazovanja. Ovaj rad analizira načine za postizanje poboljšanih obrazovnih praksi koristeći savremene informacione i komunikacione tehnologije (IKT), posebno koncept Interneta stvari, kao i potencijal ovih pristupa u postizanju ekonomskog, društvenog i ekološki održivog obrazovnog okruženja. Pored tehnologije, unapređeni sektor obrazovanja utemeljen na konceptu Interneta stvari, zahtijeva i viši stepen saradnje među institucijama, osobljem i studentima. Samo uz puno angažovanje svih zainteresovanih strana i njihove spremnosti za saradnju, ideja o potpuno redizajniranom obrazovnom sektoru, zasnovanom na upotrebi savremenih tehnologija a koji će biti ekonomski, ekološki i društveno-kulturološki održiv, je moguća. Rad predstavlja analizu značaja saradnje ljudi i tehnologije u cilju modernizacije obrazovnog sektora i realizaciji obrazovnih praksi i sektora obrazovanja u potpunosti zasnovanim na viziji Interneta stvari.

Ključne reči: *obrazovanje, saradnja, Internet stvari, održivost*