

INTERNET OF THINGS IN EDUCATION

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ИНТЕРНЕТ НА НЕЩАТА В ОБРАЗОВАНИЕТО

Abstract: *The Internet of Things (IoT) maintains its pivotal role in the overall structure of information and communication technologies and societal growth. The goal of this research is to determine the opportunity for IoT usage in education as well as to optimize its advantages and to encourage students to use it in their education. The research demonstrates usage and implementation of IoT in education. It describes how the IoT, and its services and equipment are implemented and how they are used during the teaching process in lower schools, high schools, and universities. The findings of this research will benefit educational institutions and their employees in general, as well as students in particular.*

Keywords: *Internet of Things; IoT Education; Smart Schools; IoT Application; STEM.*

1. Introduction

IoT or the Internet of Things is gradually but surely trespassing on many sides of peoples everyday lives. Kevin Ashton first used the phrase “Internet of Things” (IoT) in 1999. The term has, however, been expanding over the past 10 years to include a variety of applications, including services, medical care, transportation, etc. [2]. Anything and everywhere may now be linked to the world of the internet and considered "smart" thanks to the idea of associated gadgets or objects. Related electronics may interact with one another and exchange data, which is then evaluated more to make decisions, which is called the Internet of Things. Technologies for the Internet of Things are already being used in many different industries, including the provision of healthcare services, sales, client service, home automation, surveillance of the environment, and industrial computing. Educational institutions are now aiming to integrate IoT into educational activities to benefit students, teachers and the overall educational system due to their

pervasiveness. Among the most crucial components of education is environmental building.

Additionally, based on [1], stated that the educational system was changing and that intelligent educational environments were being created. This setting mixed various information and communication technologies in an effort to activate the educational experience and fulfil the needs of various students. Despite the fact that the IoT concept offers many opportunities for future technology, there are still many difficult technical, social and economic issues that need to be resolved. By 2022, wireless technology will make up 43% of all networked devices worldwide, predicts a Cisco study [5]. IoT connections have grown dramatically, from 6 billion in 2015 to 27 billion in 2025, based on [11]. There will be 2.2 billion IoT mobile connections with linked vehicles accounting for 45% of this total. In financial terms IoT is expected to generate 3 trillion US dollars in revenue by 2025. For instance, educators in Japan, the United Kingdom and the United States based on [6], are already using IoT technologies in educational processes. Numerous educational institutions have also adopted IoT technology to improve security on campus including the University of San Francisco [10]. Despite the fact that there are several studies accessible on the IoT, there are not many on its uses in education. The most current findings, difficulties and potential effects of the Internet of Things on education are summarized in the following study. On Figure 1 are presented the three perspectives of IoT.

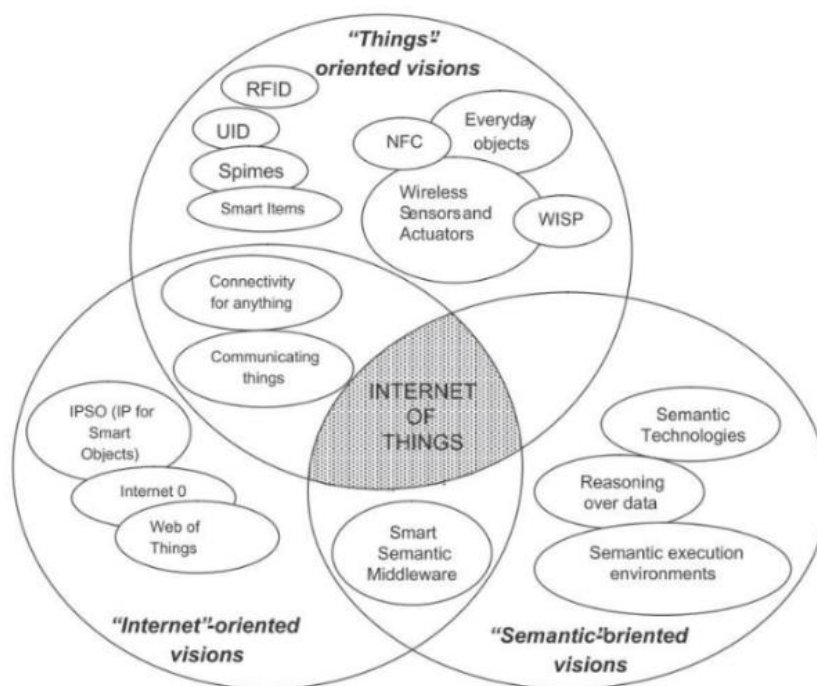


Figure 1. The Internet of Things concept formed by three orientations [3]

The phrase “Internet of things” is ambiguous since various people describe it through various points of view [3].

2. Literature Review (IoT in Education)

One of the innovations transforming the world today is the Internet of Things. For instance, China has begun a strategic initiative to support the growth of essential IoT technologies and applications, with a special emphasis on transportation, power and other important sectors. Some of the biggest companies around the world have been researching and implementing IoT technology for a number of years. To learn about the Internet of Things in education it is good to first try the use of open source or eventually low cost programs or platforms. If we see that they are working well then, we can continue with the development of any customized platform or even buy and modify any relevant platform.

As far as it is concerned, controller programming is the key element for understanding IoT. The study of controller programming is a key topic that may assist students at all skill levels in developing their logical thinking and coming up with working prototypes to address difficulties they experience in automation and robotics on a daily basis. These technologies are useful which transforms them into wonderful learning materials by enabling student participation. One outstanding example of IoT is the course by "The Open University" created in 2011 [9], for studying the technology. Students with no prior computer programming expertise have taken this course, which was separated in three sections such as:

- The Arduino microcontroller, which features analog input ports for sensors and I/O devices;
- All students and teachers were connected at the same time to a cloud infrastructure;
- Visual programming environment.

When it comes to deploying IoT devices, the education sector is one of the most flexible and effective. This will increase educations collaborative, interactive and open nature for all students. Not only can practically everything be automated and moved from the physical world to a central system based management environment, such as these smart attendance gadgets, but also boards which are integrated to alarm systems in schools, tools for assessing student progress, cameras etc. Regarding the usability of IoT in education, we can say that the rise of mobile technology and the IoT allows schools to improve the safety of their campuses, keep track of key resources and enhance access to information in the learning environment.

2.1. Capabilities

Intelligent whiteboards, tablets, and laptops are examples of IoT devices that can support in class collaboration and real time communication between professors and students. IoT platforms make it possible to develop IoT solutions more quickly and more effectively. The levels of connection and network administration, device management, data collection, processing, analysis, and visualization, integration and storage are where their core competencies lie. For instance, while a teacher is presenting information to the class on an intelligent whiteboard, the students may use their tablets to ask questions,

discuss ideas and work together on group projects. Regardless of where they are, this technology may make it simpler for teachers to communicate with their students and for students to collaborate. Additionally, it can aid in removing geographical boundaries, enabling students from other nations to communicate and work together in real time.

2.2. Applications

Regarding the application of IoT in education, below we have presented nine of the most important issues, such as:

1. **Distance Learning** – IoT based systems have the ability to store and form data in the form of an application with specialized software and in the form of a sign-in feature on websites that enables anyone from anywhere to access that data with a user ID and a password, which can be provided by the institution to their distance-learning students. This can assist anyone who wants to complete their educational program but is unable to enrol in a legitimate educational institution;
2. **Close Monitoring** – There is always the possibility of tracking the actions and time spent by the student on a certain topic, whether the online portal is utilized from inside the school or from somewhere else. The sensors used in IoT in education gather data and automatically recommend academic subjects that students might find interesting for further learning. Additionally, it is simple to identify who participated in which evaluation, and progress may be monitored along with scoring;
3. **Special Education** – Getting a regular and thorough education for kids with special needs used to be almost impossible and comparably difficult. In order to meet the unique demands of the children with sensory disorders, the educational curriculum is being changed, and the classroom surroundings are being made sound and light sensitive with the use of IoT tools and smart devices. In order to extend the concepts to what is described in the books, the teachers can employ a system of sensor-connected gloves and a tablet to produce spoken speech that is translated from sign language;
4. **Evolving Methodologies or Techniques** – IoT in education refers largely to the use of internet-connected, digital smart devices by both students and teachers in educational institutions. Electronic books that can be downloaded and have zooming and saving features are being adopted. The way traditional schools and educational systems have always operated is changing as a result of technologies like voice command systems for teachers, smart security cameras, GPS equipped school buses, disaster alarms, tablets, and smartphones with educational applications;
5. **Improved Collaboration and Productivity** – Students are more engaged when taking lessons using virtual applications on their smartphones. Through interaction based learning, students may become more motivated to

- participate in evaluations, activities, and even self-learning by scanning barcodes on books to access the corresponding digital version;
6. **Monitoring health of students and staff** – Physiological indicators identify and keep an eye on students health. Medical professionals can quickly examine students health thanks to the information that is maintained in databases. IoT also aids in the storage of data such as blood pressure, medical history, allergies, and medication details to be used in the event of an unfortunate accident;
 7. **Safety on the Property** – Most schools do not have the resources to identify warning signs of theft, abuse, sexual assault, and other crimes that may take place there, nor do they have a proper emergency plan in place. IoT may significantly contribute to the resolution of these problems since, in the event that any objectionable action is observed by the camera, it can be instantly addressed thanks to a network system that enables the video footage to be shown on multiple screens around the space;
 8. **Automatically Recording Attendance** – Teachers are concerned about student attendance, and in schools this is a daily responsibility that cannot be substituted. As students enter the classroom, their attendance can be automatically recorded using biometrics or a barcode system based on their identity card number. However, such methods may be made more successful by sending a clear message to the parents of their absence in the classroom, informing them of the situation;
 9. **Augmented Reality (AR) Equipped Systems** – With the use of technological tools, augmented reality may be described as an improved version of the real world that is presented in a more intelligible manner. The use of AR can increase the efficiency of IoT based systems and devices. Students can receive accurate marks and information simply by scanning a barcode next to the subject they are studying. When integrated with a software system, augmented reality may offer greater information and 3D views of the subject being taught.

2.3. STEM in Education and Its Application

At its base STEM education essentially refers to teaching children about four distinct subject areas: science, technology, engineering, and math. An educational system that aims to imbue pupils with classroom information and apply that knowledge to real world circumstances incorporates these four aspects within its teaching methodology. STEM promotes the creation of fresh ideas which are crucial in times of rapid globalization. The system works to increase the likelihood that everyone who goes through the educational system will play a significant role in society. STEM extensions: STEAM (which includes arts) and STREAM (which has reading, writing, and arts).

Based on [4], 56 publications included various spectrums of STEM education and were published between 2007 and 2017 in the SCOPUS database, the Journal of STEM

Teacher Education (JSTE), and the International Journal of STEM Education. Therefore, this means that every day, the implementation of STEM in education is growing even more with the latest technological developments and the need in education for more innovative lessons.

Regarding the results, in the presentation at the conference, we discussed the results and their explanation and provided several practical examples that were the subject of other articles.

3. Challenges and Future of IoT in Education

3.1. Challenges

IoT is one of the main factors of technological advancement these days and has the greatest ability to change humanity manner as well as other sectors. As a result, there are still a number of issues that need to overcome for all the associated parties including developers, engineers, businesses etc. [7]. In the following we presented few obstacles facing the educational system:

- The expenses of installing IoT might be high;
- The absence of universal, circumstances aware learning environments;
- The resistance of teachers to using modern technologies;
- Necessity to reconsider current teaching approaches like structuralism and the theory of cognition;
- Because certain IoT apps and devices are incompatible, deployment is challenging;
- The challenge of protecting the privacy and security of IoT devices.

3.2. Future of IoT in Education

As part of the future of IoT in education, below we have explained five of the most important issues, such as:

1. **Increasing Tech Proficiency** – IoT devices in the classroom have a significant impact on how much technology children will be exposed to throughout their academic careers. However, combining the IoT with education will unavoidably aid in defining pupils technological attitudes;
2. **Gamification and Education** – Children and young adults learn best through play. Conventional educational approaches made learning via play challenging, if not impossible. To encourage learning via play, these gadgets combine AI algorithms with smart cameras, microphones, and other sensors;
3. **Personalized Learning** – IoT devices are making it simpler than ever for teachers to customize their students learning experiences while also releasing the promise of interactive and immersive learning. As augmented reality technology advances, smart glasses will be able to serve non-traditional students and individuals with particular learning needs more effectively;

4. **Interactive Learning** – The IoT devices allow students greater possibilities to actively connect with the teacher, their classmates, and the course materials, whether they are in a traditional, in person classroom or a virtual one. For instance, during virtual learning smart technologies like interactive whiteboards allow students to make changes to charts, texts, and other materials on the whiteboard from their workstations using an internet-connected tablet or from a computer at home;
5. **Immersive Learning** – The introduction of augmented reality and virtual reality (VR) technologies into the classroom is arguably one of the most exciting technological developments in recent memory. Gadgets like untethered VR headsets and augmented reality glasses may deliver a genuinely immersive learning experience.

3.3. Accessibility

In contemporary education digital accessibility to the educational resources and learning process for the people with different disabilities is mandatory. The IoT offers great potential for both the greater inclusion of students with disabilities in higher education and a better and more customised learning experience for all students [8]. These include different types of obstacle sensors, voice and face recognition hardware and firmware etc. Also, STEM education techniques should be adapted for digital accessibility. In example popular mathematical education specification MathML is adapted by World Wide Web Consortium (W3C) to be used by people with different disabilities [12]. That is why in other papers of the authors the concept of digitally accessible educational content will be presented in more details.

4. Conclusion

IoT solutions for education have come up with answers to enhance the quality of education across the globe by making it easy to understand and available to all. IoT expands academic achievement, contributes to the method of instruction and learning, and raises expectations for educational standards. These technologies help boost learning for students and make it more engaging with systems like AR, VR and even more. In addition, it allows educators to digitize the learning process and make their processes more efficient and easier. Although there are many benefits to IoT in education, there are some challenges concerning security, accessibility, cost and more.

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