ROLE OF INTERNET OF THINGS (IOT) IN HIGHER EDUCATION

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Abstract

With enormous development and cumulative role of technology in all walks of life, conventional and classical methods of education in classroom are no more attractive and efficient for the learners of the 21st century. With the increasing popularity of Internet of Things (IoT), small gadgets are gaining wide popularity, especially, when students use wearable devices with small sensors for connectivity with learning systems. Modern interactive devices are equipped with IOT sensors, which can connect to end users devices and provide them limited access to download data as based on types of accounts they are using. The Internet of Things enables connection of devices to the Internet, is in the process of transforming numerous areas of our everyday lives. The online learning system with the help of Internet has deeply rooted itself into our schools, and e-learning has become a common practice in modern schooling systems. But the applications of the IoT in education are numerous, and the implications for this disruption are tremendous and it serves the system and community with many folds like the popularity of mobile technology. In addition, the IoT allows schools to improve the safety by tracking of key resources, and enhance access to information which facilitates teachers to create "smart lesson plans". The students, particularly in colleges/Universities, are progressively moving away from paper books toward IPADs/Tablets which are equipped with interactive apps with in-built graphics and simulations with liberty of time and space. This paper is discussing all aspects of IoT with their productivity level which will help educators and learners of modern era to learn from result of processed data, which shows different learning trends and with success ratio of those applied methods. Furthermore, we can also see the room for improvements in different sections based on age, category, region etc. The results will help the decision makers and suggest optimal teaching model for improvements on some particular platform for some particular community, with more specialized approaches. This will be done by an analysis on Big Data, generated by these IOT devices and variety of data will continue to reach into new areas that have never before been available for analysis. Interactions between teacher/student using media platforms, the automation of processes, and the aggregation of data coming from different sources that creates the Internet of Things (IoT). This digital transformation will reveal new insights that promise to change the way we think, learn and implement things in our real life and more specifically in the future education system.

Keywords: Cutting-edge, IoT, Smart Society, industrial 4.0, 5G, AIEd, IM.

1 INTRODUCTION

We can call our current era as the emerging Internet of Things (IoT) era without any doubt, which is equipped with ubiquitous computing & networks of interconnected and Internet-enabled objects. We can't deny the value of understanding of digital technology in this era. Micro-controllers, sensors, actuators, and MEMS are considered as the building blocks of IoT. Cutting-edge technology leaders are mostly focusing on

implementing these components in commodity objects. With these phenomenal advancements of digital technologies and ubiquitous computing, it is becoming mandatory to train our society about emerging concepts of computer science and IT skills regardless of their core areas of specializations. On the other hand, for students, who are currently enrolled in any program at educational institutes, it is of utmost importance to prepare them for these technologies. Companies will be looking for candidates, who will be equipped with knowledge of the latest state of the art technologies. Industry leaders such as: Cisco, Microsoft and many others have already added IoT, Cloud Computing & Virtualization in their current academic curricula to train the future engineers and IT experts. Educational institutes on the other hand not only teach computer science concepts but also encourage critical thinking and innovation. The June 2017 issue of Computing Now from IEEE Computer Society [5] elaborates how technology can be effectively utilized by teachers in the IoT era. The selected articles introduce methods for integrating IoT into Science, Technology, Engineering, and Mathematics (STEM) education while simultaneously building educational environments that values problem solving and exploration. Additionally, the videos highlight how working with open-source IoT platforms can help foster creativity among the 21st-century learners. We further discuss various perspectives of Teaching and Education that must be incorporated while developing educational curricula to fulfill the requirements of Smart Society literacy requirements.

1.1 Use of IoT Platforms and Visual Programming Languages in Teaching

According to Gartner [10] in the last year 6.4 billion connected devices were in use across the world, which is 30% more than the preceding year of 2015. By year 2020, this usage will reach up to 20.8 billion devices. IT Companies like Cisco [11], Xerox, IBM, Bosch [12], NI [13] , HP, Apple and others have envisioned IoT to be the major disruptive technology for education just as it is for all other industries. Many prominent researchers [14] [15] [16] [17] have suggested following IoT tools and technologies for teaching in the classroom:

- Microcontroller development boards,
- Advanced embedded systems,
- Electronic white boards
- Mobile phones, iPADs, Laptops and Tablets
- Automatic Electric lighting
- Smart HVAC systems
- RFID enabled Student ID cards
- Wireless door locks
- Security cameras and video conferencing
- Biometric Attendance tracking
- eBooks
- Augmented Reality
- Virtual Reality
- Additive Manufacturing Devices to create 3D objects
- MOOCs

Classrooms equipped with electronic interactive white boards allow richer and consistent experience for the learners and teachers during the whole course of study making it easier to share, add, edit contents with students while bringing online contents on the fly to support the discussions in classrooms. Students are encouraged to bring their own devices (laptops, tablets, mobile phones etc.) to the classrooms allowing them to perform their classwork and assignments on their own devices. This allows the students to take the work performed in class room when they return to their homes providing them an opportunity to revise and reinforce the concepts in their leisure time. Students can use micro-controller development boards such as: Arduino, Raspberry Pi, and STM32 Nucleo as small IoT platforms. A very prominent example of it is in British schools, where children learn to use the BBC micro:bit, a single-board computer with Bluetooth and USB connectivity, an LED display, and two programmable buttons. All of these boards offer add-ons to extend their functionality to meet the myriad requirements of IoT application development. (What happens as a result of this usage? Elaborate in a sentence or two. The result or impact of it). Another option is to use

advanced embedded solutions, which combine micro-controllers with Field-Programmable Gate Arrays (FPGAs) The Blu5 SEcube security-oriented open platform is a good example, as it's a single-chip design that expertly integrates three main parts: a powerful microcontroller, a Common Criteria-certified smart card, and a flexible FPGA. Developers (and students) can fully control and customize Blu5 SEcube. Visual Programming Languages (VPLs) are GUI based environments that use graphical elements for programming, and one of the most well-known is a Scratch. It was developed at MIT. This programming language helped millions of trainers and learners to develop programming concepts and logical thinking. According to Gans [20], Scratch can complement IoT platforms in education: "BBC micro:bit can be seen as a simple IoT computing platform, making it easy for students to create ubiquitous computing applications using a range of computer languages (such as Scratch), perfectly matching different age or group abilities". Researchers believe that learners must not only understand underlying principles and theories but also have the creativity to produce effective solutions and physical or virtual implementations. To overcome barriers in obtaining and utilizing high-end technologies, they propose adopting a requirement engineering approach that focuses on quality-in-use employing general usability and quality models which measures specifics to pre-college engineering education.

2 COMPETITION BETWEEN TECHNOLOGY & EDUCATION

If we look at current era of technology and popularity of automation with the introduction of industrial 4.0 there are great opportunities that at first level routine jobs scenarios will be toppled by the steady rise of the robots and human interaction, which will eventually result in increased productivity of industry. With that development there will be dire increase for need of ever smarter algorithms deployed on bigger data-sets. However, the consequences of this for learning have received relatively little sustained and thoughtful attention. If we fairly look at current situation, major part of our global education system is being led by economists rather than educators. So eventually, they will be looking for economic outcomes and profits rather than quality of education. This research [24] also reflects gaps in existing quantitative research, which focus largely on job categories, rather than skills, and on the roles likely to be automated, rather than those likely to be created. The authors explained components of Artificial Intelligence based Education system which can be combined to develop an impartial smart real-world testing and evaluation platform for the students. They further discussed requirements of having more understanding which should eventually result in more productive output by use of smart machines in day to day routine at work place. This will bring a positive change and significant impacts of globalization on existing issues in education sector. They completed two things.

I. Mapping the catalogue of AIEd tools, which will eventually help for massive challenge by supporting the next phase of education system reform.

II. Set out the ways in which AIEd can be deployed to help for understanding and realizing this reform agenda.

There is need of timely and actionable feedback from students. We should prioritized and made affirmed that the 'purposes' of education are than getting a job. For example, a list would include discovering your passions, experiencing the flow and satisfaction of good work, and being a moral person with the capacity and desire to affect positive change in your family. Community, country, and the world. Having said this, getting a good job is consistent with the list above. Indeed, it is one of the central reasons why governments invest in education. The table shows our mapping of the tools of AIEd against the likely requirements of the jobs market in 15 years' time In Engineering Programs, early exposure to IoT development frameworks can help students feel comfortable with IoT fundamentals and applications. Jing He et.al. Presented a case study in which the authors showed how a module design method can be used to develop a course lab-ware on the basis of embedded training boards. This technique was very effective as in a fun environment; the students gained understanding of computer based automation and maybe one or two more. Teachers should motivate students to innovate, with the goal of gradually preparing the students for IoT era through smart approach of doing tiny experiments to build their hands on experience for innovation in a seamlessly manner.

3 RELATED WORK

Intensive research is going in the field of education to fulfil latest technological needs and align it with cutting edge technologies. Here is work from leading researchers and educationists. The researches (Barron, Kemker, Harmes, & Kalaydjian, 2003; Bauer & Kenton, 2005) have discussed the possibilities of effective integration of technology in education to inculcate the 21st century skills. For effective integration teachers must know more than the technical aspect of technology, and must understand its affordance and constraints both for representing content and identifying pertinent teaching approaches (Harris, Mishra, &

Koehler, 2009). The Technological Pedagogical Content Knowledge (TPACK) framework has been offered as an integrated framework for teacher knowledge for effective technology integration. The integration of technology and computer based teaching have been introduced in many countries at large scale (Bebell & O'Dwyer, 2010; Sung, Chang, & Liu, 2016) discussed the integration of mobile devices used by students and teachers to promote innovation, creativity, shared learning, innovative, and exploratory learning outside the classroom. The other researchers (Klopfer, Sheldon, Perry, & Chen, 2012) have talked about the fun learning though game-based learning, which further leads to the educational method which help in subject content learning, and facilitates the development of communication, problem solving, creativity, and high level critical thinking. The integration of technology and blended learning also helps in delivering interdisciplinary courses in health sciences (Medicine, Nursing, Pharmacy, Occupational Therapy, Physical Therapy, Dentistry, Dental Hygiene, Medical Laboratory Science, and Nutrition) team process skills was redesigned without compromising the pedagogy (Carbonaro et al., 2008). The traditional classes are now transforming due to the introduction of IoT in education. E-learning elements and stages have been under expanded weight because of commentators and government in light of completion rates, costs, employment, and career readiness. The learning systems can be improved by using new advances to decrease costs, and enhance the end-to-end following of general learning(Suja P Mathews, 2017). The students and teacher in the IoT era are associated and have full access all the time to discuss the issues and find their solutions. It will also enhance the interaction and cooperation of educator to more students beyond the campus boundaries. In addition, it will provide an access to the parent who can track the progress of their children and take the corrective measure and interfere wherever required through the IoT framework. The IoT is not only assistive in teaching and learning, but it has can provide a great support in streamlining the operations at school, i.e. monitoring attendance, online assessments, online homework and assignments, instant online feedback, results, and notifications about any urgent situation, with a very low cost and in an efficient way(Prof. Dr. Srisakdi Charmonman, 2015). The IoT can be of a great help in managing emergency and disaster situations, i.e. interacting automatically informing and alerting the police, disaster management authorities, fire station and hospitals. IoT and cloud systems make surveillance automated and easy.

IoT for Special Needs (learners with disabilities)

The Internet of things can be very helpful in teaching and enabling the special needs people with disabilities to work and be dependent. There are about a billion people including children (or about 15% of the world's population) are estimated to be living with disability (Domingo, 2012). If there are no proper services provided then these people would be financially burden and be depended on their families. However, the IOT can offer these people a respectable way of life, where they can learn skills and then get jobs to support themselves regardless of their disabilities. The benefits of IoT to consumers broadly and people with disabilities specifically is relatively new, consumer-based IoT products have been available since the year 2000. There are now sensor based appliances available, which facilitate the people with special needs to do things without any hassles (Hollier & Abou-Zahra, 2018).

Personalized learning though IoT

Lot of research has been conducted in making grounds for the personalized learning providing learners with freedom of pace, time, space and still making them achieve the best results. With the advancements in technological enhancements and its integration into teaching, educators are able to place personalized education at the center of a student-centered teaching approach. This would help in providing students to customize their learning activates, do things at their own pace, style, and adjustable circumstances. It has been noticed that the students in large crowds and big halls attending classes with hundreds of students, loose their interests as their individualized needs are neglected, which leads them to disinterest in the subject resulting into failures. The IoT provided an effective solution to such issues through integration of technology after careful planning and studies (Meacham, Stefanidis, Laurence, & Phalp, 2018).

Figure 1: IOT reshaping Thoughts

The IoT further assists in developing attendance and monitoring system through RFID tags, where students are directly monitored by the scanners. In addition, the (Brown, 2017) with the latest sensor, which students would wear on their forehead can inform the teachers about their personalized learning style and help them to create curriculum addressing those needs. The personalized learning goes a step forward through collecting individualized feedback helping the educators to cater and address those needs. Furthermore, the linkage of of social media, such as Facebook and Twitter to the students' accounts can help the researchers to collect data and use it to design things which are more meaningful to the learners (Ahn, 2013). The IoT and Pocket Labs are popular buzzwords today with the IoT being much better known in wider circles, while the Pocket Labs are a relatively new concept offering new teaching opportunities which are to be further explored and analyzed. The IoT comprises many technologies working together to create a seamless link between real and virtual worlds that yields new qualities and benefits pervading our technical civilization (M Cvjetkovic, 2018).

The G-IoT:

It's evident that technologies have become an integral part of the educational systems, especially Internet of Things (IoT) are having an increased role to play in improving educational standards. The new technologies integration is helping in teaching and learning processes at the classroom as well as at an institutional level making the whole process more effective and meaningful to the stakeholders. There are various technologies, tools, and strategies which bring innovation, creativity, and connectivity in the education system: Consumer Technologies, Digital Strategies, Enabling Technologies, Internet Technologies, Learning Technologies, Social Media Technologies and Visualization Technologies. The IoT helps the educational system in many ways, such as providing a virtual platform, shared and intelligent experimental teaching and learning environment (Maksimovic, 2017). Embracing the power of ICTs and IoT in educational practice, students benefit in numerous ways. Technology helps them to address all learning styles, to interactive participate in knowledge obtaining and sharing, all education activities are student centered and supported, making the learning personalized, dynamic, collaborative and up-to-date. Furthermore, learning goes beyond the classroom. Interacting with so many everyday objects connected to the web, students have access to unlimited information from anywhere, anytime, in customizable learning manner.

The increasing involvement of technologies in educational system can have extremely harmful effects on environment. The G-IoT explores the ways to reduce cost, usage and minimize the potential harm of these machines on the environment. The sustainability of the ICT resources in educational institutions requires greener behavior by the schools, universities, staff members, students and administration people. G-IoT, through taking the precautionary measure, holds the potential to transform the educational environment, making it economically, socially and environmentally sustainable (Maryam Bagheri, 2016).

4 TECHNOLOGY AND EDUCATION

Teachers today are using digital devices and gadgets to help their students learn better. Though there are some views of the negative impact on the young learners.

"Teachers will not be replaced by technology but teachers who don't use technology will be replaced by those who do " Sheryl Nussbaum-Beach.

There are multiple reasons for the technology love in teaching and learning

1. One of the main reason is that student's love using technology and they feel comfortable with these devices. They are more interested and engaged while using technology for learning.

2. The other reason is that it engages the four components of learning: active engagement, group work participation, frequent interaction and feedback and connection to the real world experts.

3. It also provides professional development opportunities to the students. When these kids would go to job and workplace their computational skills would help them to do the work more efficiently. In addition, a small incident, or a viral video on social media can make someone a celebrity.

4. The technology has made the teachers' lives easier. They can get material for the lessons, post online tests with auto corrections, and have the online meeting with parents saving time.

5. The research shows that the use of technology has improved the test scores. The students retain the information learned at their own pace and perform better in the tests.

6. Technology helps the learners with low attention spans. Technology is a famous tool for teaching kids with special needs and teaching languages.

7. It provides an opportunity to go beyond the class. The learners can learn from the experts while staying in the classes, though online available resources.

8. Improved homework responses. The technology really helps kids to do homework on the computer using online platforms. They can review the lesson videos, and watch other related resources.

9. It helps in saving resources and money. There could be more functional teachers in classes using technology.

The technology helps in removing obstacles. i.e. the audio-visual aids though amplifiers and multimedia. If the audiovisual aids are effective than the class management becomes way easier and effective

4.1 Impact of Technology on Teaching and Learning

"Throughout history, advances in technology have powered pragmatic shifts in education". Thomas Frick, 1991, Research Education through Technology. How we acquire knowledge then and now?? That is a question to the history, present and future. The way we use the acquired knowledge in past has totally been transformed in the present days and it is continuously transforming especially with the digital and smart devices. "Books will soon be obsolete" Thomas Edison. We are in a time where there are no more classrooms, no more books, no more teachers and fixed schedules. E-books, digital devices, and smart gadgets are bringing a great shift in the learning ways. Now learning can be done at a distance with no limits of time and space.

Figure 2: Smart Learning Place

The education is moving towards a totally virtual system with computing complexities and artificial intelligences. The introduction of robots is going to bring a greater shift in the future, by which human interaction is becoming minimum. A new paradigm of education transforming professional development and focusing on assessment connection, leadership, innovation, knowledge, discovery, creativity, ethics and risk. The emotional reaction to uncertain and fast rapidly changing future. The change in everything is so rapid that sometimes we cannot expect and judge and develop a right reaction to that. 10 million people out of which 5 million are high school students from the USA, requesting the online web developer for a continuous update to make things more relevant. The company works for the big companies in the area of uncertainty, which has low probability but high impact risks.

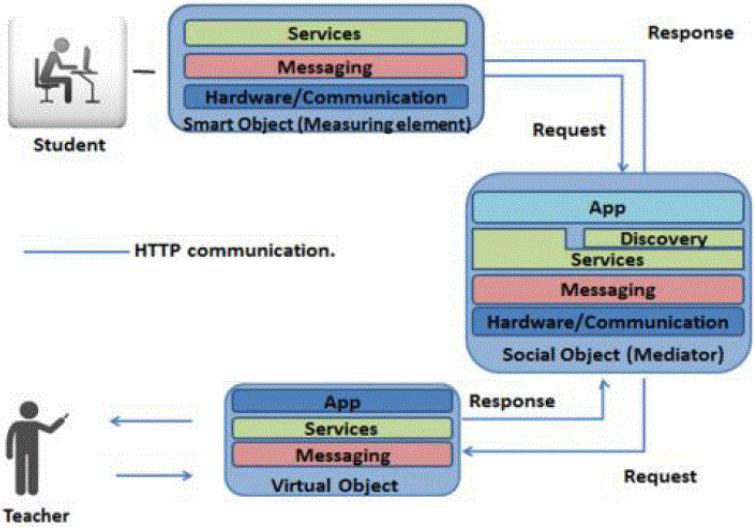

Figure 3: Automatic Computational thinking Model for better communication.[18]

For better understanding and delivery of messages automatically computational think model can be used by introduction of smart phone application. Where teacher and students will be having liberty to communicate with each other by mobile application, SMS service or through virtual object, which will forward the request through mediator know as social object, this mediator will be residing on hardware platform to transmit messages as per available application or available configured services. On the user/student side there will be interface to avail these services through his mobile or computational device which will be housing these applications in communication with central system.

Figure 4: Smart Classroom

4.2 The Future of Classroom Education

Future is about emotion. Emotional reaction shape realities. Anything can have high impact when it's linked with emotional reactions. I.e bird flu had developed that reaction in people where people even left eating chickens. Almost all the incidents have an impact on emotion. We need to make the right choices so that the kids who are taught in schools today should not feel bad when they are in their 30s. The traditional classroom has been redesigned with the help of technology and digital devices. The books are becoming impractical and a burden, as one source can provide access to countless books with no worries of carrying them. Computers and the smart gadgets are replacing the books. In 2008, 58% of the school had public laptops and 39% had on campus WiFi access throughout the schools. The digital resources save time and improve the efficiency of finding the correct sources in less time. More than that, searching an information through a book would take hours, however that task can now be done with one click of word search in computers. Technology has helped with a great deal in improving education through the use of the computer, internet, and online resources, online learning management systems, open ware courses, CBTs.

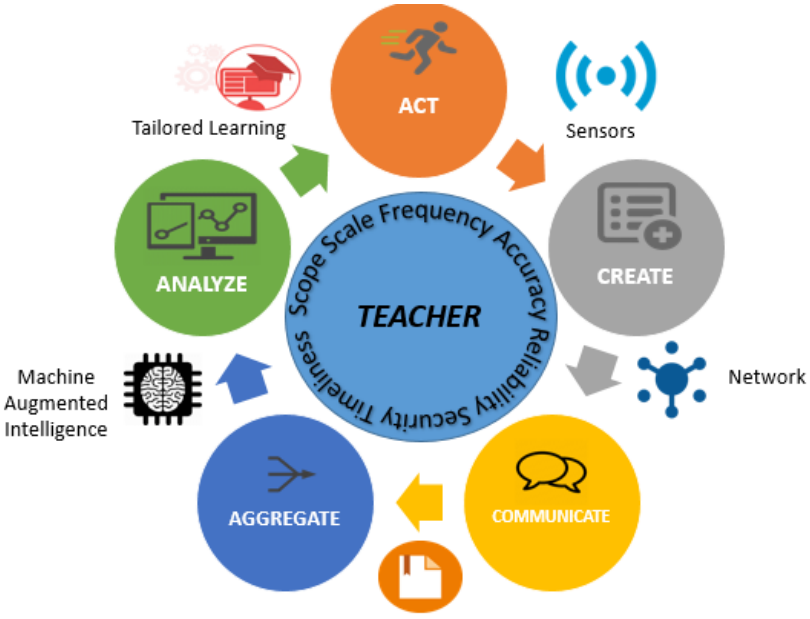

Figure 5: Learning Life Cycle in IOT Enabled Classroom

In an IOT enabled classroom students are not only depending on teachers teaching skills but it's more important for to them to increase their expertise in to learn from latest technology gadgets.

5 FUTURE LEARNING TRENDS

IT is shaping the way how higher education is evolving with internationalization. Researchers at Pearson and UCL Knowledge Lab proposed use of Artificial Intelligence based system to improve the learning and teaching in education. Figure 3 shows their envisioned concept. The Horizon Report portrays how higher education will evolve with the improvement of technology. It highlights different aspects along which teaching and education will evolve. The young people know a whole lot more about a lot of technologies that we know. The digital media is actually transforming the nature of learning from the passive receipt of information to active participation in production. It is not important that how young kids are learning, but what are they learning. The learning mechanism has changed from pencil and paper to digital. Now we see the young kids of 3 or 4 years of age using the devices and learning autonomously. The bit grown-up kids are left to the computers to take help and learn from it, which is totally contrary to the classical style of learning. Kids are aware of the things now and they can be asked and they can be observed to monitor their performance. In this digital era, the school has lost its primary place and it has become one of the components of the learning process, where kids learn some social behaviors. The technology needs to be introduced to the classes not for only learning but to make it more relevant to the learners. The technology might actually be transforming how young people interact how they organize socially how they play how they imagine how they think how they solve problems how they develop their identity how they confront ethical dilemmas, how they understand and judge information. Haystak stands for humanities arts science and technology advanced collaborative. This organization was founded by Kathy Davidson and David feo Goldberg has become an interdisciplinary and international organization that works across various universities and civic institutions this event electronic tectonics is a culminating event of the information year.

6 COMPUTATIONAL THINKING (CT)

In a modern day education system, the students should be introduced to the computational thinking. Computational thinking (CT) is about formulating things with enough clarity, and in a systematic enough way, that one can tell a computer how to do them. (Wolfram, 2016). In simple words we can say that CT allows us to deal a complex problem, understand it well, and develop possible solutions to solve the problem. CT is not limited to computer sciences rather it is used in multidisciplinary areas to solve the problems across the variety of subjects. CT help students to see things in a more practical way by creating a link to real life and making them more relevant. The way computer scientist thinks and use their skills to make programs and create codes is computational thinking. These ways of thinking can be used anytime we want to develop a process or algorithm to solve a problem. CT is a process which involves multiple steps to solve the problems:

1. Decomposition: In this step the complex problems are further broken down in manageable parts.

2. Pattern Recognition: Here the similarities are found among or within the problem.

3. Abstraction: Here more focused is given to the main information. The extra and less important details are ignored.

4. Algorithm Design: Here step-by-step solutions or rules are developed to solve the problem.

CT skills are more public, they are not limited to the computer scientists. "CT represents a universally applicable attitude and skill set everyone, not just computer scientists, would be eager to learn and use". [19]

7 CONCLUSION

Today, we have various ways to teach skills that students will need in a global IoT world, which has totally changed our perception for different services [23], but we don't always implement them effectively in the classroom. To fulfill the requirements of future-proof education, the educators and institutions need to integrate IoT platforms into science and engineering curricula to help students develop digital literacy and innovation skills. Moreover, AI based data analysis and adaptation strategies will be required to provide student centric progress driven contents that enhance level of understanding while boosting the receptivity of the students through multimedia contents. We also discussed the short term, medium term and long term trends in education and use of supporting technologies to prepare the future students of Smart Societies.

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