EMERGING TECHNOLOGIES FOR IMPLEMENTATION OF EDUCATION SYSTEM FOR THE CITIZENS OF SMART SOCIETIES

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Abstract

The Future of humanity is evolving rapidly with the introduction of new innovative technologies in our lives. Although, primarily these technologies were developed to enhance our efficiency and ease our routine tasks, conversely, they have disrupted our lives and became essential necessities for us. In this era of Internet of Things (IoT), the ever increasing demand of competitiveness and quest for perfection has raised the bars for competence level required in all walks of life. The citizens of Smart Societies of the future will have to enhance their knowledge, skills and expertise in newer dimensions of cognition which were never considered mandatory in the recent past. We are witnessing the dawn of a technological revolution in which robots will replace the ordinary workers (Industry 4.0), unimaginably fast mobile communication (5G) will connect billions of autonomous devices, and Quantum Super Computers that will perform 100 million times faster than our standard laptops. This is essentially a paradigm shift that requires non trivial forms of teaching and learning methods for preparing the millennial students of today and future-proof workers of tomorrow to succeed in the increasingly complex and digitally driven AI based Smart Societies.(in the increasingly complex and digitally driven *Smart Societies).* We discuss in this paper the challenges posed and their possible solutions by positively introducing these new technologies in pedagogy, curriculum design, ICT skills and outcome based education.

Keywords: Actuators, Smart learning*, IOT, smart society, industrial 4.0, 5G*.

1 INTRODUCTION

We can call our current era the next technological revolution based on emerging Internet of Things (IoT), AI based Big Data Analytics and cloud technologies which provide new business models as services allowing low performance, low energy devices to perform daily routine tasks that were previously not even possible by high performance on premises servers. We focus our research on providing an implementable solution of an evolving, future-proof, adaptive and self-tuning education system that is based on available and recently emerging technologies to create the complete educational echo system. These technologies vary from sensors to computation units to network based storage systems to AI based learning engines that perform

decision making on short term, medium term and long term data analysis of learning environments.

We discuss all of the above components and others that are essential for providing an adaptive futuristic education system after brief overview of various learning perspectives.

2 LEARNING PERSPECTIVES

Learning Process can be seen from several different perspectives which will help to understand the big picture of cognition, understanding and knowledge acquisition.

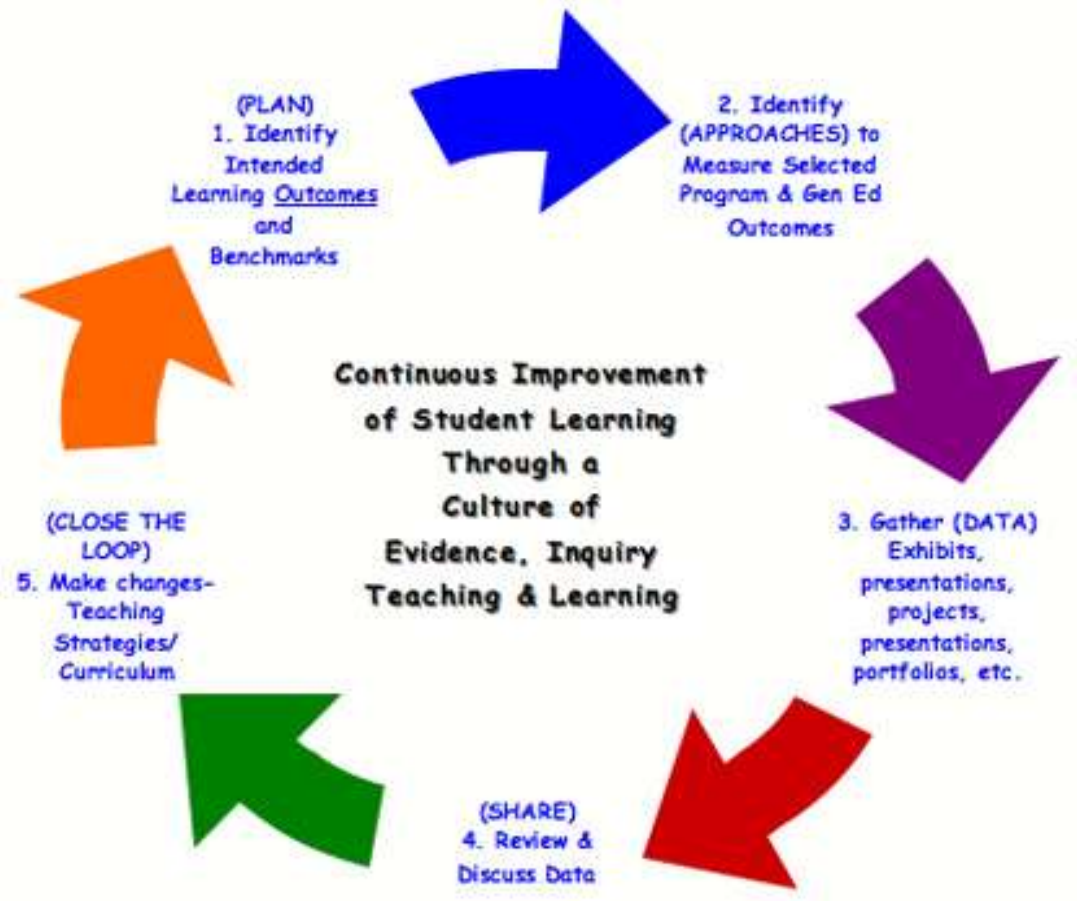

Figure 1: Students Learning Through EITL Cycle

Learning is a continuous process with constant improvement in the knowledge while refining the teaching

better solutions without requirement of formal On Job Trainings by the employers. This is the most commonly reported reasons mentioned by CEOs and CTOs in support of early adoption of technology based learning methodology and learning skills. Figure 1 shows this process highlighting each step in the learning process.

2.1 The Society Perspective

Individuals make societies; thus individual students who learn technology oriented concepts will certainly have better standing in the era of Industry 4.0 where man and machines (robots) will work together and compete for typical jobs which were traditionally performed by humans. Moreover most of these industries will prefer robots to work in industries without having to cater for the environmental safety levels typically required for human workers. Thus future workers have to be more versatile to have knowledge that is superior to AI based systems or have skills that are not easily imitated by the robots or cyborgs (humanoid robots). Future Smart Societies will be utilizing rules based robots or cyborgs for tasks that do not require individual judgment and can have centralized command control system such as security services [10], law enforcement [11] and even battlefield deployments [12].

2.2 The global village Perspective

The world has become a global village where knowledge created in one part of the world gets delivered

across the planet through the Internet. MIT's Open Course Ware and MITx are excellent example of such contents that are created by the leader in education which are freely available to all who seek knowledge in any specific subject area. Online training platforms such as Coursera [13], Udemy [14], Harvard Online Learning [15], Stanford EdX [16], Open Yale Courses [17], Carnegie Mellon Open Learning Initiative [18] etc. offer free online courses that can help students of all ages to learn concepts and gain knowledge at any time of convenience in a self-paced mode of learning.

2.3 The Industry Perspective

Flexible and modular open-source IoT platforms can provide students hands-on experience and teach them to develop real-world applications by gaining experience from their classes. This experience will help them perform better in the industry and deliver methods in academia. As CTO of Boeing [19] mentioned in his keynote presentation to American Society of Engineering Education (ASEE) that "We need these young people to come in and have the ability to look at a problem, understand how they could make that situation better, and then do the complete lifecycle of conceiving a solution with a detailed design, figuring out how the manufacturing process could be put together, actually building the thing, testing it, knowing how to service it, understanding how the finances work — we want someone with that full lifecycle of knowledge"

2.4 The Humanity Perspective

Although it is highly motivating to train our students for the greater challenges in the future and to prepare them for effectively dealing with machines to get maximum productivity in their respective industry, in the bigger picture, they will eventually be providing services to the humanity e.g. increased production in food industry, precision farming and agricultural technologies would increase crop yields upto 67% in 2050 [20] that will help alleviate starvation in poor areas of the world and all the people will have easy access to get needed food. Similarly the same can be seen in terms of basic necessities of life for people all over there world.

Introduction of affordable and accessible technology for the masses allowed many tasks to be performed with easy today that was previously considered impractical or unconceivable. e.g., Smartphones or tablets allow self-diagnosis of diseases on their own without having to visit medical doctors far away by sharing their symptoms to get prescription and medical advice in few minutes [21].

3 CHALLENGES OF CONVENTIONAL EDUCATION

Like any other verticals, education as a field also faces many challenges that hamper the effective delivery of knowledge to the pupils. Some of the major challenges are elaborated in [22] which are reiterated below:

3.1. Enhancing Professional Recognition of the Teachers

The educationists of today are faced with far greater challenges of developing novel teaching and learning strategies along with measurable unbiased evaluation mechanisms that can cope with the steep practical requirement of the future Smart Societies. This not only requires teachers with excellent pedagogical and communication skills but also raise the bar for their digital literacy and technical competency in the use of emerging technologies such as augmented reality, interactive online collaboration platforms, social media, multimedia content creation and delivery systems, IoT enabled embedded hardware, network connectivity and storage devices. This makes the teachers for future generations of students to be excellent communicators as well as technologically proficient in their specific areas of teaching and research. The 1st challenge is therefore to have greater recognition for teachers as high ranking professionals having multidisciplinary expertise as suggested in [23] [24]. This will make it a career of choice, for those who want to contribute in teaching as a knowledge-based profession.

3.2. Reducing Difference of Standards between Same Levels of Education

Due to the difference of capabilities of teaching staff, students' educational background and allied facilities in classrooms, laboratories and libraries, there has been a significant disparity in the levels of teaching and learning between the teachers and students of different areas of country. The 2nd most prominent challenge affecting the education system is how to reduce this disparity between learning experiences of students belonging to different geographical areas.

3.3. Curriculum Design for Smart Societies

With the industrial and IT revolution, the world today has become entirely different from that of 30 years ago. Owing to increased globalization, technological advancements, enhanced connectivity and social

interactions the speed of change is accelerating. The curricula being taught as well as the conventional methods of teaching are no longer able to keep up with the complex demands of future workplaces in Smart Societies. Therefore, new flexible and customizable curricula have to be developed to challenge the students for using their own abilities immersively in the taught contents thus making their concepts easily applicable to real-world problems. The 3rd commonly discussed challenge is the development of curriculum that has the right balance of progressive difficulty level, introduction of new concepts, application of ideas, measurable level of understanding, maximization of knowledge delivery and outcome based assessment in the subject area.

3.4. Provision of Progress Oriented Flexible Learning Environments

All humans have different levels of capabilities as well as diverse ranges of abilities to perform. Some have greater memory retention and recall abilities while others have more applied and practical approach towards learning. To provide same training contents to all the students while expecting same levels of understanding is not realistic. Thus the 4th challenge for educationists is to design new methods of training and learning that allows flexibility of customizing the curriculum, learning hardware and allied training infrastructure according to the abilities and progress of the individual students while keeping all of them at par towards the completion of each course topic.

3.5. Understanding and Catering for the Requirements of Low Progressing under-Achiever Students

As discussed earlier, all students are not identical with same levels of abilities. This essential creates scenarios where some students lag behind the others while others feel slowed down by the frequent questions by those who have difficulty in understanding the concepts delivered in classroom. Typically in such cases, the teachers make separate arrangements for the lagging students to cope up with the rest of the class. Understanding the deficiencies of all students individually and catering for their needs is quite difficult for a single instructor. Thus the 5th challenge is the earliest identification of individual student who lag behind and to address their individual learning requirements.

Now that we have discussed the common challenges in education, we now propose some available and emerging technologies that can be effectively utilized in solving these above mentioned challenging problems of educators.

To enable the Smart Classrooms and Knowledge Spaces of future, let us discuss some of the commonly available and emerging technologies that will be essential to support such conducive learning environments.

4 TECHNOLOGIES FOR FUTURE LEARNING SPACES

To enable the Smart Classrooms and Knowledge Spaces of future, let us discuss some of the commonly available and emerging technologies that will be essential to support such conducive learning environments.

i. Cloud Based Thin Computing Devices

To enable online interactions, classroom participations, handouts, homeworks, quizzes, assignments, presentations and IoT projects, the students will be using thin computing devices in classrooms that identify the students through biometric or facial recognition to login into their cloud profiles and pull all the contents stored online into the devices. Once the student leaves the device, it clears its contents and automatically logs out the student and become ready to serve other students. Pi-Top, Pi-TopCEED [25] and Superbook [26] are some of the contenders for such a classroom environment.

Ii. Online Social Media Platforms for Collaborative Learning

Social Media Platforms will be designed specifically for use in classrooms with focused contents suited to the needs of the class contents. Online classroom engagement services like Edmodo [27], MineCraftEdu [28], Wikispaces Classroom [29], edoo [30], Twiducate [31], Tweentribune [32] and SumDog [33] will allow instructors and students to collaborate online through these platforms for more immersive learning experience.

iii. Flexible Displays and Multi-Touch Screens

OLED based extremely thin, lightweight flexible displays such as Sony's Digital Paper E Ink Mobius [34] will replace books and copies of conventional classrooms and students will be able to use them for writing naturally using stylus pen.

Iv. Biometric Authentication Systems

Multiple authentication mechanisms will be used in the classrooms of tomorrow where students will be identified by facial, voice and gait recognition, in addition to conventional biometric identification mechanisms and accordingly their training materials and learning modules will be customized to enhance their learning abilities and participation in the class. Moreover, wearable devices such as Nymi Band's always on authentication technology [35] will provide additional physiological feedback about students.

v. Gamification of Learning

It has been proven by research that students have longer retention and are able to study for longer stretches in one go if they are taught concepts using gamification techniques. As discussed earlier platforms like MineCraftEdu and Scratch allow students to learn coding in exciting graphical environment. They allow background learning of programing concepts while students engage in implementing their logic graphically. Such training techniques will be common in the learning spaces of future where AI enabled languages and development platforms will assist the students in learning and building practical applications for complex problems solving.

vi. 3D Prototyping and Printing

A picture is worth a thousand words but scaled down physical models of a real-world objects enhances the students' ability to interact with them using their hands, allowing them to easily comprehend the use of such modules in bigger complex systems. 3D prototyping and printing systems such as MakerBot [36] allow instructors and students to create practical prototypes of real-world system with similar functionality to enhance learning experience. Their Thingiverse [37] online community shared projects library allow instructors and students to build their own projects by combining other project components available online.

vii. Augmented Reality and Immersive Virtual Reality Interactive Systems

Augmented Reality allows layering of computer generated 3D objects on top of real-world objects such as paper drawings etc. allowing learners to have greater immersive and enhanced interactive experience over conventional teaching materials. Although currently mobile apps such as Quiver Education [38] are required to view augmented reality objects using the device camera to hover them over the AR triggering markers, the future classrooms will leverage augmented reality with 3D holograms and gadgets like Google glasses [39] or Microsoft HoloLens Mixed reality product [40].

viii. MOOCs and Online Learning Fora for Parallel Teaching in and Outside the Learning Spaces

Massive Open Online Courses are free multimedia courses created by prominent universities and educational content creators that can be enrolled and completed by the learners on their own time of convenience. This mode of teaching allows instructors to provide supporting online course that can help students get additional knowledge on concepts that are discussed in classes during their leisure time. Thus delivering parallel teaching material to the students enhancing their knowledge base. A list of MOOCs available online is prepared by [41] for use of students.

ix. AI Based Adaptive Training, Flexible learning and CAT Based Grading Systems

Although AI based adaptive training systems are at very initial state but with the invention of quantum computers and cloud based TensorFlow Processing Units [42] deliver unprecedented computing capabilities for machine learning applications. By building applications on these types of computing platforms will allow development of Smart Education Systems that utilize Computerized Adaptive Testing that adapts according to the examinee's ability level.

x. Always Accessible Peer To Peer Permanent Knowledge Archives

Although important literature and scientific material had been preserved throughout the ages in the form of books and manuscripts, they are recently being digitized into computer readable formats as electronic knowledge archives. These archives will not only provide easily accessible information sources to humans but also for Artificial Intelligence applications to perform better in human level understanding of real-world facts. With the advent of a disruptive technology platforms of BlockChain [43] new ways of storing information and transactional data that can never be manipulated opens up new applications to preserve knowledge and human generated contents in all walks of life including the field of education. Opensource projects such as Interplanetary File System (IPFS) [43] will provide peer to peer collaboration in future

classrooms to share and produce learning contents that can be easily searched and stored for long times in future.

5 CONCLUSION

In today's era of IoT and Cloud based services, education is also evolving to fill the gap between the future requirements of Smart Societies and the teaching and learning approaches. In this paper, we identified some of the most widely accepted challenges faced by the educational sector and mapped some of the possible solution of these challenges by existing or emerging technologies that will be commonly available in all smart spaces and the next generation classrooms for future Smart Societies.

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