

Effect of ICT on Smart Education

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Abstract: *Smart education, smart universities, and smart e-learning are emerging and fast-growing fields. They have the potential to change existing teaching strategies, learning environments, educational activities, and technologies in a classroom. Smart education and Adaptive e-learning concentrate on empowering educators to innovate new ways to achieve teaching excellence in smart, high-tech classrooms and smart universities, and provide students with new ways to maximize their success and the best learning options to select, learning style, and way of conveying learning content. The ongoing crisis related to COVID19 is forcing various higher education institutions to explore and find new forms of adaptive modern educational practices technology-based, innovative pedagogy, active use of cutting-edge technologies and systems, and to develop new business models. COVID is accelerating the changes enormously.*

Key Words: *Smart education, Smart learning environments, Adaptive e-learning.*

1. INTRODUCTION:

The general trend, whether locally or internationally, is completely dependent on technology in all aspects of life, creating a highly experienced generation who acquire their knowledge from direct contact with these technologies, with the varying age stages, the younger ones have become more knowledgeable. Therefore, society must provide them with a smart environment to fit these capabilities and affect them, and consequently, the opposite is true, where the technologies are also affected by rapid growth of individuals' capabilities, when it comes to education, it has been proven the Corona pandemic, the extent of the success of Information Communication Technology (ICT) in communicating with learners, delivering materials, discussion groups, online exams, etc.

Smart and digital learning has an effective, critical role in filling the gap of digital divide caused by the traditional digitized environment to transform it into a lifelong, smart learning environment in all its axis: learning material itself, classroom, well trained and highly skilled human resources based on the recent technologies (Artificial intelligence, cloud computing, internet of things) which has an essential role in facing a lot of challenges depending on ICT and Data Science that are considered the essence of the higher education's futurity.

2. SMART LEARNING ENVIRONMENT:

For education to be smart, it must be surrounded by a smart environment by all its means of smartness to increase the next generation of students' capabilities, to have a more comprehensive view adding the value of deep visualization which is playing a vital role in acquiring knowledge and understanding, so it will be Learning, not Education.

With the power of technologies in transforming everything in our lives to be SMART by achieving the goal of learning process objectives to be Specific, Measurable, Achievable, Relevant, and Targeted/Time-bound.

Therefore, there must be a smart environment to support the learning process, which could be defined as "physical environments that are enriched with digital, context-aware and adaptive devices, to promote better and faster learning" [1]. This represents a new wave of educational systems that involve an effective and efficient interplay of pedagogical technology and its fusion to enhance learning processes [2]

Currently, a Smart environment has become a fact in our society to support learners in achieving their goals, offering them an adaptive content that suits their learning style, whereas digital devices have a certain task, which is to facilitate the smart learning process, therefore it is necessary to pay deep attention to learners and the learning content more than devices as they have been automatically developed.

A smart learning environment (SLE) is responsible for allowing learners to access digital resources and interact with learning systems in any place, at any time. It also provides them with the necessary learning guidance, hints, and supportive tools.

2.1. SMART LEARNING ENVIRONMENT ISSUES

The previous lines clarified that SLE is a student-centered environment with different learning styles, personalities, and previous educational backgrounds, Therefore, SLE must provide the learner with adaptive content that fits their own style, based on different strategies, to be motivated and engaged during all phases of learning process in this isolated environment, to prevent him from falling behind, shifting the teacher role to be a facilitator. SLE must be well designed to achieve its goal, taking into consideration the following issues:

- User participation-based design: that provides learners with a set of methods, tools, systems, and models that can enrich educators' experiences with different scenarios.
- Support users with precise feedback: using learning analytics tools to bridge the gap between students and content provided by teachers to improve the learning process and students' performance. Where learning analytics enables institutions to support learners making progress and to enable rich and personalized learning. The general goal of learning analytics is to monitor the learning process and then use the data analysis to predict the future performance of students as well as to find their potential problems [3].

2.2. SMART LEARNING ENVIRONMENT COMPONENTS

The learning process is vital, especially the adaptive e-learning one, supported by a smart learning environment with entire physical and virtual components that are integrated perfectly with each other to achieve its goal, the following paragraph will summarize these components: [4]

- Student (learner): is considered one of the main axes of the learning process, he must be provided by content and different learning materials based on his characteristics, behaviors, previous educational background, and learning style (LS) to ensure the continuity of lifelong learning, where (LS) known as the "composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with and responds to the learning environment" [5]. also learning styles are considered "the ways in which individuals characteristically approach different learning task" [6], as the learner could be one of the following four types visual, auditory, reading and writing, and kinesthetic, the learning management system used in the educational organization can easily detect the differences between learners through the detection tools or entire module based on the student portfolio.
- Teacher: has a critical role in the e-learning process as he can communicate with all these different styles of students or resources in different ways, especially through the adaptive and personalized content, so he may act as a facilitator to help them to navigate the content and provide them with needed technical support, also act as remediator when the students fail to solve any problem to prevent them from falling behind to improve their abilities, besides the most important and effective role of being a course creator and setting up the content in the right and efficient way.
- Content (learning resources): is essential to be flexible, personalized, and customized with different types and nature to meet the students' requirements and needs, also to trigger students' motives and awareness by providing them with various contexts such as textbooks, flashcards, posters, videos, workshop discussion groups, online courses, movies, models and virtual labs.
- One of the most interesting, successful, and effective approaches to a new vision is to let students participate in the preparation of the selected content and create a new context. When students are learning online, they have the ability to link new information to retrieved one and acquire meaningful knowledge to allow students to reduce time and space limitations It has high interactivity, collaboration, and authenticity. [3]
- Smart Technology (Tools): from my point of view, it could be simply an adequate way to communicate through SLE by providing smart services using smart devices in a smart environment. Smart technology like big data, IoT, Cloud computing, Data analytics, machine learning, and artificial intelligence to provide cognitive awareness to the objects to achieve the required goals and to improve the ability in the smart environment, will be discussed later.

3. SMART EDUCATION:

Since this research is relevant to SLE so the smart education concept must be discussed, taking into consideration its axis: the content and how it affects the learning process, smart classroom, smart campus, well-trained Human resources, and finally the challenges that facing these issues.

Smart Education could be described as *the influence of diverse technologies (Combinatorial Optimization, Machine Learning, Big Data, data visualization, Internet of Education Things, learning analytics, and others) to enhance the quality of education. In other words, Smart Education is the process of optimally managing human, economic and technological resources from educational institutions and research centers.* [7].

High-speed cellular technology, wireless technology, and smartphones make communication and learning systems easier. These sophisticated technologies can bring tremendous benefits to knowledge acquisition and delivery methods. The smart education system encompasses the brand-new technology to impart education. The component of a smart education encompasses a smart classroom, smart teaching, smart learning, smart learning environments, and a smart campus. Some of these components will be mentioned in the following paragraphs as the rest mentioned before.

3.1. SMART EDUCATION AXIS

The Smart Classroom is the most advanced form of a digital classroom. It is a typical smart learning ecosystem [8], as many researchers mentioned its generations.

The first generation focused on the synchronous delivery of learning content to online and face-to-face students. The second stage focused on real-time use of the Internet of Things, mobile devices, and automatic communication between learner and SLE, which applied to Samsung Smart Campus with its entire three core components, covering most of the campus modules: a) smart management system, b) smart students' information system, and c) learning management system, which directly affecting the student monitoring and interactivity to reach the last level of smartness gradually. The next table1 summarizes smartness levels.

Table 1: Smartness Level Source: [2]

Smartness levels (i.e. ability to...)	Details
Adapt	Ability to modify physical or behavioral characteristics to fit the environment or better survive in it.
Sense	Ability to identify, recognize, understand and/or become aware of phenomenon, event, object, impact, etc.
Infer	Ability to make logical conclusion(s) on the basis of raw data, processed information, observations, evidence, assumptions, rules and logic reasoning.
Learn	Ability to acquire new or modify existing knowledge, experience, behavior to improve performance, effectiveness, skills, etc.
Anticipate	Ability of thinking or reasoning to predict what is going to happen or what to do next.
Self-organize	Ability of a system to change its internal structure (components), self-regenerate and self-sustain in purposeful (non-random) manner under appropriate conditions but without an external agent/entity.

Another smart classroom design to facilitate the interaction between learners and teachers by controlling the audiovisual equipment and smartboard showing how data could be stored, retrieved, and analyzed, constructing a smart campus-based IoT technology. It is the entire three parts of IoT hardware and software, IoT gateway, and Network Cloud, which are combined and integrated to achieve the goal of this smart system providing it with flexibility, and accuracy that, tend to enhance the effectiveness of the overall operation.

3.2. CHALLENGES FACING SMART EDUCATION

Since the scope of this paper concerns a smart learning environment, and smart education based on smart technology that has a great and effective role to establish a smart campus providing the learners with adaptive content that suit the variety of learning style and personality, this issue is facing a lot of challenges will be summarized in the following lines:

- Technology and tools: are concerning devices, software, application, platform, and infrastructure, how the internet connection speed affects the quality of accessing the content, the security issue, and accuracy.

- The design and interaction, how learning content and activities could be designed based on digital technologies.
- Learning and cognitive, how learning style, personality, different behavior, educational background o, and activity could affect the learning process to provide the student with adequate and suitable content.
- The external political issue is where regulations, policies, and curriculums, which is implemented and followed in the educational organization.
- Gradually new and high-level training innovation seems consistent. Educators should have the option to know not just how to take advantage of each new device themselves, but how to prepare their understudies for its utilization.
- Resistance to change: Many teachers have demonstrated a resistance to change and unwillingness to adopt education technology [9,10].

4. INVESTIGATION OF INNOVATIVE EMERGING TECHNOLOGIES FOR SMART EDUCATION:

The rapid development of the Internet and communications technologies, as well as the ubiquity of the Internet of Things besides innovative technologies, have led to a transformation of education in the next decade [11].

John [12] reported today higher education institutions have begun to utilize recent technologies to improve transition, efficiency, integrity, and social expertise to address the challenges of promoting digital fairness and to adapt traditional organizational models to advance the future of the education institutions. Likewise, Universities are challenged with financing, demography, quality, and competition. Improving technology sophistication and promoting digital justice are among the biggest challenges in slowing down the take-up of higher education.

The next section will be covering the innovative technologies topic used to design smart education systems, and later Internet of Educational Things (IOET) topic will be covered. These technologies play an important role in the transition from traditional to smart education.

4.1. DISSOLVE THE CHALLENGES OF HIGHER EDUCATION VIA TECHNOLOGIES

One of the most current critical challenges that face higher education institutions is leaking quizzes/exam papers, subsequently, innovative technologies create a different learning experience, and introduce smart education systems. Leaking and cheating of test papers harm the quality of education and lead to an erosion of ethical standards. Higher education institutions need to revise how they going to certify what graduates know and can do, so they need sufficiently focus on the skills and competencies that are transferable to fields [13].

4.2. RECOMMENDED INNOVATIVE TECHNOLOGIES

In order to meet the above challenges, higher institutions can use modern or recent technologies in education. some of the nowadays technologies that have changed education are artificial intelligence (AI), deep learning (DL), machine learning (ML), augmented reality (AR), mixed reality (MR), virtual reality (VR), and robotics [14]. These technologies such AI and robots have their place in higher education (e.g., chatbots that answer questions about registration, availability of courses, and assignment) and contribute to better preparing for future smart education [15]. The technologies mentioned becoming increasingly utilized in the education sector transforming both educational models and ICT development.

Higher institutions can integrate these technologies into learning, teaching, research, administration, and public services. These technologies offer a new approach to universal, high-quality, and lifelong personalized learning that saves resources and reduces costs. In other words, smart education. Smart education, with its convenience and adaptability, has become an essential need for everyone. It has attracted people's attention by connecting different fields and disciplines of knowledge through communication for educational purposes. The scope of smart education includes learning methods, educational institution activities, academic projects, research, anywhere access, and related skills development [16]. The ICT dimension is a set of tools used to deliver different aspects of smart education, it supported learning can increase student interest, and independent learning becomes even more efficient through the use of collaborative learning methods [17].

4.3. TECHNOLOGY-BASED LEARNING

Technology-based learning can be implemented and used to support teaching and learning. In smart education. In smart education, technologies can serve as tools for accessing learning content, questioning, communication and collaboration, design, expression, and evaluation [18].

Technology-based learning is used to provide flexibility in learning. Intelligent technologies such as learning analytics, big data, cloud computing, blockchain, etc. promote the emergence of smart education.

4.4. INNOVATIVE TECHNOLOGIES APPLICATION

These innovative new technologies and its application are discussed in the next section

- Virtual, Mixed, and Augmented Reality Technologies: AR, VR, and MR can place students in any virtual or real-world situation with an active role in the process through various tasks they must complete [19]. [20] in ecosystems of smart education, the student will learn by practicing, experimenting, and training till they reach their goal. Smart Education Labs highlight the exciting ways higher education institutions and families are using technology to meet their needs. [21] Virtual Reality is becoming increasingly possible in the classroom thanks to mobile phones. The usage of Virtual Reality in the classroom is still in its infancy. It also allows students to build their own exciting learning worlds. while Augmented Reality is the integration of digital information with the user's environment in real-time. This recent technology of AR blurs the line between what's actual and what's computer-generated via way of means of improving what we students, hear, experience and smell. It can engage and motivate students by making the science, mathematics, engineering, technology and. and coding learning process faster, more fun, and better than ever.
- Blockchain Technology: Blockchain provides security and can reduce transaction costs or asset transfers between individuals and intervention by others [22]. Each time new features are added, additional costs would be incurred. Frequent updates and adding new features can lead to data leaks which can become a security issue [23]. In smart education, blockchain-based applications are still in the early stage, although they are accelerating rapidly in various areas of education such as certificate management [23], consent to digital guardianship [24], collaborative learning environment, competencies [25], learning outcome management, online learning, processing of payments, learning system, lifelong learning, [26], competition management [27], copyright management [28], assessment of students' professional skills [29], examination [30], and student skills assessment [29].
- AI Technology: In recent years, smart education has attracted widespread attention in projects carried out globally. With the introduction of rich new personalized education methods such as AI that will dramatically transform the learning experience for students, AI has largely taken over traditional classrooms and revolutionized the way education is delivered to the admiration of many [31]. From the smart education application perspective, there are various functions of AI applications for education including virtual AI teaching assistant [32], Intelligent teaching system [33], Intelligent learning tool or partner, big data analytics [34], Intelligent tutee system, [35], and evaluate students' performance.
- Cloud Computing Technology. Cloud computing is based on the traditional hosting idea that the Internet can be used to store software applications, data, or both. A client can access these services from anywhere over the Internet. In higher education institutions, cloud computing is rapidly being deployed and becoming an integral part of institution experience [36]. There are several cloud computing services that can be deployed in the education settings such: Cloud Rendering, Gamification [37], Mobile Cloud Computing [38], MOOC [39], Open Educational Resources [40], and Google Apps.
- Data Science Technology: Kross [41] cleared data science technology is becoming more important in the modern educational context. Today, data science methods are changing learning methods by applying hypotheses. For modeling, the data science model includes the problem and data domain, data preparation, data mining, and assessment of discovered knowledge. Gomede [42] explored Examples of modeling applications are Educational Governance, Educational Strategic Planning, Student Modeling, and Predicting Student Performance [43]. For the analysis, this leads to important new methodological developments in intelligent education. Development needs experts from educational science and data science. [44] Examples of analytics applications are Computational intelligence for data mining, storage, and analysis of educational data, Detecting Undesirable Student Behaviors, and Social Network Analysis.
- 5G Technology: 5G is the 5th generation network that can extend the reach of connected devices and technologies in the classroom. 5G technology enables fast downloads and greater efficiency. There's a better compromise with seamless connectivity bridging the learning gaps for international students [45].
- Deep Learning Technology: Han and Xu [46] stated that deep learning is a subset of ML technology. Deep learning techniques could be used to create deeper content analytics that dynamically restructures and optimize learning content based on learner needs. Today's students are used to acquiring knowledge through doing, playing, practicing, and experimenting. Therefore, universities must encourage this type of learning by providing an appropriate environment in current education. They must prepare by creating programs that require deep learning in their learning environment. This approach improves thinking skills, cognitive abilities, and academic retention. In addition, it uncovers complicated formats between educational data and provides new ideas to suggest improvements.

5. INTERNET OF EDUCATIONAL THINGS (IoEdT):

[47] ICT has transformed the nature of learning from traditional learning to digital-based learning. [48] IoEdT is the digital networking of non-computational and computational educational objects by using sensors and RFID technology to the Internet. IoEdT's main goal is to provide effective teaching by using embedded IoT and using the Internet to connect physical objects, sensors, and controller devices.

IoEdT refers to the education's processes and activities of, research, administrative and other aspects related to higher education institutions as teaching and learning strategies [49]. IoEdT delivers smart education to the students (Smart learning), high-tech services (smart campus, smart car parking area), student-teacher interaction (smart classroom), and design and development of multimedia content for learning (smart education). Wireless sensor networks (WSN) are distributed networks of multiple devices or sensors that monitor the properties of educational objects [50].

6. CONCLUSION :

As declared, smartness is playing a vital role in reshaping whole life's aspects, digitizing was a direct trigger to a real transformation in a surrounding environment especially the learning process to become a smart learning environment that provides learners with technology-based content that suits their learning styles, personalities and preferences to improve their capabilities in acquiring knowledge, also to enhance flexibility, accuracy, and effectiveness of learning process with the help of Intelligent technologies such as learning analytics, big data, cloud computing, blockchain, etc. promote the emergence of smart education..

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