ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8

International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

http://TuEngr.com

An Integrated Framework for Smart College based on the Fourth Industrial Revolution

Sultan Refa Alotaibi[1*]

[1] *College of Computing and Information Technology, Shaqra University, Shaqra, 11961, SAUDI ARABIA.*
**Corresponding Author (Tel: +966 581446111, Email: sultanrefa@su.edu.sa)*

Paper ID: 12A4R

Volume 12 Issue 4

Received 06 November 2020
Received in revised form 29 January 2021
Accepted 15 February 2021
Available online 19 February 2021

Keywords:
Virtual reality (VR); Augmented reality (AR); Big data; Elearning; Cloud-based systems; Internet of things (IoT); Wearable technology; 3D printing; Blockchain; Smart University; Smart learning (S learning).

Abstract

The fourth industrial revolution blurred the boundaries between digital, physical, and biological worlds. It represents the fusion between several technologies such as artificial intelligence, 3D printing, robotics, genetics, etc. Smart education is a particular feature in the education sector as it comes after the supplication of recent information technologies and expeditious application of these technologies in the learning process. The main target of a smart college is to help students, and their teachers evolve skills, utilize, and implement the technologies in a method that creates advanced outcomes in the learning process. Various technologies, such as virtual reality (VR), augmented reality (AR), big data, E-learning, cloud-based systems, Internet of things (IoT), wearable technology, and 3D printing, blockchain, etc., assist the exposure of smart education. In this paper, we propose a full schema, and framework of the smart college based on the fourth industrial revolution has been discussed which includes the applications of emerging technologies in smart classrooms, smart learning, and smart teaching that are adopted in the smart college. Also, this paper depicts the requirements based on the fourth industrial revolution, and the architectures, which are necessary for the effective implementation of the smart college. Moreover, a detailed review is carried out on the current issues, and directions for the smart college based on the fourth industrial revolution.

Disciplinary: Intelligent Systems, Smart Education.

Cite This Article:

Alotaibi S. (2021). An Integrated Framework for Smart College based on the Fourth Industrial Revolution. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies, 12*(4), 12A4R, 1-18. http://TUENGR.COM/V12/12A4R.pdf DOI: 10.14456/ITJEMAST.2021.81

1 Introduction

Smart College is a technology-enhanced campus with classrooms that simulates the chances for learning, and education by combining advanced methodologies of learning, such as computers, automated software, voice recognition technology, networking, and devices with audio, and visual capabilities, etc. [1]. Authors [2] hypothesized behavior recognition, deep learning, artificial intelligence (AI), and computer-based educational theory to conceptualize a system as part of future smart classrooms. Therefore, a smart college is one of many practical solutions used in a smart campus [3].

1.1 Higher Education

Higher Education plays a significant role in acquiring students with the necessary skills, activities, and knowledge to align them with their careers. These skills, and activities are designed to help them to attain success in academics and become involved in extra-curricular activities within the university that visualize a fulfilled career in the college. The relationship between society and education is frequently suggested to be one-way in nature where the education is anticipated to be fit within the trends of economic, and political factors. Understanding this general connection between the structures of education, and the socio-economic factors help students to form a prediction for higher education in the future connected with the fourth industrial revolution.

1.2 History of Higher Education

In the past decades, evaluation of the higher education system has gone through massive changes with the following stages; such as elite, mass, and post-massification. All the stages are discussed in the following.

1.2.1 Elite

Higher education has intensive origins from the starting of the sixth century in monastic schools. It is later developed towards the medieval European University in Bologna in the year 1088. This mainly focused on the fields of theology, and philosophy, and then further advanced towards the current education system, which is technologically advanced. In this development, universities advanced from being teaching, and learning centers, to incorporate research, and development to serve society. During this process, university education was provided for tiny elites.

1.2.2 Massification

The relation between educations as a right for the private/public results in the formation of 'massification' in the late twentieth century. According to this, higher education has to be provided to many people. During this era, higher education generated provocation in a large manner in terms of various factors such as the shape, and size of the systems, the designs of curriculum, the structure of the organization, the methodologies in the following pedagogy, the modes of delivery, the patterns of research, and the connection between institutions, and other communities from the external entities, etc. The main goal of this mass system targets the exchange of skills and planning for different kinds of contributions to technical, and economic platforms.

1.2.3 Post-Massification

Higher education has slowly improved from elite-phase to mass, and then to the stage of post-massification. Many advanced and some of the economies of developing countries implemented this phase. Another main characteristic of this phase is making both the students and staff members internationalization. At present, the main goal of many countries is to make the number of students to be increased to make a change in social, and technological factors.

1.2.4 Basic Activities of Higher Education Institutions

The fundamental goal of higher education is common in every era. The main aim of higher education is to make sure that the quality of learning can be achieved through quality teaching, to adopt the students for obtaining the latest facts or information through the investigational form of research, and to encourage the expansion of the public as a service.

• Teaching

One of the most important tasks of each university is to educate the students. Hence, it is more important to implement the most suitable strategies in teaching and to arrange the work in a way that promotes the process of learning. This has consequences on adapting the programs of learning, better experiences in learning, and implementing the learning attitude lifelong.

• Research

Maintaining the competition among institutions of higher education needs to follow a huge amount of works in the research. These works pave the way for the adoption of new technology for the process of collaboration, and cooperation globally.

• Service

To maintain the position obtained through the competitions among the higher education system throughout the world, a rapid improvement in educational services is necessary. Specifically, more innovative competition should be introduced into it.

1.3 The Fourth Industrial Revolution

The fourth industrial revolution is directed mainly by the application of AI, and physical systems based on cyber platforms [4]. The first industrial revolution was stimulated by Newton while forming his laws of motion. The main theme of the first industrial revolution relies on the working, and production of design stem engines that are mechanized much since work was being done by humans. The second industrial revolution was stimulated by Faraday and Maxwell when the electric and magnetic forces were invented by them. This revolution leads to the invention, and generation of electricity, motor running in electricity, etc. The inventions invented in this revolution came to influence numerous industries. The third industrial revolution was stimulated when the transistor and its devices were formed. These inventions get hold of the electronics era which acquired us the era of personal computers and the Internet. The fourth industrial revolution accelerated by the IoT will revolutionize all the industries gradually.

2 Literature Review

The implementation of advanced technologies in the field of education leads to different solutions to enhance the performance of both students, and teachers. Authors [5] used a sensing technology based on RFID for the benefit of students and faculty. In their method, various processes such as tracing, discovery, smart lecturing hall, laboratory-based on smart equipment's, room certainty, attendance-based smart devices, etc. were highlighted. Authors [6] highlighted the significance of applying big data and its application in fabricating smarter universities. They scrutinized how big data is applied to help to generate smarter universities. Authors [7] examined the benefits of using RFID and wireless sensors in the evolution of smart universities. Authors [8] depicted that the enhancement of pervasive computing-based technology and wireless-based communication makes the smarter campuses to be used by the faculty, and students.

The combination of RFID, wireless sensor networks, and IoT are anticipated to be the critical parts of smart colleges. Teaching based on smart technology provides a better transmission between educators and students. It also gives inexpensive education with user satisfaction and fulfilling the expectations of a learner. From their review, it can be identified that IoT-based technologies are expected to achieve notable improvements in a smart college and pave the way for smart universities. Authors [9] analyzed the work done by two groups of 25 learners who were enrolled in the same course. Among these learners, one group was trained using traditional learning methods, and the remaining learners are trained by methods based on IoT. After performing various analyses, and tests, it was found that the IoT-based technologies applied in educations works as tools for supporting, and enhancing the teaching process. The academic performance of students is also improved. Authors [10] proposed a smart learning-based model using the combination of IoT, and e-Learning strategies. The main aim of this model is to propose a smart teaching strategy by combining smart techniques, and smart learning.

Authors [11] have explored different techniques for applying AR to educational exhibits, and this project was developed at the Human Interface Technology Laboratory in New Zealand (HIT Lab NZ). These educational exhibits have received very positive feedback, and appear to have educational benefits involving temporal, spatial, and contextual conceptualization, and provide kinesthetically.

There is an AR/VR application for engineering students to teach them graphics courses, so this application was developed by authors [12]. This application is based on tangible, virtual reality (VR), and augmented reality (AR) models, to help many students better understand the 3D objects, and their projections. This application can serve as effective learning aids for engineering graphics courses. Besides, there is another application which is developed by [13] based on AR and VR technologies. Through this application, students can breed their own virtual caterpillars on host plants using this application installed on their smartphones.

There is an application for pre-school children to teach them English pronunciations, so this application has solved the problem of non-native-English students, and teachers' non-standard pronunciation. This application was developed by authors [14]. This study has found that the students learning with this application had greater learning achievement than others.

2.1 Big Data, and IoT, and Education

Identify applicable sponsor/s here. If no sponsors, delete this text box (sponsors).

Incorporating big data, and IoT in a normal lecturing hall can be converted into a smart classroom. To make students get prepared for an environment based on fiddly learning, a lecturing hall must assist creativity, expository thinking, conveying, and cooperation. Tools that allow technology for students can be adopted with audio-based, text-based, and images-based technology for providing a chance to create more advanced skills in thinking [1-54]. They enable the professionals of e-learning to incorporate the experience of E-learning to provide the students with more illumination knowledge and promoting the courses. They also listen, and analyze the speech, image, conversations, movements, behavioral activities, etc., for reaching an endpoint about the presentation of teachers, and the satisfaction of learners. This provides an opportunity for the educators to convey their presentations in a better way, and to make learners get satisfied with them. The incorporation of IoT in E-learning shows various magnificent challenges in the learning process by making the standards of education reusable, inter-exchangeable, adaptable, etc. It authorizes the adaptability of communications using internet-based, and altered the higher educational institutions extremely. IoT comes up with a more attractive environment for learning and providing more detailed information about the process of learning to assist educators to increase their learning knowledge, and to reduce the difficulties in the learning process.

2.2 VR, and AR, and EduScation

The concepts of VR and AR are not new technologies, available since the early 1990s in education environments [15]. Virtual Reality (VR), and Augmented Reality (AR) may change the method by which people interact with technology especially in the education environment. These techniques can merge virtual worlds with real life, giving huge opportunities to provide education with a new concept based on VR and AR. VR technologies play a big role in developing learning platforms in general and will define the features of E-learning in the future. Using these technologies provides a customized learning process for the students according to their abilities, and performance. Some learning approaches have been transformed into an interactive digital system that is more flexible and takes into account individual differences between students. AR and VR can support kinesthetic teaching [16].

Also, there is an increase in the use of virtual reality and augmented reality technology during student's interaction with the material to improve and enhance the assimilation process in learning [17]. These technologies allowed the development of interactive virtual laboratories for conducting physical, and chemical scientific experiments, mathematical modeling, analysis, and display of the results in graphic images directly from the computer without the need for real laboratories.

1) Advantages of Virtual Reality, and Augmented Reality

Virtual Reality and Augmented Reality are immersive tools for learning. They can play a unique role in addressing some educational difficulties [18, 19, 20]. There are some advantages of using VR, and AR in the education environment. For instance, VR, and AR have led to increased student engagement with their courses, and these techniques have increased the repetition rate of authentic learning experiences. Therefore, VR and AR have enabled many students to exercise creativity [18].

AR and VR technologies can display things, and convert them into 3D models. Also, these technologies have provided virtual examples, and various play elements to support many textbook materials. Therefore, these technologies are making educational content more understandable, and easier to remember. This helps many students to add more interaction to the explanations during the lesson, captures students' attention, and keeps them occupied throughout the lesson. It is worth noting that the use of augmented reality technology is not limited to a specific age group or educational level, but can be used in all levels of education. From pre-school education to college education [21-25].

On other hand, the practical learning process in some subjects may be facilitated by using VR which is more valuable, and realistic to many students embarking in the practical range than the traditional way of teaching [26, 27].

2.3 Using Virtual and Augmented Reality Effectively in Classrooms

To get the best out of both real, and virtual worlds, teachers are advised to maintain a balance between using augmented reality in education, and traditional learning by:

• Technology selective use:

The teachers may make some decisions based on plans about the topics, which will be presented to their students in the classroom. Therefore, using appropriate technology that is based on some of the components of virtual reality is very important for complex or technical materials that are difficult to understand with traditional learning methods.

• Provide supplementary educational materials:

Teachers may provide their students some additional resources to increase their learning outcomes. For example, conducting group discussions, question-and-answer sessions by using virtual, and augmented reality to enhanced educational content materials.

• Focus on Exclusivity:

The teachers used VR, and AR to create unforgettable lessons. For example, use virtual, and augmented reality to travel to historical eras. Also, use these technologies to recreate hard-to-reach locations.

• Take advantage of existing applications

Some teachers are keen to educate their students on the use of free applications that rely on virtual, and augmented reality technologies. These applications are designed to be easy to use to help them understand some subjects such as mathematics, science, and history.

• Expanding into the different areas, and skills

The teachers may not restrict the use of VR and AR technologies to a specific group of topics, and consider their potential in any topic they deal with.

2.4 Wearable Technology

Using wearable technology in education may assist students and teachers in the near future. Therefore, some universities and libraries around the world used wearable technology such as glasses, clothing bracelets, and watches [28]. Authors [29] mentioned that the wearables devices would be growing the relationship between technology, and people [30]. In the same context, mobile learning became integrated with everyday life [30]. Google Glass is the most popular wearable device. Therefore, this kind of wearable device presents some information in a smartphone without using hands to allow people to interact with the Internet via voice commands [31]. Authors [32] mentioned that wearable devices might change human-centric interaction with computers. Authors [33] mentioned how to create user interfaces as "micro-interactions" to fit people's lifestyles.

2.5 Cloud Computing in Education

Cloud computing has been used in many aspects, for example, health, educational, industrial, and commercial. Therefore, cloud computing is used in education to assist teachers administrators and students in the same context. Cloud computing technology may allow many students to access their homework when there is an internet connection. Also, cloud computing technology lets some teachers upload learning subjects, and easily collaborate with their students, so this saves money on data storage [35, 36]. There are two ways of using cloud computing in an educational environment. First is taking some services from third parties such as Amazon, Oracle, and IBM so on. The second is developing a new cloud platform in the educational society (students, and teachers) using current working systems in that society [35].

2.6 3D-Printing Technology, and Education

3D-printing technology is a relatively new tool, so this kind of technology can be used in some scenes in the educational environment [36-37]. There are three ways of using the 3D-printing technology in the education environment. Firstly, 3D printing technology may be used to reproduce existing manipulatives, and it is possible to add extra features to it. Secondly, the development of manipulatives and happens when it activates the cooperation between teachers and their students. Finally, many students may develop some 3D-printed objects by themselves, so this concept is called inquiry-based learning [38-53].

2.7 Higher Education in the Fourth Industrial Revolution

Wearables-assisted teaching, learning, and training are some of the most important outcomes of the fourth industrial revolution in education. At present, smart colleges are comprised of these technologies. The wide variety of wearable devices manufactured recently specifies the advancement of technology. Educational institutions have to understand and apply these wearable devices in the education system to transform the process of teaching, and training the students. During the fourth industrial revolution, when the evolution of cyber-based physical systems become a new technology, numerical deception plays an essential part in both fields of education and its practical-based applications. Within this domain, the Finite Element Analysis (FEA) is the most important technique, which can be applied in various fields of engineering such as buildings analysis [5-7]. Improvements in FEA are done with the help of computers. Due to these enhancements, the key concepts can be easily understandable to the students. This improvement also paves the way for engineers for conducting complicated simulation-based problems more easily. However, this process has limited the processes present in the FEA in an environment that is entirely virtual, and offline. Due to the advancement of a wide variety of wearable devices, and their technologies such as the Augmented Reality (AR), sense, interaction, and recognition of users can be realized. AR can be an addition by making the computer-generated information as real-time classrooms.

3 Design of the Smart College based on the Fourth Industrial Revolution

The smart college based on the fourth industrial revolution emphasizes the implementation of IoT in higher education. This is done to signify pave the easiest path for the interactivity among the students, and the teachers for generating a smart-based academic environment. It proposed an architecture for the combination of IoT and smart education that mainly focuses on all the various challenges and issues shown in the previous sections. This architecture outfits interoperability, maximum reusability, and scalability, etc. The architecture must be pliable in nature hence, that it can be easily modified, and incorporated to be modified based on the needs of the future. Figure 2 shows the schematic representation of a smart college for delivering a smart education. This comprises smart learning techniques, smart teachers, smart classrooms, smart learners, and smart education. Smart education highlights the principles of focusing on better education. This mainly focuses on the necessity for smart pedagogies as a methodology for the environments, which are focusing on smart learning. This also maintains the goals of education to produce smart learners.

Nowadays, IT has evolved as a vital part of education. Recently, the techniques based on E-learning have expeditiously developed with its various types [39-41]. Learning Management methods such as conventional, online, and workplace-based, etc. can be utilized by everyone for the process of learning, and writing the examinations [42-44]. E-learning becomes an important source for a faculty in which he/she can handle the teaching process. This can be the easiest method of acquiring the materials of teaching for most of the students. It is can also connect the instructors as well as the students. The instructor/lecturer can manage the examinations online. He/she can assess the performance of students and can notify the students of their respective grades. However, using some devices underpinning the fourth industrial revolution is further on the use of computers and e-subjects. This should be compatible with the learner-centered approach. Therefore, this will be effective in enhancing students learning experience [45]. According to Chang [46], E-learning is more effective when there is a direct relationship between the technologies with people, by using online face-to-face learning in a collaborative method, and flexible manner. Technology innovation relaxed various constraints that are present in the teaching. Open online courses are in the form of education, which provides teaching, and other related instructions by standalone [30]. However, there are many advantages present in the online learning. The expense in hardware setup, its maintenance, security, and threats makes hurdles in its effective implementation.

Figure 1 depicts the interaction between various smarts components within the smart college. In this figure, the first layer consists of smart learning, smart teaching, and smart classrooms. This layer usually employs the recent technologies in the fourth industrial revolution to work intelligently. The second layer consists of students that form the outcome of the previous layer. These students are denoted by smart students as they are harnessed with the smart environment. Finally, all of these components form the smart college. The subsequent sections give more details about each one of these smart components.

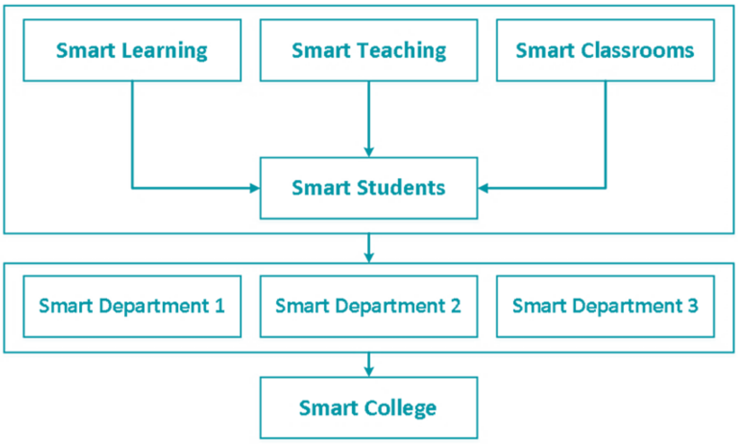

Figure 1: The interaction between smart technologies, and smart colleges.

3.1 Smart Learning

Smart learning (S-learning) is an advanced form of education. It defines a new paradigm for learning that perform the students to have an environment, which is more effective for learning. It also offers a personalized technological environment for learning with the applications of computing-based systems. This smart learning offers the following features for the learners.

(i) It focuses on content of learners based on advanced computing-based technologies

(ii) It is an intelligent-based effective, and tailored learning methodology based on advanced infrastructure of Information technology.

3.2 Smart Teaching

Smart teaching makes the potential involvement of teaching organizations to use the software tools for the activities involved in the teaching, and learning process. In general, it is the process of enhancing the quality of teaching, its experience, and learning. Smart teaching has technologically advanced classrooms with a set of tools that are teacher-centric in nature. It also permits students to apply the advantages of the internet in the teaching as well as the learning process. It has a variety of different teaching strategies, and it defined how to apply smart technologies in the classroom.

3.3 Smart Classroom

A smart classroom is a form of capability or creativity learning which facilitates the teachers to make information technology an integral segment of the education. A smart classroom is able to cause an important change where the customary teaching can be converted to a digitalized manner. Activities of the learner should be linked with the subject along with the applications of the real world. The smart classroom should also be categorized as a place with the combinations of various IoT-based devices, and its solutions that provide the way for learning analytics solutions, learner-centered teaching, and providing more personalized collaborative, and creative learning strategies. The strategy of a smart classroom for E-Learning consists of co-dependent, and interrelated components. A smart classroom makes the learners adapt resources that are digitalized and can be interconnected with the learning-based systems. It should also provide active and necessary guidance for learning, tools for supporting the suggestions for learning in the right form, right place, and at the right time. The smart classroom design based on the fourth industrial revolution should support the techniques based on audio-visual contents, projectors, smart boards in order to promote communication among instructors, and students. Moreover, it should teach how to access the data through more common devices, such as laptops, tablets, and smartphones. The smart-based campus system proposed in [31] comprises three parts such as IoT-based software, and hardware, gateway based on IoT, Network, and Cloud. In addition, there is a good application that is used in classrooms, so this application is an interactive whiteboard. This may assist the students to have a clear picture of their subject. Also, this has increased the learning effectiveness [55-59].

3.4 Blockchain

The core concept of blockchain is quite simple. It is a collection of information stored in the database in a structured format. This structure simplifies the filtering and searching of data. Blockchain has a similar structure in which data is stored in the form of chained blocks [47, 48, 49]. An important feature of blockchain is a decentralized nature which enables an irreversible timeline of data. When a block is added to the chain, it is given an exact timestamp. This behavior of blockchain makes it robust in protecting data as each node in the chain is uniquely identified by its neighbors, and its timestamp [50, 51, 52]. This technology is suggested to be employed in protecting the transmitted information among the smart actors of the smart college as depicted in Figure 2.

3.5 An Integrated Framework of Smart College

The Fourth Industrial Revolution is characterized by a set of modern technologies that depend on digitization with each other, and that directly affect education, thus this paper summarized, and designed a theoretical framework for the most important technologies in building smart colleges that depend on the techniques of the Fourth Industrial Revolution. Such as artificial intelligence, computing systems, virtual reality, the Internet of things, 3D printer, wearable technologies, etc., to achieve digital transformation in the field of learning, and education.

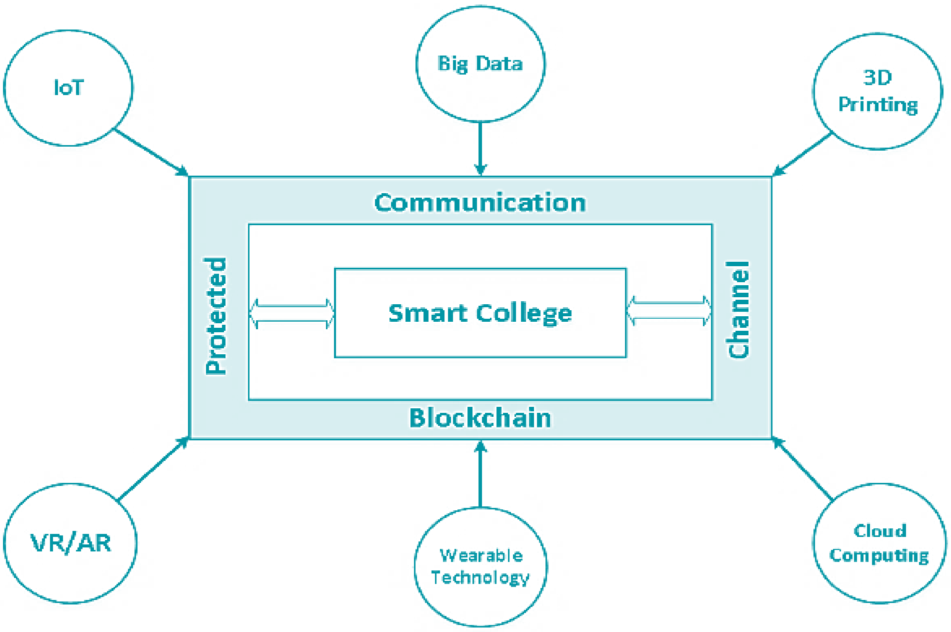

Figure 2: Schematic representation of a Smart College

Smart colleges based on the fourth industrial revolution offer many advantages. Firstly, creating an effective teaching model, and moving towards cooperative education. Secondly, achieving distinction, and competitiveness in the midst of intense competition in higher education. Thirdly, raise the value of higher education, and improve the overall quality of education. Fourthly, moving from the stage of acquiring knowledge to the stage of employing it to deal with real problems. Fifthly, empowering the educational, and administrative team with a new set of educational, and administrative capabilities. Finally, increasing productivity, and reducing operating costs.

4 System Analysis

The analysis is presented in terms of the use-case to show the functionalities supported by each component in the proposed system. The main components of the proposed system are IoT, 3D printing, cloud computing, Big data, VR/AR, and wearable technologies. It worth noting that the data, and communication between the smart college controller, and the other components in the smart college is performed in terms of blockchain-protected data exchange.

Figure 3 depicts the proposed functionalities of the 3D printing component in the smart college. These functions consist of receiving a command from the smart college main controller to do a printing job. Once a command is received and confirmed, the printer starts doing the job, and at the end of this job, it sends a notification to the main controller.

In addition, the main functions included in the big data component are shown in Figure 4. In this figure, a similar function is included which is the ability to receive a command from the main controller of the smart college. Another important function in this component is the analysis of data. This function includes both data processing and filtering in addition to the storage of the analyzed data, and decisions to be used later by the smart college.

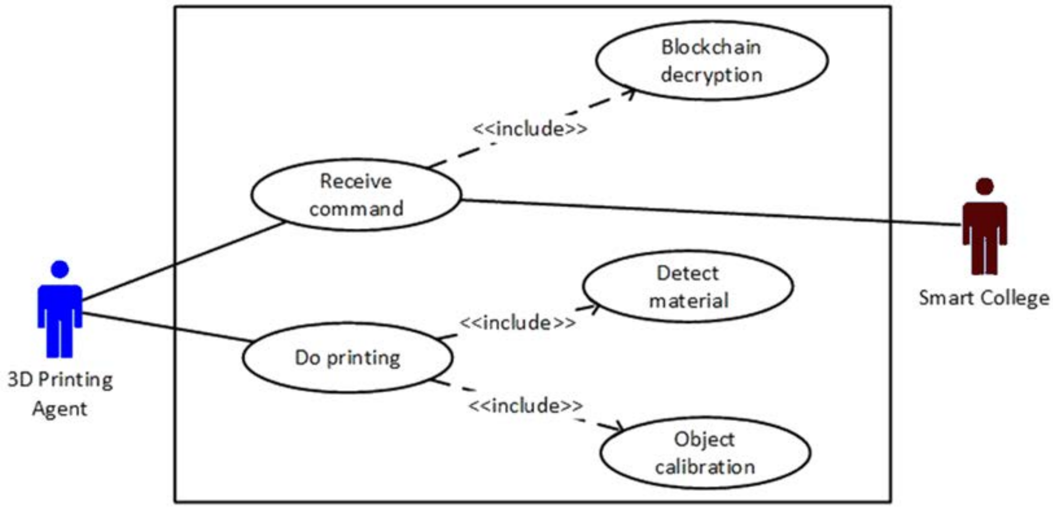

Figure 3: Usecase diagram for the 3D printing component.

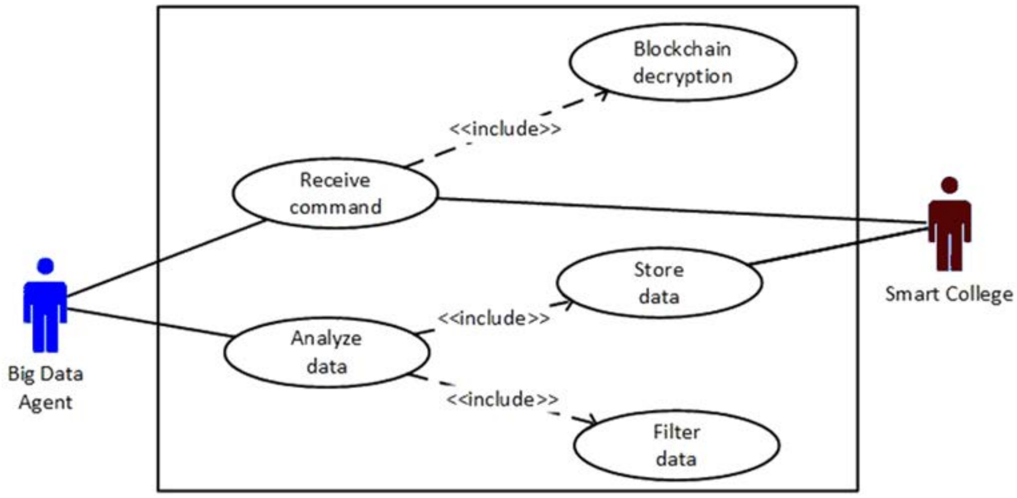

Figure 4: Usecase diagram for the big data component.

The main functions of the cloud computing component are depicted in Figure 5. Besides the function of enables this component to receive commands from the smart college, there is another function that is responsible for running cloud services when triggered by the received command.

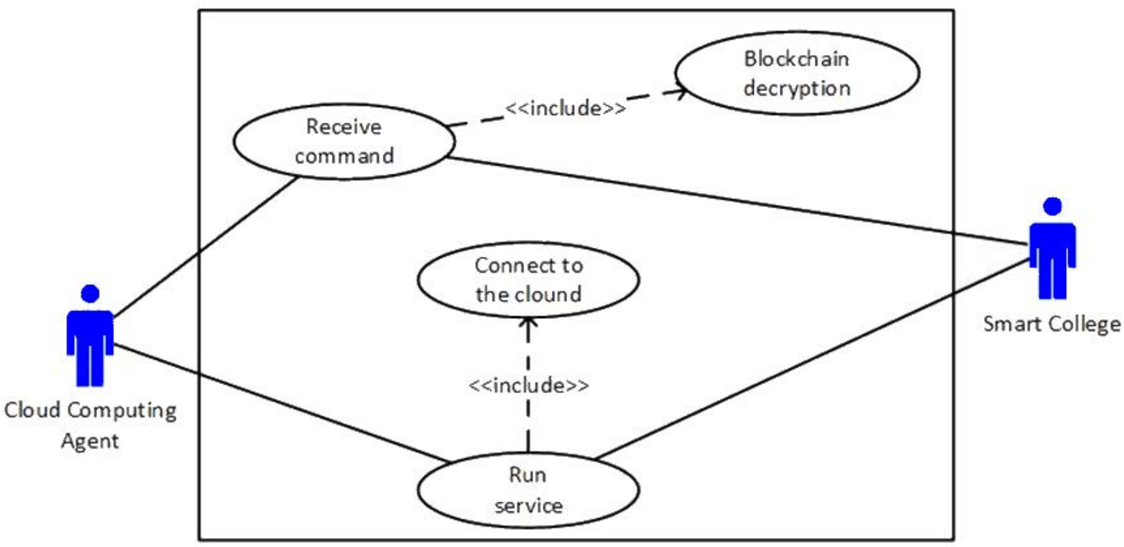

Figure 5: Usecase diagram for the cloud computing component.

On the other hand, the usecase of the IoT component of the smart college is shown in Figure 6. The main functions of this component include the capturing of data from a set of sensors installed to collect continuous streams of data. In addition, this stream of data is used in the analysis phase to get convenient decisions based on the collected data. Moreover, the component incorporates the calibration function to ensure the consistency of the collected information.

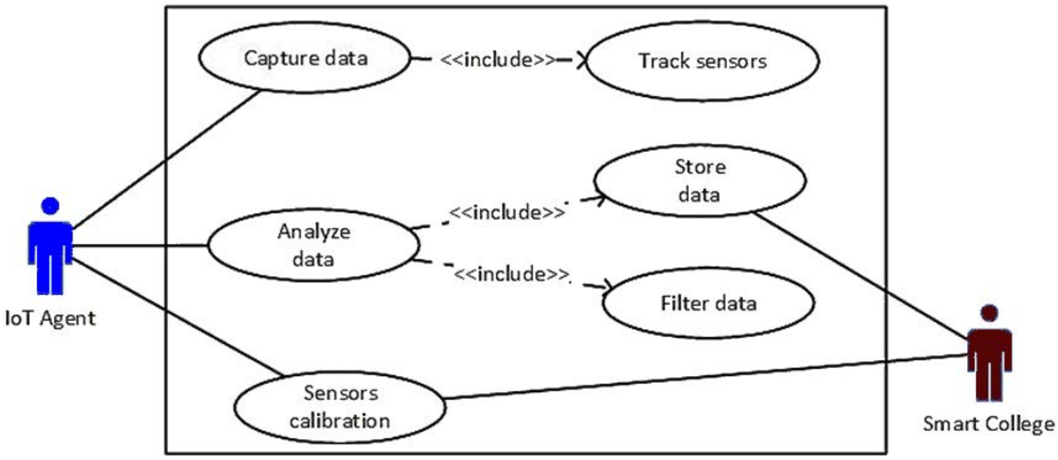

Figure 6: Usecase diagram for the IoT component.

Another important component in the smart college is the VR/AR component which is shown in Figure 7. The main functions of this component include the display function which can be activated based on the received command from the smart college controller. This function consists of the displayed object calibration for the augmented reality scenes in addition to the data analysis to adjust the displayed scenes in both VR and AR.

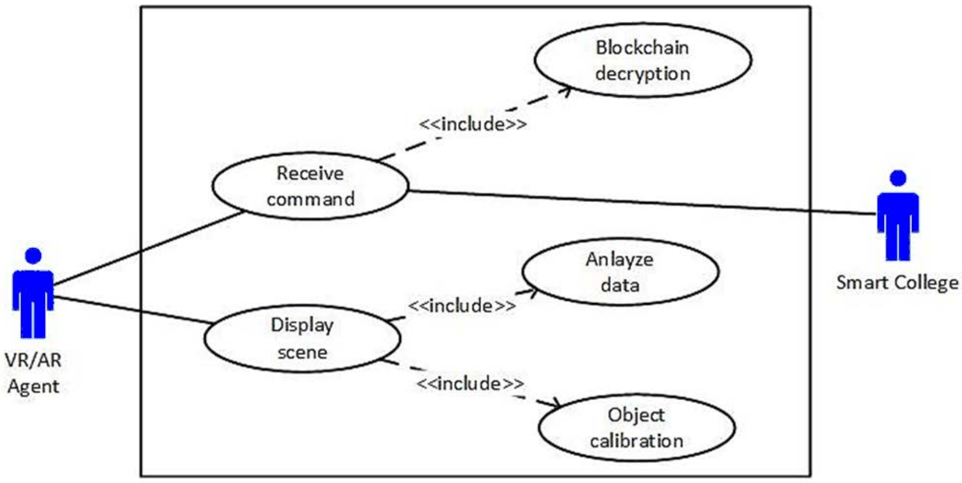

Figure 7: Usecase diagram for the VR/AR component.

Wearable technologies represent an important component in the proposed smart college. The functions of this component are shown in Figure 8. As mentioned earlier, this component is composed of all wearable components that can be used to measure or collect data, such as smartwatches, and smart glasses. The technologies in these devices are also connected to the smart college, and thus can be used to collect data analyzed, and resulting in decisions. As shown in the figure, the proposed functions of this component are the receiving of the command from the main controller of the smart college similar to the other components. In addition, it consists of a function to collect information for the wearable components to be used by the smart college, such as recording the attendance of students.

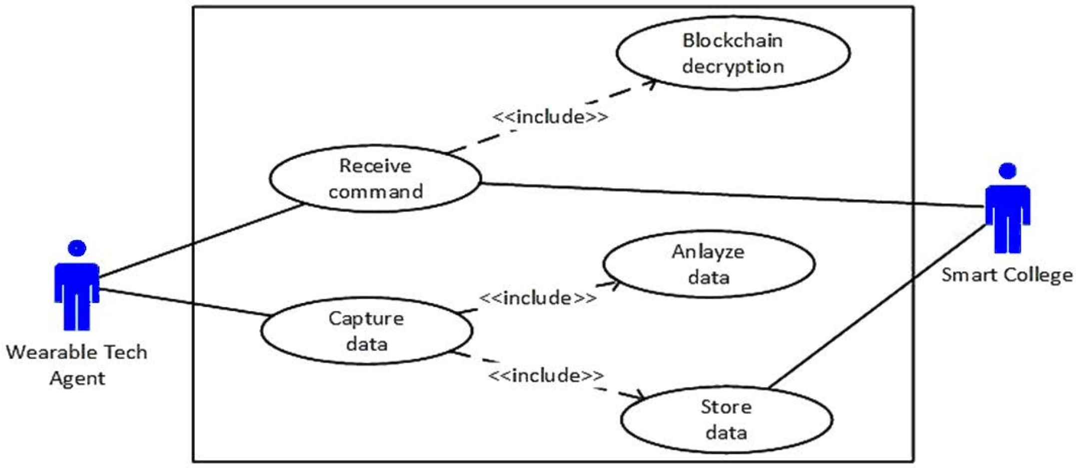

Figure 8: Usecase diagram for the wearable technologies component.

5 Conclusion

This paper presents a novel approach for smart college architecture. This architecture is based on a set of smart actors including smart learning, smart teaching, and smart classroom. Also, it employees the most recent technologies forming the basis of the fourth industrial revolution. These technologies are cloud computing, IoT, 3D printing, virtual/real reality, and artificial intelligence (AI), and wearable technologies. Besides, the application of blockchain is presented as an efficient method for protecting the data transmitted between the smart actors in the architecture of the smart college. The proposed architecture is based on a detailed review of the current issues, and directions for the smart college based on the fourth industrial revolution. The combination of IoT and AI-based smart college provides an automated real-time environment such as an open learner model to enhance the education system. The various building blocks of the smart college such as smart education, smart teaching, smart learning techniques, smart college, etc. were broadened in detail. After the application of the methods defined in the fourth industrial revolution in the teaching system, it is anticipated to significantly improve the quality of education, which leads to a smart college.

6 Availability of Data and Material

Data can be made available by contacting the corresponding authors.

7 References

[1] M.S.Malkar, Pankaj R Gopalani, Gauri N Basutkar, Raj D Garud4, Prachi P Rukar. (2018). An, android Application for Smart College. International Research Journal of Engineering, and Technology (IR-JET), 5(2).

[2] Yelin Kim, Tolga Soyata, Reza Feyzi Behnagh, Towards Emotionally Aware AI Smart Classroom: Current Issues, and Directions for Engineering, and Education, IEEE Access, Vol.6, 2018.

[3] Najwa Nasuha Mahzan, et al., “A Design of Smart IoT-Based College Room Using Arduino”, in Journal of Physics Conference Series, 2020, vol. 1529, no. 2. doi:10.1088/1742-6596/1529/2/022045

[4] T. Marwala, Finite-element-model updating using computational intelligence techniques: applications to structural dynamics. London, UK: Springer-Verlag, ISBN 978-1-84996-322-0, 2010

[5] Rehman, A.U., Abbasi, A.Z., & Shaikh, Z.A. (2008). Building a Smart University using RFID technology. In: 2008 International Conference on Computer Science, and Software Engineering.

[6] Lane, J.,& Finsel, A. (2014). Fostering Smarter Colleges, and Universities Data, Big Data, and Analytics. State University of New York Press.

[7] Al Shimmary, M.K., Al Nayar & Kubba, M.M. (2015). Designing Smart University using RFID, and WSN, International Journal of Computer Applications, 112(15), 34-39.

[8] Yu, Z. (2011).Towards a smart campus with mobile social networking. In: Proceedings of the 2011 International Conference on Cyber, Physical, and Social Computing, IEEE, 162–169.

[9] Hameed, S., Badii, A.,& Cullen, A.J. (2008). Effective E-Learning Integration with Traditional Learning in a Blended Learning Environment, European, and Mediterranean Conf, on Information Systems, 1-16.

[10] Ajaz Moharkan, Z., et al. (2017). Internet of Things, and its applications in E-learning, IEEE Intel. Conf. on Computational Intelligence, and Communication Technology, IEEE, India,1-5.

[11] Woods, Eric, et al. (2004). Augmenting the science center, and museum experience. Proc. the 2nd international conference on Computer graphics, and interactive techniques in Australasia, and South East Asia. ACM.

[12] Chen, Yi-Chen, et al. "Use of tangible, and augmented reality models in engineering graphics courses." Journal of Professional Issues in Engineering Education & Practice 137.4 (2011): 267-276.

[13] Tarng, Wernhuar, and Kuo-Liang Ou. "A study of campus butterfly ecology learning system based on augmented reality, and mobile learning." Wireless, Mobile, and Ubiquitous Technology in Education (WMUTE), 2012 IEEE Seventh International Conference on. IEEE, 2012.

[14] He, Junjie, et al. "Mobile-Based AR Application Helps to Promote EFL Children's Vocabulary Study." Advanced Learning Technologies (ICALT), 2014 IEEE 14th International Conference on. IEEE, 2014.

[15] Steinicke, F. (2016) Being Really Virtual: Immersive Natives, and the Future of Virtual Reality, Springer, Switzerland.

[16] Chien, Chien-Huan, Chien-Hsu Chen, and Tay-Sheng Jeng. "An interactive augmented reality system for learning anatomy structure." Hong Kong (2010).

[17] Squire, Kurt, and Eric Klopfer. "Augmented reality simulations on handheld computers." The Journal of the Learning Sciences 16.3 (2007): 371-413.

[18] Hu-Au, E., and Lee, J.J.(2017) Virtual reality in education: a tool for learning in the experience age, Int. J. Innovation in Education, Vol. 4, No. 4, pp.215–226

[19] Dalgarno, B., and Lee, M.J. W. (2010) ‘What are the learning affordances of 3-D virtual environments?’, British Journal of Educational Technology, Vol. 41, No. 1, pp.10–32.

[20] Psotka, J. (2013) ‘Educational games, and virtual reality as disruptive technologies’, Educational Technology, and Society, Vol. 16, No. 2, pp.69–80

[21] Angeloni, I., Bisio, F., De Gloria, A., Mori, D., Capurro, C., & Magnani, L. (2012). A Virtual Museum for Flemish artworks. A digital reconstruction of Genoese collections. Proceedings of the 18th International Conference on Virtual Systems, and Multimedia (pp. 607–610). Los Alamitos: IEEE Press

[22] Chang, Y.-J., Wang, C.-C., Luo, Y.-S., & Tsai, Y.-C. (2014). Kinect-based rehabilitation for young adults with cerebral palsy participating in physical education programs in special education school settings. Proceedings of the World Conference on Educational Multimedia, Hypermedia, and Telecommunications (pp. 792–795).

[23] Chung, L.-Y. (2012). Virtual Reality in college English curriculum: Case study of integrating second life in freshman English course. Proceedings of the 26th International Conference on Advanced Information Networking, and Applications Workshops (pp. 250–253). Los Alamitos: IEEE Press

[24] Gieser, S. N., Becker, E., & Makedon, F. (2013). Using CAVE in physical rehabilitation exercises for rheumatoid arthritis. In F. Makedon (Ed.), Proceedings of the 6th International Conference on PErvasive Technologies Related to Assistive Environments (pp. 1–4). New York: ACM Press

[25] Perez-Valle, A., & Sagasti, D. (2012). A novel approach for tourism, and education through virtual Vitoria-Gasteiz in the 16th century. Proceedings of the 18th International Conference on Virtual Systems, and Multimedia (pp. 615– 618). Milan, Italy: IEEE.

[26] Chandramouli, M., Zahraee, M., & Winer, C. (2014). A fun-learning approach to programming: An adaptive Virtual Reality (VR) platform to teach programming to engineering students. Proc. the IEEE International Conference on Electro/Information Technology (pp. 581–586).

[27] Falah, J., Khan, S., Alfalah, T., Alfalah, S. F. M., Chan, W., Harrison, D. K., & Charissis, V. (2014). Virtual Reality medical training system for anatomy education. Proc. the 2014 Science, and Information Conference (pp. 752–758). http://doi.org/10.1109/SAI.2014.6918271

[28] Sapargaliyev D. (2015) Wearable Technology in Education: From Handheld to Hands-Free Learning. In: Li K.C., Wong TL., Cheung S.K.S., Lam J., Ng K.K. (eds) Technology in Education. Transforming Educational Practices with Technology. Communications in Computer, and Information Science, vol 494. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-662-46158-7_6

[29] Kukulska-Hulme, A.: (2014). Mobile, Wearable, Companionable: Emerging technological challenges, and incentives for learning. Encontro sobre Jogos e Mobile Learning, pp. 12–15. CIEd, Braga.

[30] Peters, M. (2017). Technological Unemployment: Educating for the Fourth Industrial Revolution. Journal of Self-Governance, and Management Economics, 5(1), 25-33.

[31] Google. (2014). Google Glass. https://www.google.com/glass/start/what-it-does/

[32] Pedersen, I.: Ready to wear (or not): Examining the rhetorical impact of proposed wearable devices. In Proc. International Symposium on Technology, and Society, Toronto, pp. 201–202 (2013).

[33] Starner, T.: Wearable computing: through the looking glass. In: Proc. the 17th Annual International Symposium on International Symposium on Wearable Computers, pp. 125–126. ACM (2013)

[34] Cappos J. Beschastnikh I. Krishnamurthy A., Anderson T. (2009). Seattle: A platform for educational cloud computing. In Proceedings of the 40th ACM technical symposium on Computer science education (pp. 111-115). New York, NY: ACM. 10.1145/1508865.1508905

[35] Wagh N., Pawar V., Kharat K. (2020) Educational Cloud Framework—A Literature Review on Finding Better Private Cloud Framework for Educational Hub. In: Chaudhary A., Choudhary C., Gupta M., Lal C., Badal T. (eds) Microservices in Big Data Analytics. Springer, Singapore. https://doi.org/10.1007/978-981-15-0128-9_2

[36] Dilling, F., Witzke, I. The Use of 3D-Printing Technology in Calculus Education: Concept Formation Processes of the Concept of Derivative with Printed Graphs of Functions. Digit Exp Math Educ 6, 320–339 (2020). https://doi.org/10.1007/s40751-020-00062-8

[37] Novak E., Wisdom S. (2020). Using 3D Printing in Science for Elementary Teachers. In: Mintzes J., Walter E. (eds) Active Learning in College Science. Springer, Cham.

[38] Witzke, I. & Hoffart, E. (2018). 3D-Drucker: Eine Idee für den Mathematikunterricht? BeiträgezumMathematikunterricht 2018 (pp. 2015–2018). Münster: WTM-Verlag.

[39] Mushtaq Hussain, Wenhao Zhu, Wu Zhang, Syed Muhammad Raza Abidi, Student Engagement Predictions in an e-Learning System, and Their Impact on Student Course Assessment Scores, Computational Intelligence, and Neuroscience. 2018, Article ID 6347186.

[40] Nasim Abdulwahab Matar, Defining E-Learning Level of Use in Jordanian Universities Using CBAM Framework, International Journal of Emerging. Technology in. Learning, Vol 12, No 3, pp. 142-153, 2017.

[41] Quadri Noorulhasan Naveed, Naim Ahmad, Critical Success Factors (CSFs) for Cloud-Based e-Learning, International Journal of Emerging. Technology in. Learning, Vol.14, No.1, pp. 140-149, 2019.

[42] I.Portugal, P. Alencar, D. Cowan. (2015). The Use of Machine Learning Algorithms in Recommender Systems: A Systematic Review. https://arxiv.org/ftp/arxiv/papers/1511/1511. 05263.pdf

[43] E. Khater, A. Hegazy, and M. E. Shehab, “Ontology-based adaptive examination system in e-learning management systems,” in Proc. 2015 IEEE 7th International Conference on Intelligent Computing, and Information Systems, 2015, pp. 243–250.

[44] Nader Abdel Karim, Zarina Shukur, Using Preferences as User Identification in the Online Examination, International Journal on Advanced Science Engineering, and Information technology, vol.6. No. 6, 2016.

[45] Oke, A.; Fernandes, F.A.P. Innovations in Teaching, and Learning: Exploring the Perceptions of the Education Sector on the 4th Industrial Revolution (4IR). J. Open Innov. Technol. Mark. Complex. 2020, 6, 31.

[46] Chang, V. Review, and discussion: E-learning for academia, and industry. Int. J. Inform. Manag. 2016, 36, 476–485.

[47] Nakamoto, S. Bitcoin: A Peer-to-Peer Electronic Cash System. http://www.Bitcoin.org/ bitcoin.pdf Accessed September 2019.

[48] Earley, K. Supply Chain Transparency: Forging Better Relationships with Suppliers. https://www.theguardian.com/sustainable-business/supply-chain-transparency-relationships-suppliers Accessed November 2019.

[49] Virtual Currencies, and Beyond: Initial Considerations. Available online: https://www.imf.org/external/ pubs/ft/sdn/2016/sdn1603.pdf Accessed on October 2019.

[50] Iansiti, M.; Lakhani, K.R. The Truth about Blockchain. Harv. Bus. Rev. 2017, 95, 118–127.

[51] Awaysheh, A.; Klassen, R.D. The Impact of Supply Chain Structure on the Use of Supplier Socially Responsible Practices. Int. J. Oper. Prod. Manag. 2010, 30, 1246–1268.

[52] Skilton, P.F.; Robinson, J.L. Traceability, and normal accident theory: How does supply network complexity influence the traceability of adverse events? J. Supply Chain Manag. 2009, 45, 40–53. [CrossRef]

[53] Garcia J, Yang Z, Mongrain R, et al. 3D printing materials, and their use in medical education: a review of current technology, and trends for the future BMJ Simulation, and Technology Enhanced Learning 2018;4:27-40.

[54] Rachel H. Ellaway, Martin V. Pusic, Robert M. Galbraith & Terri Cameron (2014) Developing the role of big data, and analytics in health professional education, Medical Teacher, 36:3, 216-222, DOI: 10.3109/0142159X.2014.874553

[55] Walker, R., Interactive whiteboards in the MFL classroom, TELL & CALL, (2003), vol. 3, pp. 14-16.

[56] Hall, I., & Higgins, S., Primary school students' perceptions of interactive whiteboards, Journal of Computer Assisted Learning, (2005), Vol. 21, No. 2, pp. 102-117

[57] Wall, K., Higgins, S., & Smith, H, The visual helps me understand the complicated things: Pupil views of teaching, and learning with interactive whiteboards, British Journal of Educational Technology, (2005), Vol. 36, No. 5, pp. 851-867.

[58] Elliot, C., Using a personal response system in economics teaching, International Review of Economics Education, (2003), Vol. 1, No. 1, pp. 80-86.

[59] Cutrim Schmid, E., Enhancing performance knowledge, and self-esteem in classroom language learning: The potential of the ACTIVote component of interactive whiteboard technology, System, (2007), Vol. 35, No. 2, 119-133.

[60] KERIS, Adapting Education to the Information Age 2008. Korea Education, and Research Information Service, (2009).B. Newman, and E.T. Liu, Perspective on BRCA1, Breast Disease 10 (1998), 3-10.

Dr.Sultan Refa Alotaibi is an assistant professor at the Department of Computer Science, College of Computing, and Information Technology, Shaqra University, Saudi Arabia. He got his PhD in 2017 from the Information Systems department, University of Strathclyde, United Kingdom. His research interests are Smart Education, E-Learning, Intelligent Systems.