An Interactive E-Learning System for Smart Cities based on IoT

eLearning based on IoT

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Abstract—**This research paper presents an advanced solution for interactive education systems based on new technologies for smart cities. Background/Objectives: The new coronavirus COVID 19 made an impact on most of the daily activities in the whole world. Normal daily activities such as going to school or university became a challenge for many pupils and students. Many companies and education stakeholders started to find suitable solutions to attend meetings remotely, study remotely, or use online connections instead of physical presence. Methods: The paper presents the development of an interactive E-Learning system based on Internet of Things (IoT) connections and Virtual Reality (VR). The proposed system provides a solution for practical classes to attend classes wearing VR glasses to feel the interactions between devices and tools as practical as in practice. Findings: The paper presented the main challenges in the eLearning solutions from surveys from different researchers. The papers proposed an interactive solution for learners to use an interactive platform based on IoT and VR to provide a solution that makes practical learning possible. Classroom teaching could be completely replaced by online teaching mode. Novelty: The proposed system might be an attractive solution for many purposes using IoT environment and Virtual Reality (VR) to decrease the feeling of disconnection between co-learners and to make practical learning is possible**

Keywords— e-Learning; Smart cities, Internet of Things (IoT); Virtual learning; Service Oriented Architecture (SOA); Mobile learning; COVID 19

I. INTRODUCTION

Globally, the outbreak of COVID 19 makes drastic changes in society. The Government of many countries has taken numerous initiatives to normalize the situation to promote the health and well-being of society. The Higher Educational Institutions maintain the continuity of Educational activity through E-learning platforms. However, it needs much collaborative effort among faculty, administrative staff, and students for successful completion. Though Online teaching is one of the innovations in the teaching and learning process, a complete switch over from traditional teaching practices affects the students and teacher as well. There are many differences between Traditional teaching and online teaching methods. There are similar studies carried out in earlier days to assess the educational policies and practices (1). Presently, the researcher would like to find the difference of opinion among the teaching fraternity regarding Online teaching mode to overcome the shortcomings in the future. The purpose of the study was to assess the faculty's perception of Alternative teaching practices (E-Learning – Blackboard) during COVID 19.

In the years, universities have tried to incorporate in their environment, learning environments, and eLearning solutions in its educational process, which combine characteristics of technological and instructional type; however, to achieve a modern, customizable and evolutionary environment, encouraging learning communities with social and interactive presence, either in the eLearning environment (2). In this work, the study is based on the review of the literature regarding the use of technological tools in the educational process, both formal and informal, for which the following objective of the research is presented by studying whether the eLearning tools will achieve the active and participatory participation with students with a cognitive social presence promoting the interaction, communication, and collaboration among the educational actors, to break the closed walls of the traditional LMS, interrupting the formal imbalances of power between the student, teacher and the university (3).

A. Teaching and learning approaches with technology

The concept of teaching includes teacher-focused and learner-focused methods. In the teacher-focused method, knowledge is transmitted by the teacher to learners with the use of technology. In such a case, the teacher needs to have a better orientation towards the use of technology for effective teaching. In learner-focused teaching, the teacher instills knowledge in the learner actively using technology to achieve learning goals.

The learning pyramid, which was developed by the National Training Laboratories Institute (2), Bethel, Maine in the early 1960s proposes that the average retention rate is more in participatory methods than in passive methods including lecturing, demonstrations used in classroom teaching(3). Also, discussions, practice by doing methods have a high retention rate but in an E-learning platform, it is highly unusual to adopt all participatory methods of teaching and learning.

In this work, the study is based on the review of the literature regarding the use of technological tools in the educational process, both formal and informal, for which the following objective of the research is presented: knowing whether the synergy of these two technology Social Network Sites (SNS) and Learning Management Systems (LMS) (2) tools will achieve the active and participatory participation with students with a cognitive social presence promoting the interaction, communication, and collaboration among the educational actors, to break the closed walls of the traditional LMS, interrupting the formal imbalances of power between the student, teacher, and the university.

B. Background of study

There has been a big need to develop new effective solutions for the eLearning system to cope with the new COVID 19 pandemics (1). Recently, many solutions have been provided for online learning. Many organizations require needs for the learning process when they need to present the content of the courses for students to get the concept of the course. In general, the aim of any E-Learning system is integrating or reusing the available resources.

Service-Oriented Architecture (SOA) provides great solutions for eLearning, where each service has a particular task to do. The web service contains an interface which is responsible for the functionality or the service provided by the provider. It contains a contract as well where the service user can find out how to interact with the service. The interface defines how a service provider will perform requests from a service consumer, the contract defines how the service provider and the service consumer should interact, and the implementation is the actual service code itself (7). The proposed system is an intelligent learning system based on IoT and cloud computing to provide a solution for organizations with an interactive solution that allows students to communicate with the course tutor with the other course attendees.

There were many published works on eLearning during and after COVID 19 crisis, refocusing teacher presence and learning activity (1). Chatziralli presented the global perspective on transforming ophthalmic education into virtual learning during COVID 19 pandemic (2). Almaiah et al. explored the critical challenges and factors influencing the E-learning system usage during COVID 19 pandemic (3). Elsamanoundy et al. published an article on enhancing students' engagement in using blackboard as an online learning community tool in clinical Biochemistry (4). Ali et al. presented online and remote learning in Higher Education Institutes, a necessity in light of the COVID 19 pandemic (5).

Alsadoon et al. published an article on the impact of an adaptive e-course on students' achievements based on the students' prior knowledge, Education, and Information Technologies (6). Walabe et al. submitted a Postdoctoral thesis to the University of Ottawa regarding E-Learning Delivery in Saudi Arabian Universities (7). Wei Bao studied COVID 19 and online teaching in higher education: A case study of Peking University. The study concludes with five high impact principles for online

education (8). Amit Kumar Arora mentioned in his article that for those who have adopted virtual mode, the mean of actual benefits is significantly less than the mean of expected benefits (9).

Abdullah Aljaber conducted a study titled on E-Learning policy in Saudi Arabia: Challenges and successes, Research in Comparative and International Education (10). R. Raja et al. in 2018 published an article titled Impact of modern technology in education. Emphasized that technology is a gift of God. Technology has certainly changed the way we live. Further, stated that technology eases the task of teachers in the learning process (11). Paul et al. in the study of "The myths of the digital native and the multitasker" pointed out the present-day students belong to the digital media world and fundamentally different from previous generations of students. They have been labeled as digital natives and can multitask (12). Christine Frazer et al studied-on Faculty Perception of Online Teaching Effectiveness and Indicators of Quality in 2017. They mentioned that effective online teachers facilitate, connect, lead, and work in synchrony with students to obtain indicators of quality in teaching and learning (13). Theresa Capra quoted in her article that online education has experienced dramatic expansion and growth. Although this growth is impressive, it does not occur without consequences. It was evident that there are many withdrawals and failures in online courses (14). Heather et al highlighted that online learning is increasing these days, hence the teachers need to have good learning experiences to enable them to equip the students with high-quality education thereby overcome the challenges faced by the online teaching process(15).

The COVID-19 pandemic forced most universities and colleges everywhere in the globe to prohibit the physical presence classes to stop the spread of the pandemic (3). The coronavirus COVID-19 made big changes in all sectors including the education sector has not been immune. The e-learning systems became a demand based on the logic of the exception that extraordinary times call for extraordinary measures—one common trend in education systems around the world has been to respond to the pandemic with "emergency eLearning" protocols, marking the rapid transition of face-to-face classes to online learning systems.

Many researchers worked on eLearning systems to provide the learners with solutions to learn from anywhere where there is internet from multiple possibilities such as laptops, PCs, tablets, mobile phones, etc.) (4). The learners nowadays can attend lectures from home, garden, coffee, restaurants (5). Internet and new technologies offered many solutions for eLearning. Many universities and education facilities provided different solutions for online learning tools that can be eligible and tangible by the learners.

In (6), the authors proposed a recommendation system based on collaborative filtering. The user-based collaborative filtering algorithm is chosen as the main recommendation method (7). Historical data is gathered from the learners to be recorded on the Database of the learner in a collaborative method. There are common

three methods for recommendation systems: collaborative filtering (CF)-based methods, content-based methods, hybrid methods (8).

Education has been badly hit with several students stranded reception, looking at the screens and partaking of educational instruction passively. in line with the international organization Educational, Scientific, and Cultural Organization (UNESCO), nearly 1.6 billion children in 190 countries have been affected by the college closure (9). the tutorial community in India took to its new WFH (work from home) role with much trepidation within the beginning. However, with the lockdown being no dampener in teachers' creativity and spirits, they learned fast to attach with 'remote' students (10). The physical distance of online teaching failed to deter them from the sacred responsibilities of shaping the minds and spirit of the scholars. This extraordinary situation fostered quickly the opening of the digital interface of education, (10). Even in Tier 2 and three cities, in a single-family with two children, there's the availability of only 1 smartphone to access school instruction. Some financially weaker sections might not afford the specified technical gadgets and high-speed internet services(11) School closure within the country brought an unprecedented situation in students' life since all their classes turned virtual. It was not only a first-time incident in their lives but also the therein of the teachers. because of the accelerated adoption of the digital platform, many educational institutions considered this challenge as a chance to experiment with technology tools. to not let the crisis hamper the curriculum, e-learning spread its wings faster than it might are possible in normal circumstances. This turned educational pedagogy from teacher-centric to student-centric, with greater engagement between the teacher and the taught to form a virtual learning experience as real as possible. However, the standard and pace of this transition depended on the net connectivity, availability of technical devices reception, and preparedness of the teachers to induce comfortable with e-learning practices. it had been no but a historic period triggered by a crisis that found us without any premonition (12).

II. MATERIALS AND METHODS

The paper presents a study on eLearning and the user's experience with the technology. In the paper, there is a new technique based on IoT, and VR is used to provide learners a new solution for practical classes.

A. Participants

The data has been collected by different researchers from respective faculties of various discipline in which 7 (16.67%) from the Nursing branch, 11 (26.9%) from the Science department, 5 (11.9%) faculty from Math's discipline, 15 (33.3%) belongs to language studies and 4(9.52%) from the business department. In terms of teaching position of participants, there was 1(2.38%) professor, 2(4.76%) Associate professors, 13(30.95%) Assistant professors, 24(57.14%) lecturers, and 2(4.76%) others shared their views. Also, it was evident that the majority of 35 (83.33%) teaching faculties are experienced with more than 5 years and the least have in vice versa.

B. Platform development

Web services are pieces of software that can be made available over the internet. They provide a way to exchange information between the server and the system. web services can be styled as Simple Object Access Protocol (SOAP) or Representational State Transfer (REST). SOAP is a standard protocol that is employed to communicate between the web service and clients via Simple Mail Transfer Protocol (SMTP) or Hypertext Transport Protocol (HTTP) (9). Extensible Mark-up Language (XML) is used in web services as the standard language for communication as shown in figure 1.
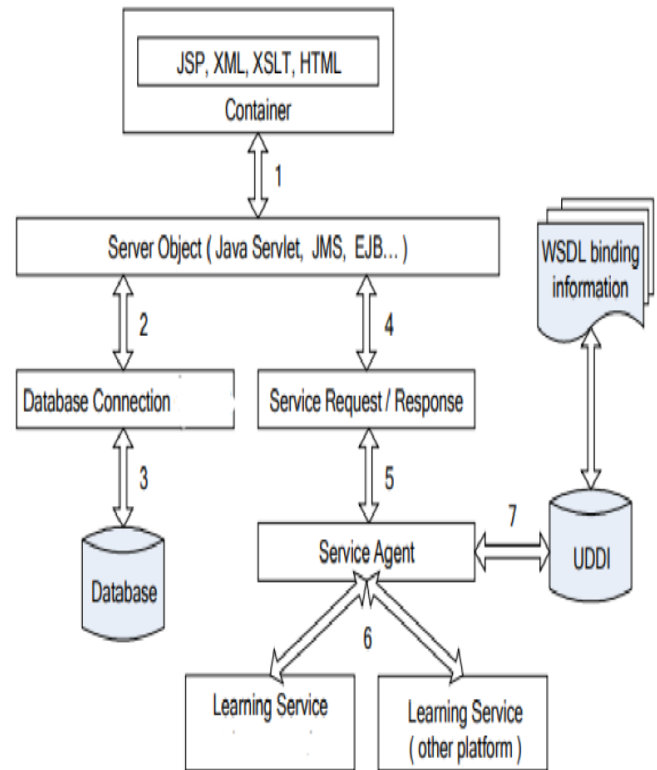

Figure 1: SOAP in eLearning.

Unlike SOAP, the REST is an architectural style that has been adopted to address the limitations of SOAP. REST has a more flexible architecture and is lightweight compared to SOAP leading to better performance. Additionally, it also allows different messaging formats such as XML, JSON (JavaScript Object Notation), HTML (Hypertext Markup Language), and even plain text. Figure 2 shows a general schematic of how REST APIs are invoked by client applications via HTTP requests.

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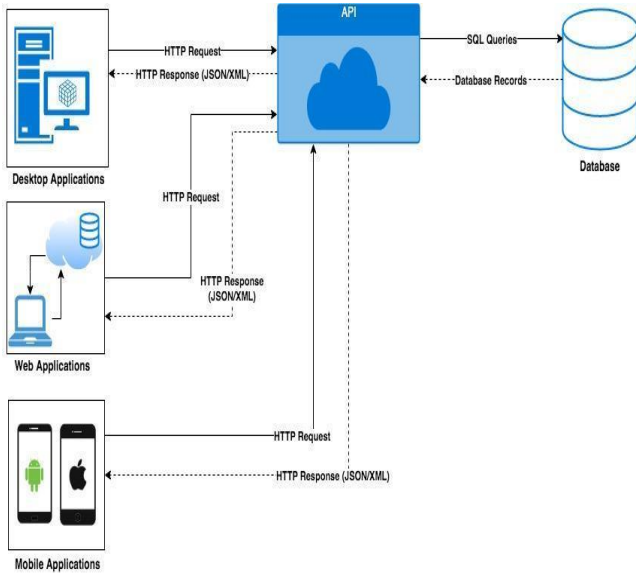**ISSN: 2278-0181**
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Figure 2: The Rest API implementation in eLearning.

VR is a 3D-technology that provides a user with virtual 3D content by wearing special glasses connected to computers. VR is used widely in in-game environments and 3D shows. We are at a time when ICT has a presence almost in all human activity, and could not go unnoticed in the educational field, so many people are very engaged in their training community in person, but on the other hand In part, different studies show that the virtual community also reaches levels of commitment equal to or higher than face-to-face. This leads us to consider that mixed learning (eLearning) emerges from the synergy of these two modalities.

Online teaching or mobile-based (M- learning) have some basic components as shown in Figure 3 (13). It should authenticate the learner by using a login form by checking the user login data, if the user is the admin, they can add the course content and activities for learners. These systems provide a straightforward solution for managing and controlling classrooms with some other features regarding user management to allow the admins to add and remove learners or give them assignments if it is needed.
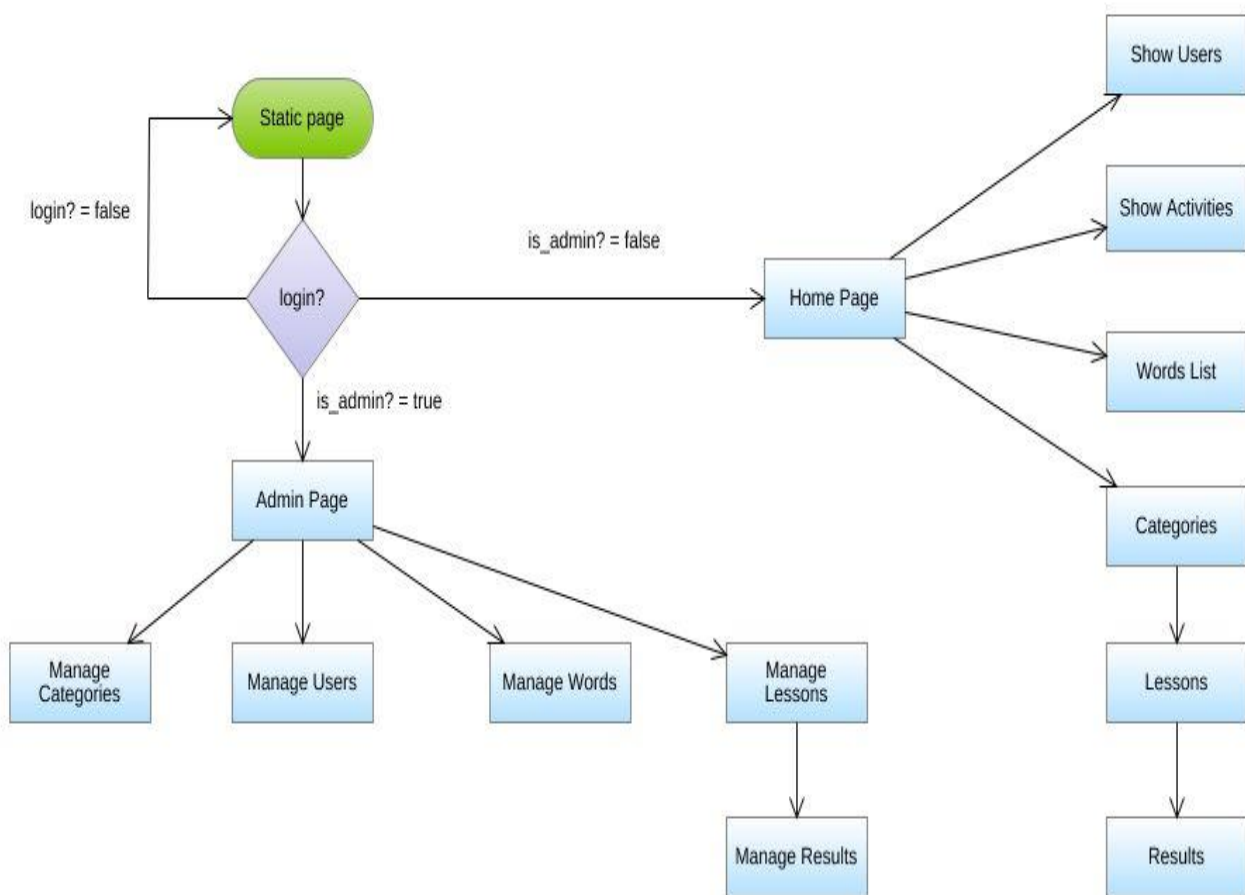

Figure 3: M-learning Environment Model.

The traditional approach of teachers to evaluate learners by the number of tasks. The type of question bank influences the importance of evaluation in education. Varying of these questions helps in evaluating students efficiently (14). There are many websites providing E-learning solutions with content and supervision from high-ranked universities such as the "edx" website, As shown in figure 4 the system is based on the identity of the learner and they provide customer support to help learners during the courses. Some courses are limited with a timeline and others are open with fees.
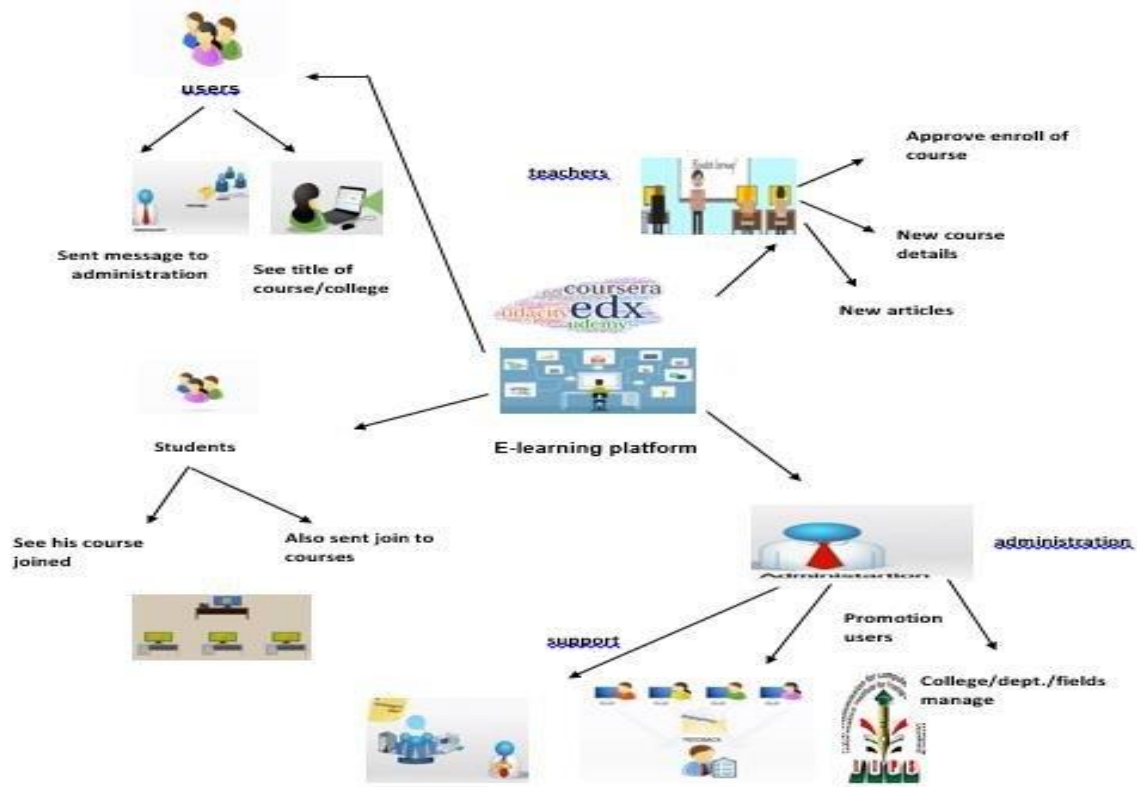

Figure 4: The online university courses system.

In a study in 2020 was carried out by the authors in (7), they found out that there are great trends in eLearning systems and the rates of learners who use the technology to learn became more common as shown in figure 5. They applied their study in Spain for university classes on 107 students. Different variables such as cultural, demographic, and psychological were used as satisfaction factors that can have an impact on online students. To measure the dropout and retention factors, they studied some factors that motivate users for online studies such as the teaching content design, the activities in the classes, the activities between students to solve and reach a target, proactivity attitude of the instructor, the communications, and guidance. Self-regulation used the presence as a positive indicator of self-controlling to attend the classes. The last factor they studied was the motivation which was associated with the teacher roles and how they motivate students, the effort, the environment. One of the limitations of this study that some factors were not be used in the study such as the quality of life, the student preferences, and the content difficulty.
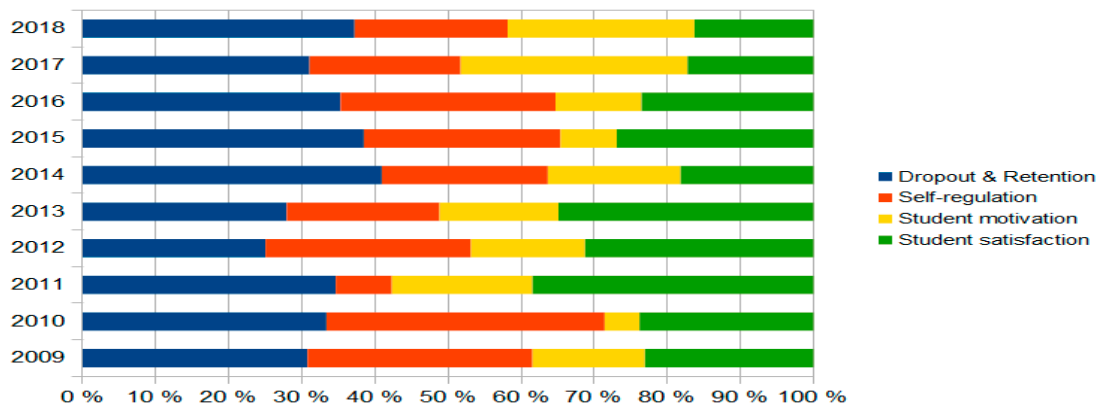

Figure 5: The E learners' feedback about the available eLearning system (6).

Last ten years, the reasons for an exponentially growing number of people who use Facebook have been identified, two main factors that undergo their use, such as external stimulation that encourages users to participate in behaviors that deal with Facebook (for example; birthday reminders, automatic emails sent by the social network), and the internal motivations that deal with the gratifications provided by the content and use of the media. That is, the social connection, join groups, and organize events, publish, and view photographs, among others (19). In the relevant literature they state that by engaging in social interaction through SNS, there is the potential to increase subjective well-being, the compatibility between technology and users, and the attitude towards technology. One of the main factors that could distract the learners using eLearning methodology is the distraction because of social media websites (20).

C. AN AUTHENTICATION SYSTEM FOR E-LEARNERS.

One of the most challenges in e-learning systems on how to authenticate the users for efficiently attending offline classes. The proposed system as shown in figure 6 gives the users the possibility to attend the courses online by looking for the databases authorized users to allow the user to access the content with their identified accounts.
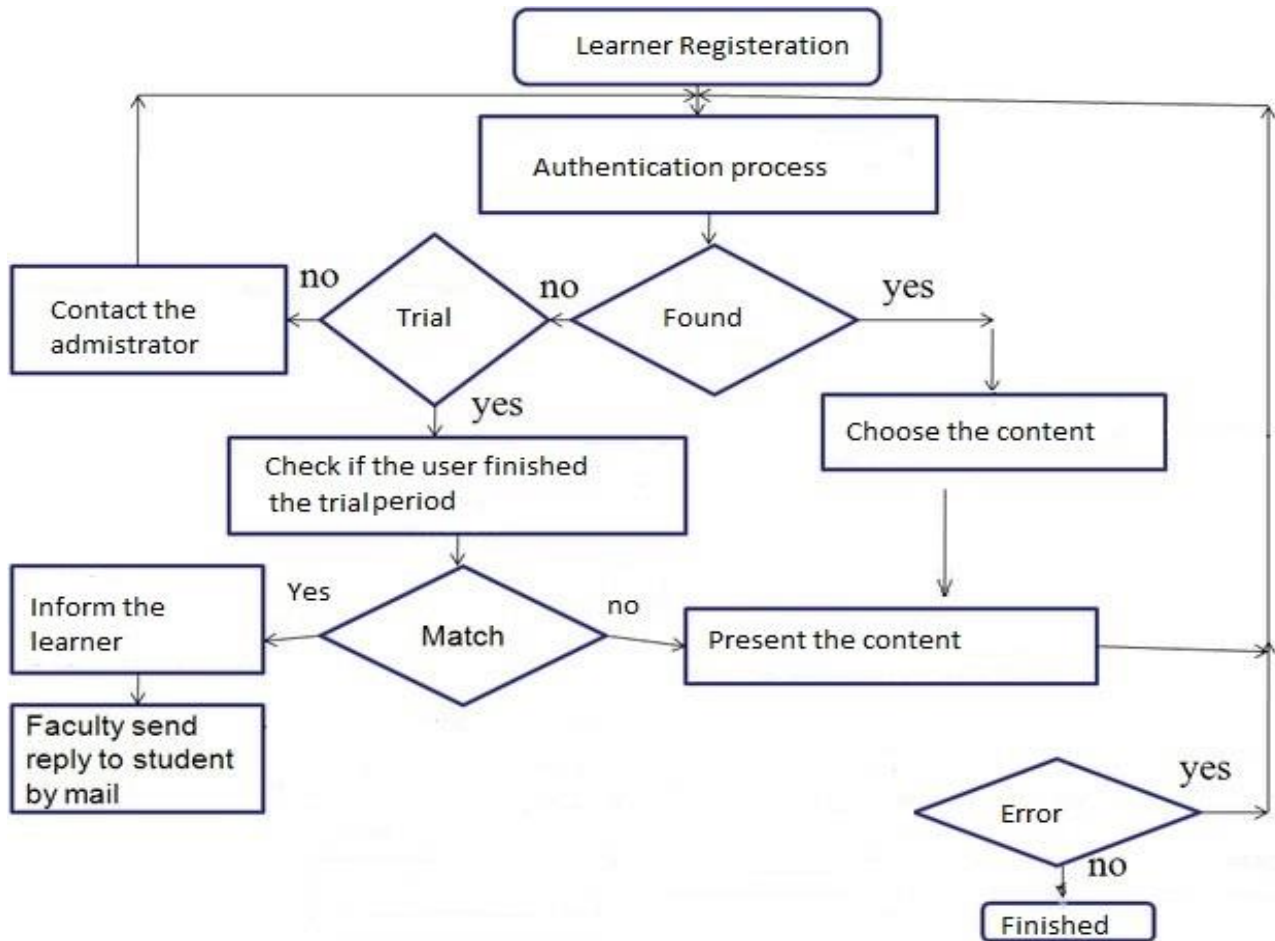

Figure 6: The authentication flowchart for the e-learning environment.

D. The proposed interactive eLearning solution

Many organizations provide handy solutions for the eLearning environment and give the learners the possibility to access the contents and the training online using web services as shown in figure 7. The proposed system is based on a web service that shows the content from the storage database.
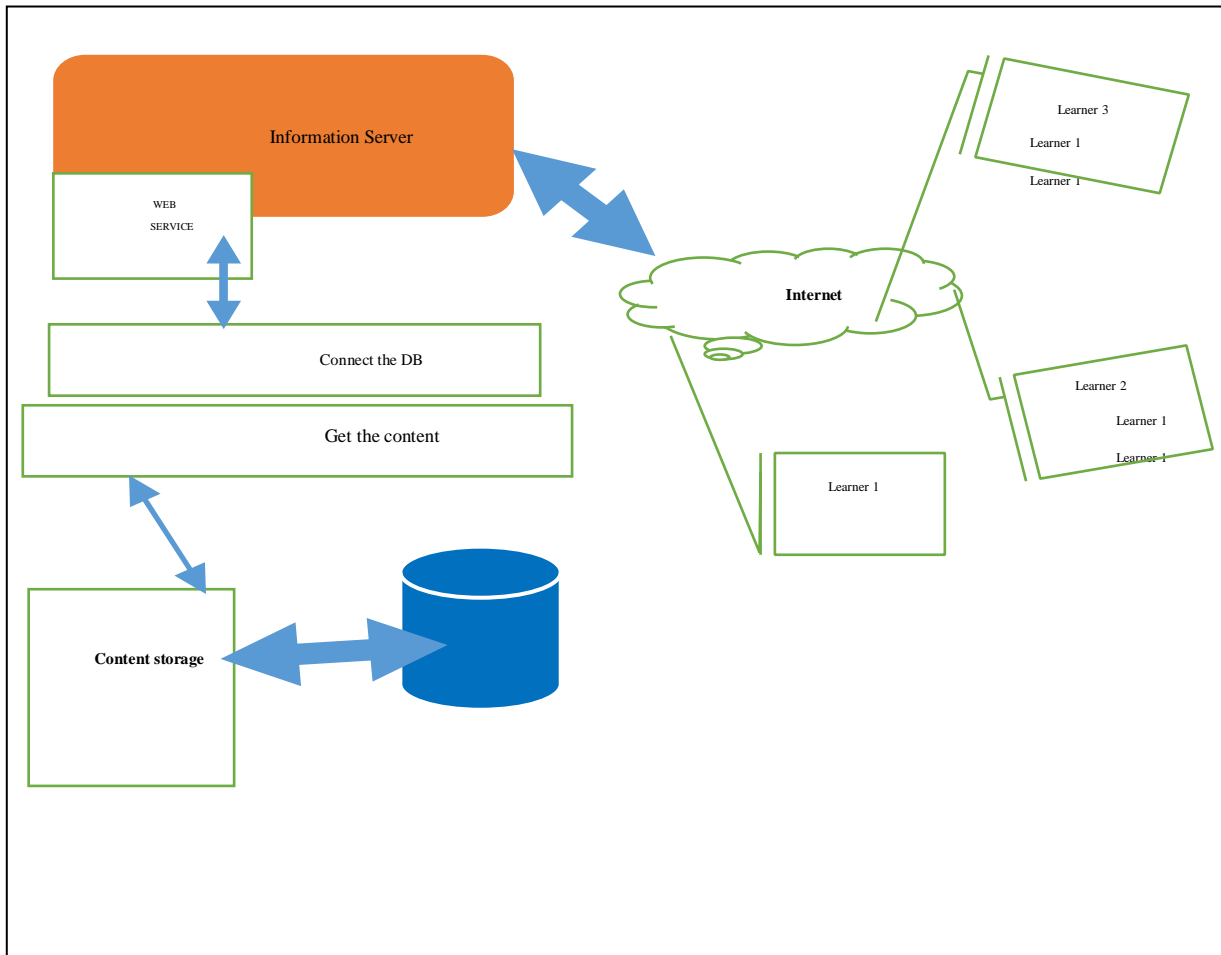
Figure 7: The architecture of the proposed eLearning system.

The related work did not utilize various side information in a widespread manner and take advantage of the available data. Traditional collaborative filtering approaches use user opinion and suggestion as input to make the recommendation. User Feedback or ratings are given are useful as input in the recommendation system. The hierarchical Bayesian algorithm can do very well as a recommendation system because it combines deep learning for content knowledge and collaborative filtering for the feedback matrix. Convolutional neural network (CNN) is also one of the alternatives for collaborative deep learning (CDL) for recommendation systems (21). The proposed system as shown in figure 8 provide an advanced solution for the eLearning environment to solve two basic challenges in the eLearning solutions, first is the streaming issue when the system is based on the server buffering for streaming the content, and the second challenge is the lack of interactivity between the participants of the course.

The Amazon web services (AWS) is used to scale the need for streaming resource on demand (22). The proposed system provides a solution based on VR to make the interactivity between the participants as high as the real classroom.

IoT has become one of the daily life basics to run the need of many stems. The main idea of the IoT paradigm is to reduce the existing gap between the digital and physical worlds. The IoT extends the actual form of the Internet to a network of connected people and objects (things). Within the IoT, objects obtain intelligent behavior as they can collect, exchange data, and make decisions. The data gathering and exchange are guaranteed thanks to microcontrollers, sensors, and software embedded in objects. Applying

The proposed system provides VR with IoT devices such as smartphones to give the learners a better experience to learn on go in an interactive environment. The VR helps the learners to have the feeling of the classrooms with the content of the courses. The proposed solution may help many practical courses to make the content available and share the content on the cloud to make the streaming process for 3D content and video streaming data more efficient. The proposed smart system is based on web services to present the classes for students and learners using smartphone connections.
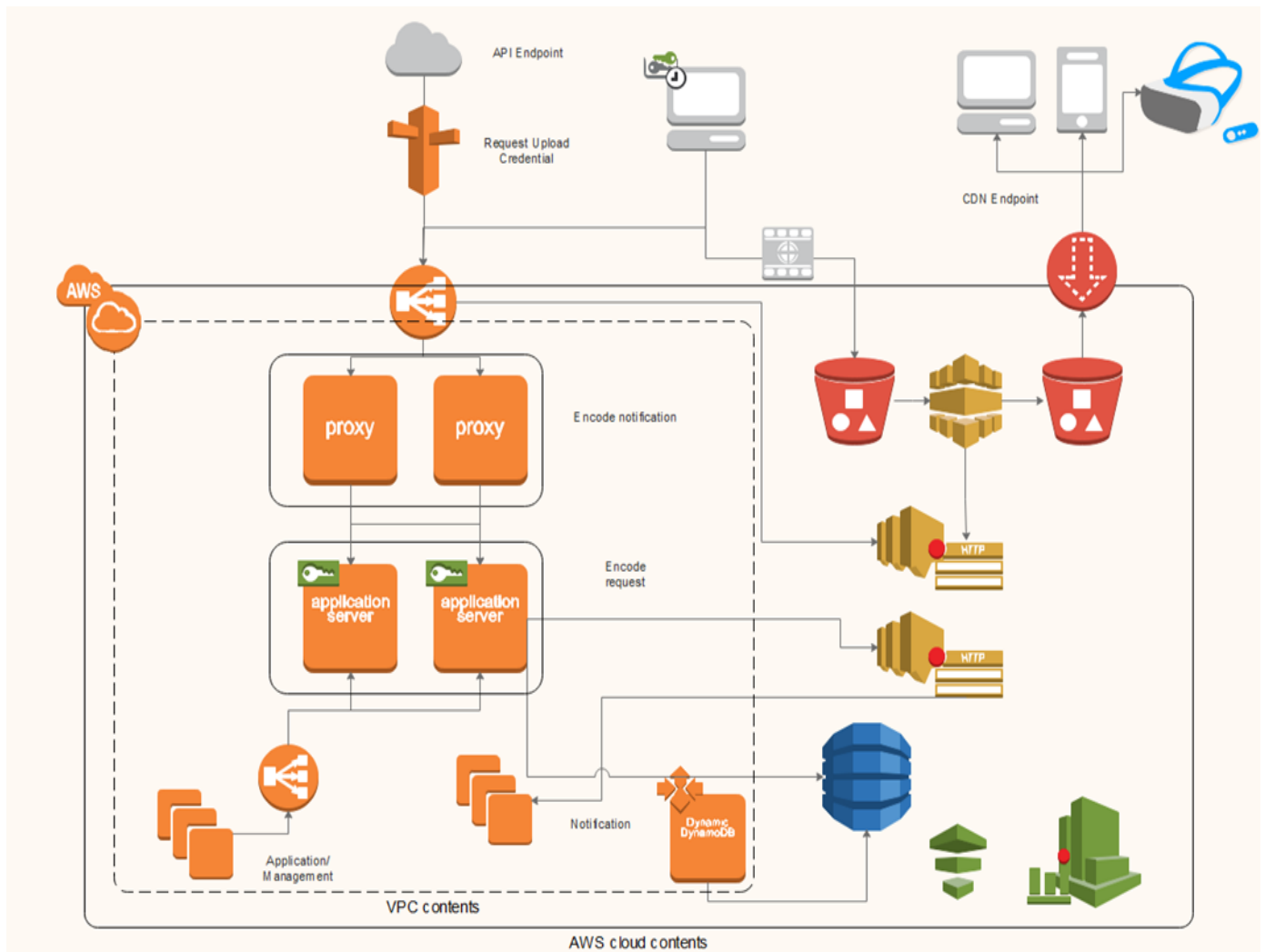
Figure 8: The proposed learning system based on AWS.

E. Procedure

In a survey was carried out by the authors in (16)., they made a study based on the users and their preferences (see figure 9). The survey was conducted through a self-administered questionnaire among the faculties online during the first two weeks of June 2020. The purpose of the study was mentioned in the questionnaire. The researcher emphasized the participants on voluntary participation and withdrawal. The participants are instructed about the data confidentiality procedure. Anonymity was also maintained. Institution permission was taken before the conduction of the study. Faculties who volunteered to participate filled out the questionnaire and the data collected through Email. The collected data was then analyzed using descriptive statistics at the end of June 2020.
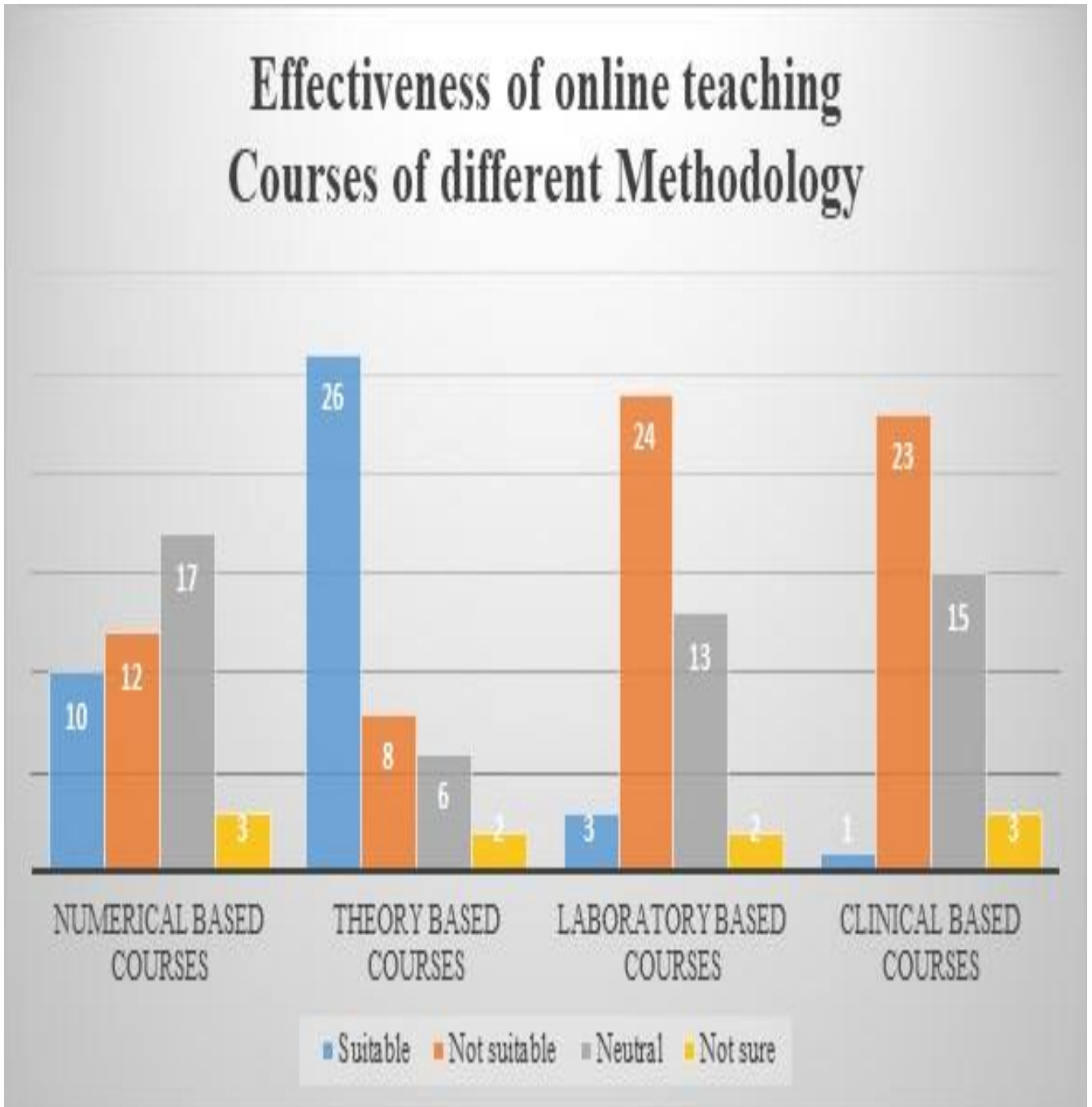
Figure 9: ELearning systems efficiency based on the topics.

F. THE PROPOSED RECOMMENDATION ELEARNING SYSTEM

The paper presents algorithm 1 for eLearning to recommend the classes for the learners. The proposed solution collects from the user their objectives, interests, and the time that they aim to consume on the course, and the price they can afford. The system starts to collect this information to suggest the optimal classes based on their choices. The system employs the historical data of the learners to help them to make the right decisions for the class based on the learner's interaction with the system. The present study focused on the faculty perception of online learning solutions based on virtual environments. The findings of the study were grouped into four categories comprising the E-learning platform, E-learning course delivery, E-learning difficulties, and Effective teaching mode. When analyzing, faculties' perception towards the E-learning platform, all the faculties were using university platforms for E-learning. In addition to that, they were using synchronous and asynchronous methods according to the availability of resources and study objectives. Wi-Fi was used as a network mode by many of them. Also, it was mentioned that many of the faculties do not have previous experience. Nearly half of them experienced technical difficulties including network issues, hardware issues, and lack of awareness (23-24). Many of them used laptops as the mode of conducting the class. It was also evident that an average of 2 to 4 hours of classes has been delivered in a day with additional spending of 4 hours for class preparation, voice

recording, uploading files, assignment, test, attendance than the traditional classroom teaching. Some research studies were conducted by researchers mentioned that the COVID-19 pandemic enacted great challenges in the field of Ophthalmology Education as well (3). The experience gained through virtual training platform, may change the traditional teaching practices in the world and provide new educational opportunities for both teachers and learners (2). Also, Elsamanoudy has written in his article about the perception and satisfaction of second-year medical students concerning the Blackboard online platform. The student found it effective along with face-to-face classroom-based learning methods for better learning achievement (4).

Algorithm 1: The proposed recommendation eLearning algorithm:

Input: Collect information from the learner

Output: Choose Learning style based on user interaction

Step 1: Learner registration

Step 2: Available online classes

Step3: choose an interactive course or record one

Step4: Start the class

Step 5: case Interactive learning: show 3D show of the course

Step 6: case Recorded: Present the course

Step 7: Results: Answer the questions

Step 8: Evaluation

Another category is the faculties' perception of E-learning course delivery. Accordingly, many faculties used shared video/notes at the time of the lecture, some before the lecture, and few more performed spots lectures. They further mentioned sharing video/notes at the time of the lecture is more effective, than in other ways. It showed further evidence that most of them recorded the lecture and upload it before the online class. Also, many of them were comfortable in recording the lecture. Though there are some difficulties in recording lectures including disconnection issues, disturbance in-network, lack of voice clarity, and problems in uploading. The student's response was found less in the online class rather than in classroom teaching. Many of them noted that the discipline is less towards online class rather than classroom teaching. The quality of teaching and learning is not improved in Online teaching. The faculties stated the reason as there was a lack of classroom culture, difficulties in grading & maintaining attendance. The online assessment methods adopted by the faculties include Quiz, assignment, discussion, oral examination, Homework, and presentation. It was further evident that online teaching was suitable for Theory-based courses and then for numerically based courses whereas, for practical classes, it is a bit more complex and not that effects such as for clinical and laboratory-based classes. On contrary, Chatziralli et al stated in the article that online learning becomes a useful platform to provide education of adult learners in terms of its cost, effectiveness, accessibility, and flexibility of time of place in delivering the course(2).

The third category emphasized E-learning difficulties experienced by faculties. Those include difficulties in the Online assessment Process. Also, monitoring performance assessment is more challenging, students' expectations of interacting materials, time consumption, maintenance of attendance become additional difficulties. There was a greater physical or emotional disturbance in online teaching than classroom teaching. Almaiah et al. explored the critical challenges and factors influencing the E-learning system usage during the COVID-19 pandemic in Education and information technologies. They enlisted technological challenges, individual challenges, cultural challenges, and course challenges. It may be a major suggestion for the policymakers, designers, developers, and researchers which enables them to get acquainted with the key aspects of Elearning for successful usage during the COVID 19 pandemic (3). Another study by Chrysi Sapanta states that online teaching and learning becomes a particular challenge and has been an urgent and unexpected request than face to face teaching. It implies certain pedagogical content knowledge especially to technological designing, organizing, and delivering course material for a better learning environment (1).

The fourth category was the faculties' perception of the effective teaching model. The majority of them disagreed with the statement "Classroom teaching be completely replaced by online teaching mode" According to the study findings, faculties mentioned that traditional classroom teaching practices as effective in improving academic performance and preferred mode of teaching. However, some researchers proved the effectiveness of online teaching in terms of students' achievement. Elham AL Sadoon mentioned in the article that the impact of an adaptive e-course on students' achievement is not correlated with prior knowledge (6).

In the field of education, the latest approaches have been in use including the application of technology, the use of modern aids, strategies in teaching, construction of need-based curriculum, independent evaluation strategies for the attainment of diversified competencies for past decades. Technology can only be used as a supplement. If online teaching continues, it will alter the educational landscape and new issues emerge among instructors and students. Preparation for teaching online is time-consuming and it extracts an additional 10 hours which eventually becomes a teaching load. Similarly, students must face many struggles due to lack of social interaction, low grades than traditional

classroom teaching which may result in sudden withdrawal from learning. To combat the limitations, it is necessary to follow certain principles including improvement in student-faculty contact, an adaptation of the active learning process, giving prompt feedback, and effective communication among teachers and students.

To enhance learning, eLearning can be used efficiently. The eLearning recommender system improves the process of reaching proper decisions regarding the course content and style implicit and by conserving the explicit feedbacks from the user. To avoid some of the shortcomings as shown in Table 1[1] are used like browsing/activity and the user interactions using the eLearning system.

Table 1: The comparison between the recommendation algorithms.

Method	Strengths	Weaknesses
Memory-based collaborative filtering	1. Implementation is easy 2. Adding new data entries is not complex	Relies on the interaction from users
Model-based collaborative filtering	1. Scalable 2. The prediction accuracy is high	Limited scalability for large dataset
Hybrid collaborative filtering	1. Improve prediction performance 2. Overcome limitations of sparsity	The high cost of the implementation
Content-based filtering	1. It ensures privacy 2. No scarcity and cold start problems.	Complex

The recommendation system for eLearning should be easy to apply for the education providers and be more accurate as much as possible. The comparison between different recommendation algorithms just proved that applying the algorithms to improve the content for the learners is a big benefit. Every algorithm can work well for the environment with or without applying the exclusive feedbacks from users. The user's preferences and choices can help to implement an easy and low-cost recommendation system. If the user does have the full picture of their need, it may require an algorithm such as content-based filtering to find suitable content based on the user interaction with the system.

Applying deep learning technology in recommendation systems can provide some other features such as direct feature extraction from the content, handling heterogeneous data. It can collect more accurate information about users and items. Applying machine learning and deep learning technologies and Artificial Intelligence (AI) can help in improving the recommendation systems by applying the streaming data from the learner interaction with the system. IoT provided many solutions in different fields (25-30) to improve life quality and provide people with a way to communicate and do tasks better. In eLearning applications nowadays IoT helped users to use smartphones to have a new experience with education.

III. CONCLUSION

The paper presented a solution the effective learning based on the interaction between the learners and the tutors. The use of VR as a smart solution in the smart city concept, and its related technological tools, can ensure that quality is perfect. This paper shows the need to work towards employing smart tools in smart cities to improve the learning process quality among stakeholders. The paper introduces a solution based on recommendation systems for eLearning systems to improve the content based on learner needs. The proposed work did not provide a solution for offline collaborative classes for learners who suffer from internet issues. In the future work to use the social network applications from the learners to give better recommendations in eLearning systems. Moreover, an offline interactive solution for education based on digital content would be a great solution. Though the current students were born in the age of digital media with high potential in learning multiple intelligence approaches, sudden transformation does not occur without consequences. The teachers are facing many challenges due to the sudden transition of new technology. Difficulties in alternative teaching practices, course delivery, assessment process, and teaching mode were the major concern for the faculties. In addition to that, a lack of social interaction seems to be a concern for the teaching-learning process.

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