

The role of the Internet of Things in the Educational System during the Corona Pandemic

Mohammad Karimi Moridani
Department of Biomedical Engineering,
Faculty of Health, Tehran Medical Science
Islamic Azad University, Tehran, Iran
karimi.m@iautmu.ac.ir

Abstract— *One of the biggest consequences of the Coronavirus outbreak in Iran and the world was universities and schools' closure. The threat of closure of educational institutions turned it into a golden opportunity to use the Internet of Things to learn and progress. This paper aims to compare traditional education and IoT-based education in the amount of learning and student participation in the classroom. A questionnaire was prepared and distributed among students participating in both educational systems to conduct this descriptive study. The data extracted from 400 returned questionnaires were analyzed using descriptive and analytical statistical methods using SPSS and MATLAB software. The paper results showed that the scores obtained by students in IoT-based tests were higher than traditional tests. The percentage of students' attendance and participation in the classroom in the IoT-based education system showed a considerable increase. The midterm exam scores, homework scores, online and quizzes, the final exam for the IoT-based and traditional education system was 2.39 ± 0.51 , 2.02 ± 0.78 , 2.50 ± 0.44 , 5.20 ± 1.86 and 1.69 ± 0.83 , 1.18 ± 1.05 , 1.55 ± 0.63 , 3.70 ± 2.26 respectively. Statistical analysis of the results showed a significant difference in the scores of students who participated in the IoT-based educational system from students who traditionally participated in classes ($P < 0.05$).*

Given the brilliant results of using IoT-based education and also some of the advantages of traditional IoT education, it can be concluded that the combination of the two education systems can cover the weaknesses of IoT-based and traditional IoT education methods, and students can benefit from IoT-based and traditional training at the same time.

Keywords— *Corona Pandemic, IoT, Educational system, Statistical analysis*

I. INTRODUCTION

Corona is a virus that has spread around the world in less than a few months and has placed many constraints on communities, especially educational systems. The Corona Pandemic (COVID-19) is a rigorous test for educational systems worldwide, and it became apparent that much of the educational system in the community was unprepared for the test. Changing classrooms from physical to smart device-based classes has shaped the online learning experience for schools and universities [1]. However, the Corona pandemic forced the educational system to embrace technology in a new and sudden way, especially smart technology and the Internet of Things (IoT) [2]. Virtual class software, webinar software, learning system management (LMS) software are examples of an educational system equipped with IoT [3].

Today, the use of information technology in education has many benefits and can provide more effective and deeper learning for a wide range of students [4]. Due to the spread of the internet in most places in the country, the need to pay attention to the educational system based on IoT is strongly

felt [5]. Today, instead of using bags full of large textbooks, students can attend the classroom with the help of smart devices and will be able to access unlimited information. Students who cannot participate in class for any reason will be able to They were able to follow their lessons at home through an Internet-based system [6].

In this paper, we try to examine the use of the IoT in education and know-how. This can create a huge change in the style and quality of education in students. In recent years, many universities in the world have invested in this field and have received good results [7]. By taking advantage of this, they have created a surprising change in the educational system. The use of the Internet of Things in education can positively affect the quality of learning and the process of education in two ways. Students can use technology to learn educational materials in a special and better way and easily understand geometric and non-geometric shapes and problems [8-9].

Virtual education is active and intelligent learning that plays a key role in the process of teaching, learning, and knowledge management, and in the future, virtual education based on electronic space will be the conventional educational method in the world [10]. A 2012 study found that other teaching methods, such as the use of multimedia, PowerPoint, could not fill the gaps in traditional education as much as virtual learning [11]. Virtual education, due to its advantages, such as its availability everywhere and at any time, changing the focus of education from the teacher (traditional education) to the student, makes this method a useful and reliable tool for teachers to provide quality education [12]. The use of information technology, especially the World Wide Web in education, is an appropriate solution to solve the problems in education. Surveys show that many Internet users (91%) use this medium for one type of distance learning [13].

II. MATERIALS AND METHODS

A. Database

To conduct this descriptive study, a questionnaire was prepared and provided to students participating in IoT-based education. Before completing the questionnaire, the formal validity of the questionnaire has been approved by the faculty members. The reliability of the questionnaire was assessed extensively by performing in a selected small group before implementation. First, the students completed the questionnaire understudy in two-time intervals with a certain interval. The results obtained from the two stages were compared with each other, and its correlation coefficient was determined. The obtained correlation coefficient is $r = 0.93$. Accordingly, according to the obtained correlation coefficient, the questionnaire's reliability was confirmed by the retest method at an acceptable level.

Then, the research results were analyzed from the data extracted from 400 questionnaires completed by students using descriptive and analytical statistical methods using SPSS and MATLAB software.

B. Proposed Method

Virtual training requires the use of smart devices equipped with the internet. In this paper, students' satisfaction with IoT-based education compared to traditional education was examined.

To compare the impact of using the Internet of Things on the educational system, all professors provided online course content and information transfer to students through virtual training on the Adobe Connect platform.

Adobe Connect software has many capabilities, including the ability to upload documents (Word, PDF, and PowerPoint), images and display them, with a whiteboard to write on it and show to others, ability to chat with all students or a specific student in the virtual classroom, audio and video conferencing to present the project, the ability to share a personal computer screen for others to use software and websites while teaching, the ability to record conferences and Sharing the relevant file, the ability to put links on the page, the ability to conduct surveys to receive student feedback and, etc.

Students could enter the virtual classroom using any smart device equipped with the internet, such as mobile phones, tablets, laptops, etc. Students could enter the virtual classroom using any smart device equipped with the internet, such as mobile phones, tablets, laptops, etc. Student evaluation

including homework score, class exam score, project, attendance, and end-of-semester exam score was considered. In each session, students could ask their questions orally online and receive answers from the instructor. It was also possible to type questions through the Adobe Connect platform. To assess the students' attention to the topics raised in each session of the class, four test questions were asked at the end of each session, and students had to answer those questions within 2 minutes. Also, Students had to upload the answers to the virtual system assignments according to the dates specified in the lesson plan. All students' grades were entered online by the professor in the system, and students could view their grades.

Given that one of the goals of IoT-based education is to encourage students to study at any time and place, these items were also carefully considered in implementing this type of education. The answers to all the questions and the individual questions were clear to the teacher and the student. Of course, the speed of answering questions is essential when a good result accompanies it in the test. This can help the professor identify the scientific quality of students by comparing their performance during several tests.

At the end of the semester, the total scores of the online exam obtained, and other evaluations (midterm, class activity, attendance, and final term) will be announced as the final grade of the course. After each test, despite the correct option's appearance, the questions raised would be fixed and explained with it in case of ambiguity. Figure 1 shows the capabilities of the virtual educational system based on IoT.

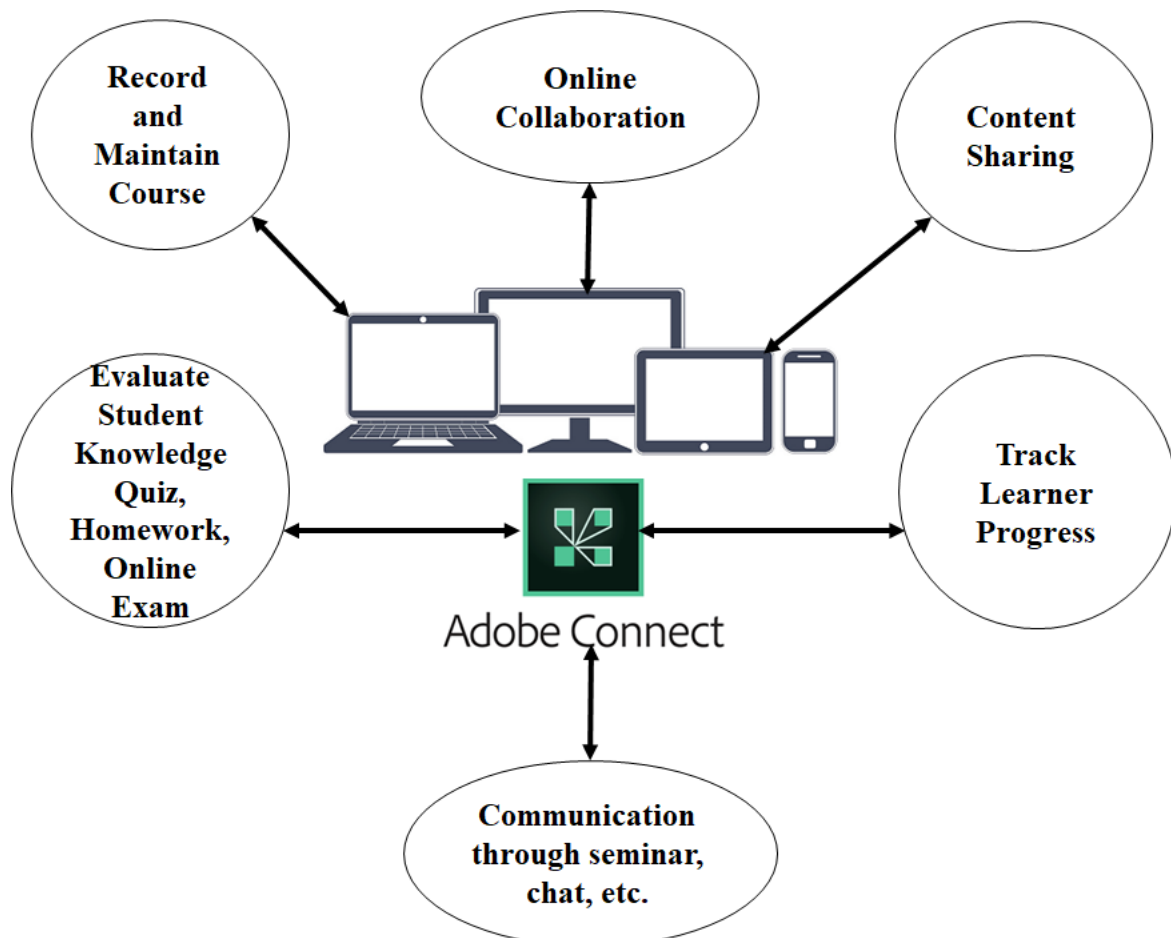


FIGURE 1. BLOCK DIAGRAM OF A VIRTUAL EDUCATIONAL SYSTEM BASED ON THE INTERNET OF THINGS

III. RESULTS

In order to compare the impact of IoT-based education on students' learning process, the final scores of students in previous semesters who traditionally attended classes, as well as the scores of class activities, midterm scores, and average attendance, were compared. Also, to match the activities and compare the effectiveness of IoT-based education in the final result of the students, all the structures, including topics, educational slides, intermediate exam content, assignments, and quizzes, were considered the same and differences in the way the class was held (virtual and interactive), how to hold the exams (online) and also receive homework (via the virtual site). The midterm exam score is 6 points, the homework score is 3 points, the online and quiz exams are 3 points, and the end-of-semester exam is 8 points. The final score is calculated from 20. The result of comparing the midterm exam according to the two methods based on the Internet of Things and traditional is shown in Figure 2. The average score obtained based on the IoT system is higher than the traditional system (score 3 is also obtained based on the IoT system). The standard deviation obtained from the IoT system is less than the traditional method. Considering that the maximum score obtained by the IoT-based training method is higher than the traditional method and the lowest score obtained in this method is higher compared to the average score of the traditional method, it can be obtained in the IoT training method student learning has increased significantly.

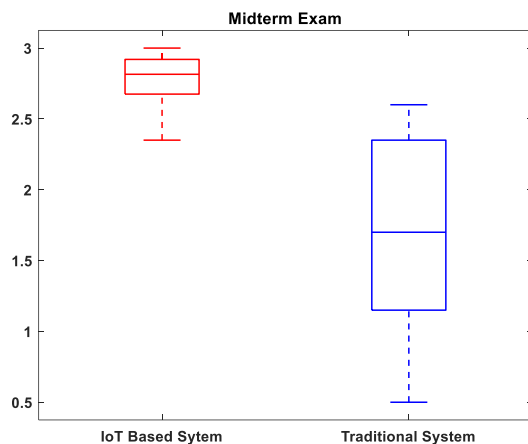


FIGURE 2. COMPARISON OF MIDTERM EXAM SCORES BASED ON IOT AND TRADITIONAL EDUCATIONAL SYSTEM

For a better comparison of the two educational systems in terms of students' ability to solve homework, Figure 3 shows a comparison of the scores obtained in this activity. Considering that the main criterion for solving homework is the student's knowledge, several students were randomly selected and orally explained how to solve homework questions in each class session. If the student could not answer correctly how to solve the question, a negative grade was considered. As shown in Figure 3, students whose educational system has been traditional is also a negative score, which is not seen in the educational system based on the Internet of Things. The standard deviation of the homework scores obtained traditionally is much higher than the IoT-based educational system. This indicates that the rate of learning has been higher due to the benefits of this educational system.

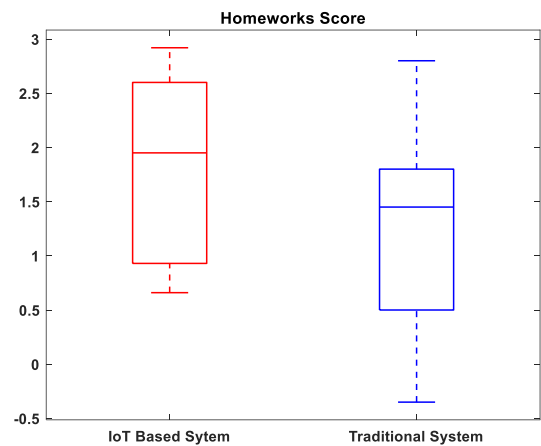


FIGURE 3. COMPARISON OF HOMEWORK SCORES BASED ON TWO IOT AND TRADITIONAL EDUCATIONAL SYSTEMS

This study showed that students' attendance in the IoT-based educational system has been higher compared to the traditional educational system so that the obtained statistics show that the average attendance of students in the IoT-based educational system is 94%. While in the traditional educational system, the average student attendance was 75%. Figure 4 shows the percentage of students attending during 16 training sessions. Considering the benefits of IoT-based education, including saving time due to not having a physical attendance at the university and reducing costs, the results showed that students also had more attendance in the class in this method of education. The lowest percentage of students in the method based on The Internet of Things (91%) is higher than the maximum number of students in the traditional educational system (90%).

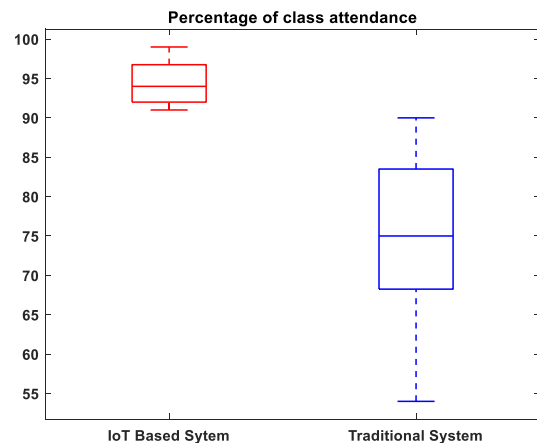


FIGURE 4. PERCENTAGE OF CLASS ATTENDANCE

Figure 5 shows online test scores and quizzes for the two training systems. The results show that students who have used the IoT-based system have higher scores, which can be attributed to many things, including the ability to browse the class's contents several times by recording and saving. Teacher teaching videos, the teacher's availability through the use of IoT-based systems to answer students' questions and possible ambiguities and, etc.

The results of the end-of-semester test for two different educational systems are also shown in Figure 6. The scores obtained by the students show the superiority of the IoT-based education system. The average grade point average for the IoT-based education system is 5.2 and for the traditional

education system is 3.7. The number of students whose scores are higher than the average score is seen in IoT-based education. This issue is less in traditional education, which indicates an increase in information and learning rate in students who have experienced IoT-based education.

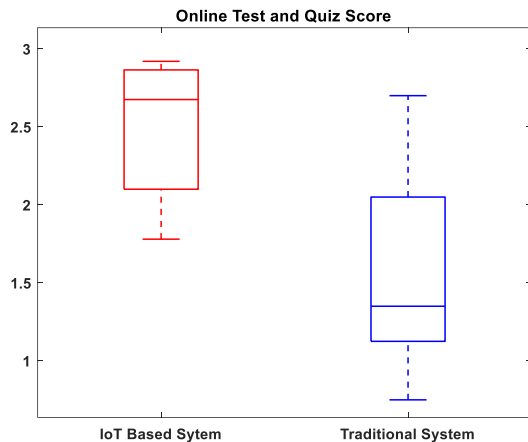


FIGURE 5. COMPARISON OF ONLINE AND QUIZ TEST SCORES IN TWO EDUCATIONAL SYSTEMS

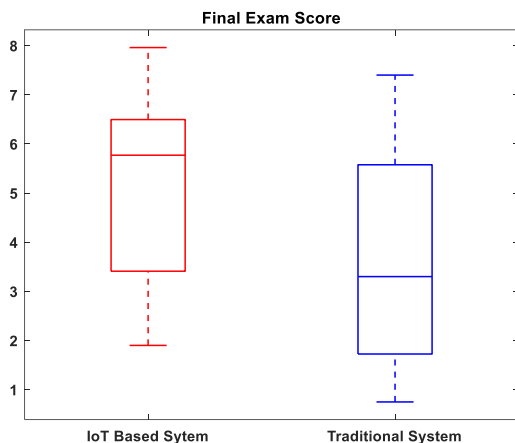


FIGURE 6. COMPARISON OF FINAL EXAM SCORE IN TWO EDUCATIONAL SYSTEMS

To compare the results, using SPSS V-23 software, data entry was performed. Then, using descriptive and inferential statistical tests (correlation coefficient and independent t-tests), the results were analyzed and compared. For statistical tests, a significance level of 0.05 was considered. Table 1 shows a comparison of students' average scores in the two systems of education based on the Internet of Things and traditional.

TABLE 1. COMPARISON OF AVERAGE STUDENT SCORES IN TWO EDUCATIONAL SYSTEMS

	IoT	Traditional	P-Value
Midterm Exam	2.39 ± 0.51	1.69 ± 0.83	0.028
Homework Scores	2.02 ± 0.78	1.18 ± 1.05	0.015
Percentage of Class Attendance (%)	94.47 ± 2.72	75.07 ± 10.87	0.003
Online and Quiz Test Scores	2.50 ± 0.44,	1.55 ± 0.63	0.026
Final Exam	5.20 ± 1.86	3.70 ± 2.26	0.037

IV. DISCUSSION

In this paper, two educational systems based on the Internet of Things and traditional were examined, and the scores obtained by students in midterm and final exams as well as homework scores, online exams, and quizzes were compared. The paper results show the significant role and impact of using the IoT-based education system to better convey lesson concepts. The increase in students' grades in the IoT-based method is also evident.

Because during the Corona pandemic, students couldn't attend university, students could take online exams remotely and anywhere, which increases the possibility of exchanging information and transmitting answers to other students. To increase the security of the exams and make the students' grades more realistic, the following measures were taken:

- The questions appeared randomly for the students.
- Moving the test question options randomly for each student
- The time for answering each question was considered to be a maximum of 30 seconds
- It was not possible to review the questions, and after answering each question, it was not possible to go back and view the previous questions

There are several benefits to using an IoT-based education system, including [14]:

- No need for physical presence and travel
- Less cost than the traditional educational system
- Ability to record the professor teaching videos and watch again for more mastery of lesson concepts
- Online test scores are provided privately and at the same time as the end of the test, while in the written and traditional test, it may take longer to do so after the test.
- This method preserves natural resources due to reduced paper use
- Learning under such conditions is independent of time and place and will become a dynamic and lively process.

Numerous studies have examined different approaches to the use of the Internet of Things in students' progress, which have also confirmed the progress of volunteers in the subjects under study. Of course, this does not mean that traditional education is inefficient and should be wholly abandoned.

Long-term use of IoT-based methods can endanger users' health. Constant use of intelligent devices causes inactivity and various diseases, including overweight, spinal problems, etc. Socially, a decrease in human communication and interaction with individuals can isolate students and decrease self-confidence in the future. Because IoT-based training is required for the internet, in the event of a technical problem or disruption to the internet's quality, it can be challenging to hold this training at a specific time and with the desired quality [15]. To strengthen IoT-based education and solve the problems and disadvantages of this method, we must first teach the culture of using electronic devices in the form of training workshops with the help of experienced and specialized professors to reduce the weaknesses of this type of training method, use Improved virtual learning capabilities; Reducing Internet usage costs and increasing bandwidth for users, along with the culture of use, can be effective in developing this method [16-17].

V. CONCLUSION

The advent of new information technologies to educational institutions (from schools to universities) and even homes have transformed simple teacher-student

relationships in general. In this way, traditional learning patterns have evolved, and users are exposed to vast knowledge and information.

Traditional universities have to adapt to new developments and changes. In the new environment, the role of coaches and professors will change. They will mostly play the role of facilitator and educator or educational designers.

Therefore, it is necessary to change or design and set up appropriate educational management systems. Distance education systems are considered as a tool for continuing education, and these training can include teachers and students of any age, geographical location, social and political status, and with any kind of education.

Education, like other interactions, has been and will be influenced by these technologies. Up-to-date content is one of the features and benefits of e-learning. The formal and written content taught in university and School is often outdated and from years past. Sometimes teachers also get bored of teaching such content, but external compulsions force them to teach it. Fortunately, there are no such compulsions in the IoT-based educational system. Teachers produce content individually or in teams, tailored to the subject matter, and then upload it to their students in cyberspace. Because in the IoT-based education system, the professor can evaluate the students with different tools, and this diversity makes students more willing to participate and try. Students' stress is reduced in IoT-based education, and they are more likely to follow the class. In this way, the student speaks calmly and without worries, and can express all their ideas and gradually gain the power to communicate in real space.

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