The Importance of Using the Internet of Things in Education

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Abstract—The subject of the Internet of Things is very important, especially at present, which is why it has attracted the attention of researchers and scientists due to its importance in human life. Through it, a person can do several things easily, accurately, and in an organized manner. The research addressed important topics, the most important of which are the concept of the Internet of Things, the history of its emergence and development, the reasons for its interest and importance, and its most prominent advantages and characteristics. The research sheds light on the structure of the Internet of Things, its structural components, and its most important components. The research dealt with the most important search engines in the Internet of Things, the steps of designing Internet of things systems. Among the important topics included in the research are the use of Internet of things technology in the educational field, the role of the Internet of things in solving education problems, and the most important applications of the Internet of things in education and its importance for students and teachers. Also indicated the contribution of the Internet of Things to ensuring sustainable development, environmental protection and the most important areas of application of the Internet of Things. The research sample amounted to (152 teaching staff) from Iraqi Universities and their academic achievement (84 Ph.D., 68 Master's, 42 Bachelor's) from (17) different scientific specializations; and (42 students). The number of respondents who use the Internet in education is 191 and the number of those who do not use the Internet and teach in person is (3) from (194) person. Students and professors use smartphones in study and teaching at a rate of (97.42%) and computers and their necessities at a rate of (92.27%) are higher than electronic devices and equipment including the smart board (11,86%). Use of IoT technology is of great and medium importance in providing electronic lectures effectively, with a percentage of 96.91%, the use of it has a large and medium role in solving education problems in giving lectures in light of health crises, especially in light of the Coronavirus crisis. Availability at the local and global levels, whether with the appropriate content or the selection of professors anywhere in the world, at a rate of 98.45%.

Keywords—notifications, data, homes, cars, networks, platforms, systems, technology

1   Introduction

Internet of things technology has gained the attention of a large number of researchers in computer science and other disciplines, both scientific and human, due to its importance in various fields of life, especially educational ones, due to the important services it provides to most educational institutions [1, 2]. Given the importance of the subject, the researchers chose to study the Internet of Things, clarify its applications, indicate its importance in education, and identify students and professors as the focus of the educational process. The Research problem lies in the following two questions: What are the applications of the Internet of Things in education; and What is the importance of IoT technology for students and teachers? A statement of the concept of the Internet of Things, its origins, and its importance. A statement of the applications of the Internet of Things in education. Explanation of the role of the Internet of Things in solving education problems. Explain the importance of the Internet of Things for students and teachers. The questionnaire was distributed to a random sample of Iraqi universities students and professors through social media groups (WhatsApp, Telegram, and Viber).

In [3], the research paper seeks to clarify what is meant by the Internet of things and to indicate its characteristics and areas of application. And clarifying the justifications that call for the need to benefit from the technology of the Internet of Things in the educational field and the areas in which the Internet of things can be used to develop the services and activities of educational institutions and clarifying the challenges facing the use of the Internet of things in the field of education. The research came out of the recommendations, including increasing awareness of the importance of the role of the Internet of Things in developing the services of educational institutions, and allocating many discussion panels and seminars on the subject of the Internet of things and its services and benefiting from its advantages to solve educational problems. B. Walid Youssef Mohamed Ibrahim and Rania Atef Shorb, Internet of Things Technology IoT: Concept and Educational Applications (2). The research paper deals with the Internet of things in terms of the concept and statement of the main components and requirements of the technology of the Internet of things from devices, protocols, middleware, applications, presentation, and distinctive characteristics of Internet of things technology and its advantages and a statement of educational services within universities, including smart education and smart classes. C. Jamal bin Matar Al Salmi, Khaled Ateeq Saeed Abdullah and Abdullah bin Salem Al Hinai, The Role of the Internet of Things in Knowledge Management in Information Institutions (3). This research paper seeks to highlight the role of Internet of Things applications in supporting knowledge management activities in information organizations and thus improving their services. The research relied on the descriptive approach, and through the investigation and analysis of the intellectual output published in the Arab world and abroad, to extrapolate the areas of the relationship between the Internet of Things and knowledge management activities in information institutions. One of the recommendations of the research is the need to take advantage of the Internet of things in information institutions to keep pace with the technological changes that are taking place and to invest in the Internet of things applications for better service and to benefit from the huge data available to them in making appropriate decisions. The advantage and benefits of the current research paper compared to previous studies: The research paper was distinguished

from previous studies by showing the importance of using IoT technology in education by taking the opinions of a sample of students and professors in Iraqi universities, as well as stating the role of IoT in solving problems facing education. The benefit of previous studies was to write the theoretical framework for the research

2   The theoretical framework of the research

2.1   The concept of the Internet of Things

The Internet of Things means that all the devices and gadgets that we use in our daily lives can connect to the Internet and are managed through the mobile application of smartphones, through a computer, or through control devices that are also connected to the World Wide Web. This means that these devices collect data, learn about user decisions, are remotely managed, get updates, and rely on the Internet to communicate and function [4, 5]. In other words, Internet connectivity is no longer limited to smartphones and computers in its narrow and traditional sense, but rather includes televisions, surveillance cameras, house and room keys, home entertainment devices, sports equipment, electronic panels, cars, etc. An IoT "thing" can be any object that has the required computing power, Internet connectivity, and the ability to collect and transmit data over a network without assistance or manual intervention. The technology embedded in the organisms helps to interact with the internal states or the external environment, which in turn affects the decisions taken as in Figure 1. [6, 7]. The Internet of Things "is a modern technology that aims to connect all electronic devices via the Internet so that they can communicate with each other through special protocols, and also communicate with humans by sending text messages. In this technology, communication is a device with a device or a device with a human or A human with a device, and often the human is the endpoint [8]. It is an emerging global Internet-based information architecture whose purpose is to provide an information technology infrastructure to facilitate the safe and reliable exchange of goods and services. That is, its function is to overcome the gap between things in the physical world and to represent it in information systems [2, 9].
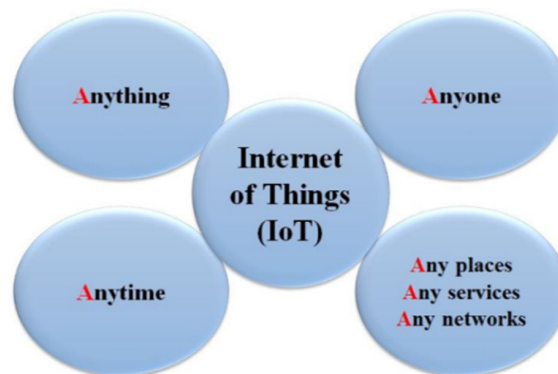

Fig. 1. Internet of Things concept

It is a modern terminology that focuses on the future of the Internet, its uses, and advanced applications based on the Internet. Kevin Ashton is the first to use the term "internet of things" in 1999, and he is one of the pioneers in the field of technology. He is the founder of the first research center at the Massachusetts Institute of Technology. This term means that things will be able to be more useful with less effort by enabling them to communicate with each other through the Internet [10–12]. Ashton expressed IoT in his quote from the RFID Magazine article "If we had computers that knew everything using the data collected without human intervention we would be able to track and account for everything and greatly reduce loss and cost" [13, 14]. The researchers define the Internet of Things procedurally; it is a modern technology that connects various devices and equipment to the Internet and facilitates the process of interaction and communication between teachers and students to transmit data and information electronically over the network without manual intervention.

2.2 The emergence of the Internet of Things

The idea of the Internet of Things emerged as an initiative in 2000 by Kevin Ashton to improve supply management by connecting RFID tracking data to the Internet, at his workplace at Proctor & Gamble. While working there, Ashton had the idea of putting a PFIC tag on lipstick and connecting it to a wireless receiver so he could monitor sales and inventory and signal when additional storage was needed. He assumed that such collected data would help solve many problems in the real world. The term was then used in theses by Neil Gere Shenfield, who was talking about similar ideas from the Massachusetts Institute of Technology's Media Lab in his book When Things Begin to Think [15, 16]. In January of the same year, the Korean electronics company LG announced the first refrigerator with the Internet of Things technology. In 2005, the International Telecommunication Union approved the research and development of the Internet of Things and published this in the annual report for the year 2005. In 2008, the International Internet of Things Union, called IPSO, was formed to promote the use of the Internet of Things protocol on network-connected devices in energy consumption. By 2009, the concepts and applications of the Internet of Things dominated a large part of the research and academic studies and the applications that tried to benefit from it. There are more things connected to the Internet than the number of people connected to the same network. In 2012, the sixth version of the Internet protocol was released, which made it possible to assign a private address to everything on this earth without restrictions or obstacles. Thus, we guarantee the possibility of connecting millions of devices [17]. The Internet of Things can operate through the use of smartphones, other handheld devices, generations of mobile data transmission services, as well as the use of software that relies on satellite systems or GPS remote sensors. Researchers in the field of the Internet of things have been able to develop tools, software, and the language of communication via the Internet among themselves, which has led to today's access to what is known as the Internet of Things. Internet things are all tangible physical things (smart things) that are linked together over a network and can be identified on the Internet by sticking a clear and static IP address on the car, TV, Google goggles, and various household items such as refrigerators, washing machines, alarms, home entrances, and home appliances. Air conditioning, the goods, and products available on the shelves of

shops and on the animals on the farms, and everything we want to control, monitor, or deal with through their electronic understanding through software and sensors that can connect to the network. So these things can collect and share data. And the human being in this case is the beneficiary of all these understandings and communications between things that are communicated to each other over the Internet. It can even be monitored and controlled online by a mobile smartphone app. All these things in airports, roads, shops, hospitals, schools, universities, at home, and at work are under control and can be managed and controlled via the Internet of Things by a mobile phone or any other means connected to the Internet [18, 19].

2.3 The importance of the Internet of Things

Interest in the Internet of Things, in general, is due to several reasons, including The Internet of Things works by linking things together through a private identity. The applications of the Internet of Things are not very different for workers in information institutions who have previously dealt with RFID object tracking technology, as they are similar in tracking things through remotely connected sensors. However, the difference here is that the communication between things and devices is via the Internet of Things through the Internet. The Internet of Things is an effective way to overcome some of the problems facing the learner and helps him to overcome the barriers of time and space and enables remote control of learning management successfully. The Internet of Things can help strengthen the relationship between the student and the teacher so that each of them can reach each other through IoT applications without the need for an actual interview. The teacher will be able to give an order to the textbook or the teaching aid to move towards the side where the student or students are in the classroom if the specialized robots that carry out the request are available. Every human being today expects to have a smartphone on which he uses applications for multiple services. The school can, through its application, provide the opportunity for learners and parents to communicate with the school via the Internet and use its electronic resources, attend classes, participate, express an opinion, and give commands to the devices available in the school to turn on or stop, or the like. It can also be tracked and its data collected through the sensors installed on those objects. Enterprises can use this technology to reduce production costs by increasing cooperation and automation between machines instead of workers. Organizations can provide more efficient, diverse, and real-time offerings based on real-time data collection from users. Institutions must change their policy in advertising their goods to potential customers and deliver those offers to the user at his doorstep through his smart mobile device at a record and convenient time. The Internet of Things offers an effective means of effective marketing its services through communication between its holdings. Rapid, sensitive, and secure response to achieve the information needs of the beneficiaries within the Internet of Things network. Raising the productivity of devices and systems by increasing the accuracy of data handling, remote implementation of operations, and less reliance on the human factor. Increasing the level of availability within information systems by improving their ability to perform their work and the speed of access and obtaining information through those things. Enabling the delivery of things anytime and anywhere for someone who uses IoT network services perfectly. Develop reference services and allow users to conduct reference questions and get answers from within the Internet of Things.

Ensuring the users' access within the Internet of Things network to view the resources and information sources through their authenticated and defined identity, and sometimes also through additional codes that are defined. Facilitate the process of saving and storing resources through cloud computing and fog computing systems, through which information resources and sources are controlled, monitored, monitored, and controlled, and their data is accurately and permanently received. The ability to sense things and give appropriate alerts, warnings, and reports about them through its ability to process and analyze data, and continuously monitor, track and make smart decisions [20–24].

2.4 Advantages of the Internet of Things

1. Data: The Internet of Things provides a lot of information that helps us to make the right decisions at the right time.
2. Time: IoT technology saves a lot of time by providing accurate information at the right time and in the fastest time.
3. Economic: IoT technology is very economical depending on the application scenarios.
4. Tracking: IoT helps in tracking or monitoring various physical objects which in turn saves time and money.
5. It contributes strongly to saving time, effort, and money by enabling the individual and the organization to remotely control things to implement what is required of them accurately, in addition to the possibility of understanding things among themselves through sensors that communicate with each other via the Internet. This achieved many results that contributed to saving time, effort, and money.
6. The human being is liberated from the constraints of time and place, where he can manage and control things through the Internet protocol without the need for him to be in the same place; and without his direct intervention in many cases, if he gives instructions in advance. [24–26]

These are some of the services that can be provided by the IoT and are considered among its advantages:

1. Monitoring Manufacturing Equipment: Optimize processes with Industrial Internet of Things (IoT) technologies. Use advanced sensors and analytics to predict needed maintenance and reduce unplanned downtime that cuts into production time.
2. Monitor customer equipment: New business models are designed that provide predictive maintenance and performance monitoring for the equipment they produce; which provides a better customer experience.
3. Field Service Improvement: Access sensor data to improve field service scheduling ensuring that the right technicians and tools are deployed before potential problems become a major problem.
4. Optimizing the use of natural resources: IoT application of scenarios ranging from energy to agriculture to deliver environmentally friendly energy transmission and efficiencies at lower prices to customers.
5. Create safer cities: Connect better traffic management infrastructure, make emergency systems more efficient, and reduce police and emergency medical response times.

6. Creating Smart Buildings: Linking building devices and systems together to provide more efficient operations and control capabilities for building owners, managers, and occupants.
7. Improving field service: Improve service efficiency, from repairing broken streetlights to maintaining traffic lights to improving garbage truck lanes. [27]

2.5 Characteristics of the Internet of Things

This system is characterized by a set of characteristics, the most important of which are:

1. Interaction: About the Internet of Things, it can be anything that is interconnected with the global information and communication network infrastructure.
2. Heterogeneity: It is one of the main characteristics of the Internet of Things (IoT) network based on its connection to different device systems and networks, where they can interact with other devices or service platforms across different networks; this supports the basic design requirements of the Internet of Things and its environments, in scalability and interoperability.
3. Dynamic Changes: The state of the connected devices within the Internet of Things network changes from the state of connected or disconnected. Also, in the context of devices including location and speed, addition, the number of devices can change dynamically, the people connected to them, and the weight of the connection.
4. Things-Related Services: Able to provide things-related services within the constraints of things such as privacy protection and semantic consistency between physical things and the virtual things associated with them.
5. Intelligence: The Internet of Things comes through a set of algorithms, software, and hardware that are linked to form an intelligent network whose capabilities are enhanced by surrounding intelligence. Which facilitates things through intelligent response to a specific situation and supports it in carrying out specific tasks, including achieving interaction between the user and the device through standard saving methods and a graphical user interface.
6. Sensing: The Internet of Things relies in its infrastructure on digital sensors and sensor applications that detect or measure any changes in the environment and give alerts and reports on their status, or even interact with the environment. Remote sensing techniques provide a means to create capabilities that reflect true awareness of the physical world and the people in it.
7. Connectivity: The Internet of Things (IoT) enables interconnection through network accessibility and compatibility, the shared ability to consume and enhance data production through collective intelligence, and provides intelligent communication between smart applications and humans.
8. Enormous Scale: The Internet of Things is characterized by massive capacity or scale. As the number of devices within the IoT network that need to be managed and that communicate with each other at least is greater than the devices connected to the current Internet. In addition, the management of the data generated and interpreted for application purposes is related to the semantics of the data, as well as the efficient processing of the data.

9. Safety: The Internet of Things (IoT) network is designed for the security of personal data and associated objects and to secure data transmission points within networks from attacks and pollutants through an expansive security model.
10. Energy: It relies on energy efficiency and its devices do not require much energy, to enable the Internet of Things network to operate with the least energy possible to ensure its continuity in work and remote places.
11. Connectivity: The devices and sensor systems are connected through the Internet or any other network.
12. Communication: Connect devices so you can communicate and analyze data.
13. Intelligence: It is the perception aspect provided by the Internet of Things devices, through remote sensing and data collection that is analyzed.
14. Action: It is considered the most important step as it monitors and discusses the phenomenon based on previously collected data, as happens, for example, in temperature change decisions.
15. Ecosystem: Providing the appropriate environment for the presence of this technology, by providing the Internet for everything and choosing the appropriate platform.
16. User Interfaces: Smart objects can communicate with people appropriately, either directly or indirectly.
17. Localization: Intelligent objects are aware of their physical location or can be located, and mobile phone networks are suitable technologies to achieve them.
18. Embedded Information Processing: Smart objects have a processor or controller, and in addition to storage capacity, these resources can be used to process and interpret sensor information.
19. Identification: Objects are identifiable by a reader medium such as RFID or a mobile device [28].

2.6 Using Internet of Things technology in the educational field

The Internet of Things improves education itself and contributes to the improvement of the physical and structural environment. A smart school has facilities that operate smoothly to provide a higher level of personalized learning. And smart devices that are used in the educational institution use a Wi-Fi network to send data and receive instructions, which helps to create smarter lesson plans. Keeping important resources on track and improving access to information, contribute to rapid communication between students and teachers in and out of the classroom anytime and anywhere. Therefore, many educational institutions have begun to realize the importance of introducing technology and integrating it, especially the Internet of Things, in their daily educational methods. There are some reasons and justifications for taking this step. The most important justifications for calling the use of the Internet of Things in education are as follows:

1. The education sector is always at the forefront of sectors that employ modern technologies at its service, as this sector represents the main pillar upon which the trends of the knowledge economy are built, which is the most prominent front for major economies in the coming years.

2. The technology of the Internet of Things and its applications in education has given and will give many advantages and benefits to each teacher, student, and school, and contribute to the tangible practical clarification of the educational process in a way that raises and raises the quality of education, and its outputs are what the country needs in terms of qualified human resources.

3. The applications of the Internet of Things in the field of education make the practical reality of educational institutions at all levels in line with everything new and modern in the areas of technology applied in practice in education in many countries of the world.

4. Experts expect the Internet of Things to change how schools, universities, and teaching and learning institutions work, and bring about an anticipated revolution in all stages of work, from teaching, guiding, learning, managing, following up, and communicating among all members of the educational process to self-managed customer services. Rather, it will be able to connect all parties to the digital network, which means that it can be monitored remotely even after completion of studies and graduation.

5. The Internet of Things is the future technology that all fields await, including educational institutions, and major institutions are racing to explore its depths and reap its fruits. Several institutions and technology companies are racing to spread and popularize the Internet of Things in all areas of our lives. So we can say that the Internet of Things will become a global force, and this technology has achieved an unprecedented connection to the digital network that included people, machines, tools, and "things" in general. These communications allow companies to monitor most of the operations that take place around us.

6. They contribute to ridding us of simple, repetitive tasks daily, focusing on important matters, and leaving machines to do repetitive tasks.

7. IoT technology enables us to automate and comply with ever more stringent international industrial regulations, codes, and standards, by improving movement within a facility, and tracking hazardous materials, components, and other products. As well as the management of vital contact points, especially in the field of food processing. However, the current price of this technology does not help much to improve the cost.

8. This technology provides a rich and flexible platform for students, teachers, administrators, and others to explore, learn and interact with the educational system in a super-intelligent environment.

9. Advanced technology helps students learn new things by supporting educational goals. It allows students and teachers to share documents online and make changes in real-time on the screen, helps teachers organize all student resources, and helps record lessons directly on the computer. It also helps students to access any information they need through a single search of one of the search engines.

10. Technology helps students communicate with teachers using different methods, it helps teachers to keep track of all students, assign them homework through various online tools and track their performance. Teachers stay in touch with students all the time and eliminate any communication gap between them. Technological use of technologies helps students take on multiple roles and take responsibility for

learning and gives them freedom of expression and work in a modern and safe environment.

11. Contribute to education anytime and anywhere, as things play a vital role in building society using different platforms on the internet, advanced technology helps teachers monitor students' progress, making it possible for learners to gain knowledge from anywhere and at any time. It allows students and teachers to keep in touch via various means, check out upcoming media and events away from the classroom, and even respond to jobs. It is one of the applications that provide a secure network and complete privacy as it allows to store unique ideas and ensure complete confidentiality [29–30].

2.7 The role of the Internet of Things in solving education problems

a. Availability in Wide Geographical Coverage: Wired and wireless networks now cover most of the population, creating unlimited platforms that increase availability. Here, the Internet of Things helps learners globally to make available locally and globally, whether with the appropriate content or by choosing teachers anywhere. The solutions offered by the Internet of Things allow a large number of learners in China, for example, to learn English through text messages and audio lessons, despite the scarcity of specialized and qualified local teachers.

b. Timely Availability, Autonomy: The Internet of Things offers educational alternatives anytime and anywhere, unlike traditional classrooms. For example, in some isolated villages, some university professors deliver lessons through podcasts that allow learners to access them anytime and anywhere and learners interact with them through text messages in an independent way for each learner in the learning process.

c. Adaptation: Educators can use IoT technology to adapt education to each learner individually, unlike the one-to-many method that provides the average needs of the group and, accordingly, reduces the importance of adapting education to the group of learners, the Internet of things helps to change that by:

  1. Customization: Each student has his learning style and a different learning speed. Therefore, teachers are often unable to follow up and respond to these differences in the learning style and speed of learners' achievement. Here, we find that the Internet of Things (IoT) technology can provide real data directly at the same time as learning through simple formative assessments via wireless technology, which helps teachers to adapt and customize education for each student individually. For example, interactive learning methods allow different ways of adjusting the difficulty levels, number, type of hints, etc, for students based on observing their different reactions to many problems.

  2. Collaboration: Students often understand and apply concepts best through discussion and collaboration with their peers. However, traditional learning environments do not allow this, especially with large class sizes. So IoT helps learners get their content, share it with peers, and share different learning paths through collaboration [31–32].

2.8 Applications of the Internet of Things in education

IoT has contributed to the development of many services that contribute to the development of the educational process, including the following:

1. Smart education: Smart education is a special teaching method that is completely different from the traditional method, where the teacher can add a lot to the educational process through various means with the help of electronic tools and helps the learner choose from a wide range of educational aids, and provides quality content on 24 x 7 range.
2. Smart Classroom: The smart classroom is the place for comprehensive educational activities and where there is learning, teaching, and assessment all happen differently and effectively. The Internet of Things also provides the ability to control smart classroom components of electronic gadgets, such as a digital screen, projector, and Internet-enabled devices that enable smart learning to be managed successfully.
3. A better educational experience, as the main function of the Internet of Things, is to enable understanding between things, such as understanding one device with another, and it saves the time and effort of the teacher in connecting, managing, and controlling devices, and helping him to provide a distinctive learning experience that can be transferred to learners.
4. Proof of attendance: Each student is verified on a dedicated cloud application using data collected from each student's RFID reader or scanner.
5. SMS Alerts: Automated receipt and access alerts are sent to parents via mobile phone.
6. Smart School Bus Management School vehicles can be effectively tracked and managed, and the bus's compliance with the road is monitored. A student's parent or principal can get alerts when a bus driver is off the road to refuel, time, and other transportation safety with the help of smart IoT technologies. And the ability to track live by displaying the bus journey live on the map, allowing more visibility for safety.
7. Emergency management: In the event of an emergency, safe paths can be identified inside the school for students to cross safely, and school buses can be routed on the road at the time of accidents or disasters. In addition to detailed information about students, such as blood type, home address, parent's phone, sensing fires inside laboratories, halls, classrooms, room temperature sensors, the nearest ambulance point, and so on. With many students in educational institutions, monitoring them is a difficult task, moreover, students in educational institutions are more vulnerable so smart security should be used compared to employees in their workplaces. The Internet of Things can greatly enhance the security of schools, colleges, and any other learning centers. With the help of technologies such as 3D positioning, students can be monitored 24/7 and their presence reported at any time in addition to providing the option of distress buttons, with these technologies the alarm can be sounded when needed. And wireless door locks that can control the doors of educational institutions remotely.

8. Improving operational efficiency in educational institutions that have many common stakeholders and the Internet of Things, thus helping to manage those relationships efficiently in terms of tracking students, staff, resources, equipment, and devices. The operation of these things can be effectively managed by implementing effective operational management process techniques that lead to overall success across IoT applications.

9. Reducing the cost: The main expenditures in the educational process represent a large proportion of the budgets of countries that consider education one of the basics of nation-building. The obsession with controlling these expenses and reducing them in a way that does not affect the quality of education remains a real concern, and when the Internet of Things is applied in the educational process, it leads to enabling automatic communication between the educational sectors and the different systems and things in them. It will automatically enhance the ability to closely monitor, thus reducing overall expenses.

10. RELIABILITY IoT applications enhance the reliability of the system and its components and the ability to manage them efficiently.

11. Educational applications: educational applications that benefit from the Internet of Things can be considered powerful creative tools that are transforming the normal way of teaching and learning. It also enables teachers and students to create 3D graphic books that feature videos and the ability to take notes. In addition to the large number of educational games it provides. Where these games provide many features that offer interesting possibilities in teaching and learning and this is what can develop the desire to learn more than ever. The educational applications that can be provided through the Internet of Things are many and varied, and the most prominent of these applications are poster boards that have been developed using the Internet of Things, where they are using multimedia stickers, as it is possible to easily create virtual posters that combine images, audio, video, text, and hyperlinks. Smartboard applications can help teachers to explain lessons more easily with the help of online presentations and videos, students are encouraged to treat interactive games as a powerful platform. Web-based tools and software help students learn more effectively [33–35].

12. Increasing Efficiency In many schools and colleges students spend a lot of time on activities that do not add any value to the primary purpose of their actual existence. For example, attendance of students should be taken several times a day and additionally, this data should be sent to the central office for various purposes. But the Internet of Things can put an end to this inefficient system. With the help of IoT circulating devices, this data can be collected and sent to the central telephone server automatically eliminating the need for any human intervention. Due to this revolutionary shift towards the Internet of Things, the tedious tasks of teachers and students can be reduced allowing them to focus more on teaching and learning [36–42].

13. Smart Classroom: Internet of Things technology can control smart classroom components from electronic tools such as digital screens, smart board control, tablets, printers, e-books, student ID cards, projectors, and Internet-enabled devices, which successfully achieves smart learning [34–36].

3 A practical framework

This framework deals with two axes. The first axis analyzes the characteristics of the research sample in terms of achievement, type of work, and general and precise specialization. The second axis provides an analysis of the data of the answers of the research sample to the questions of the questionnaire, which included (6) questions and was distributed to a random sample of professors and students of Iraqi universities and amounted to (194) individuals; after it was presented to a group of experts to prove its sincerity. It was prepared electronically according to Google Forms, the form https://forms.gle/4rjN2f7Zs68jGQbZ9 and sent via social media groups (WhatsApp, Viber, Telegram) to university students and professors.

3.1 The first axis: analysis of the characteristics of the research sample

A-The academic achievement of the respondents: Table 1 shows the academic achievement of the respondents, where the category of Ph.D. holders represented the highest and most prominent category of those who answered the questionnaire. Their number was (84) or 43.30% of the total. The second place was for those who obtained a master's degree, as their number was (68) with a rate of 35.05%, and the third for a bachelor's degree was (42) with a rate of 21.65%.

Table 1. Academic qualification of the respondents

No.	Academic Achievement	Number	Percentage
1	Doctorate	84	43,30
2	Master	68	35,05
3	Bachelor	42	21,65
Total		194	100%

B-Type of employment: Table 2 shows the type of work of the respondents. Where it represented the highest number and percentage of the category of teachers, as their number reached (152) and a rate of 78.35%. The student category ranked second, with several (42) and a rate of 21.65%.

Table 2. Type of work for respondents

No.	Type of Work	Number	Percentage
1	152	152	152
2	42	42	42
Total		194	100%

C-General and specific jurisdiction: Table 3 shows the type of general and exact terms of reference for the respondents. Where it represented the number of specializations (17) specialization. The highest number and percentage of history specialization was (34), with a rate of 17.53%. Then the specialization of educational and

psychological sciences, as number reached (31) with a rate of 15.98%. Then the Arabic language specialization, as their number reached (24) with a rate of 12.37%. The lowest percentage was represented by the specialization of physical education and specialization of education (kindergartens), as their number reached (1), at a rate of 0.55%.

Table 3. The general and specific specialization of the respondents

No.	Specialization	Number	Percentage
1	History (ancient, Islamic, modern, contemporary)	34	17.53%
2	Educational and psychological sciences (educational administration, educational psychology, measurement and evaluation, curricula and teaching methods, developmental psychology)	31	15.98%
3	Arabic language (linguistic studies, literature, language, rhetoric, and stylistics)	24	12.37%
4	Islamic sciences (Quranic studies, Tafseer, Islamic jurisprudence, hadith, theology, Islamic faith)	22	11.34%
5	Geography (natural, human, methods of teaching geography)	21	10.83%
6	Science (physics, chemistry, biology, botany, science teaching methods)	17	8.76%
7	Information and libraries (information services, information technologies, libraries)	14	7.22%
8	English (literature, linguistics)	11	5.67%
9	Kurdish Language (Methods of Teaching of the Kurdish Language)	4	2.06%
10	Medicine (surgery, dentistry, veterinary)	3	1.55%
11	Media (digital media, press, radio, and television)	3	1.55%
12	Common Law (criminal procedure, civil law)	2	1.03%
13	Agricultural engineering (horticulture and landscaping, animal production)	2	1.03%
14	Management and Economics (Management, International Economy)	2	1.03%
15	Arts (Design, Architecture)	2	1.03%
16	Physical education (physical movement)	1	0.51%
17	Education (Kindergarten)	1	0.51%
Total		194	100%

3.2 The second axis: data analysis of the answers of the research sample to the questionnaire questions

1. Do you use the internet in education? Table 3 shows the number and percentage of respondents who use the Internet in education. The number of those who use the Internet (191) represented 98.45%, which is the highest percentage. The number of those who do not use the Internet and teach in person is (3), at a rate of 1.55%.

Table 4. Number and percentage of respondents who use the Internet in education

No.	Answer	Number	Percentage
1	I use the internet in education	191	98.45%
2	I do not use the internet in education	3	1.55%
Total		194	100%

2. Identify the electronic devices and equipment you use for education: Table 5 shows the electronic devices and equipment used by students and professors in teaching. The highest number and percentage of those who use the smartphone was (184) individuals, at a rate of 97.42%, and the lowest number of those who use smart panels was (2) individuals, at a rate of 1.03%.

Table 5. Electronic devices and equipment used by the respondents for education

No.	Equipment	Number	Percentage
1	Mobile phone	184	97.42%
2	Computer	179	92.27%
3	Electronic and interactive information sources	35	18.04%
4	Digital display	26	13.40%
5	AI	24	13.37%
6	Smart Board	23	11.86%
7	Digital Pen	18	9.28%
8	HD TV	5	2.58%
9	Other equipment	3	1.55%
10	Tablets	2	1.03%

Notes: The answer to other devices and equipment, please mention them: the respondents mentioned (advanced presentations (data show), electronic classes, and specialized electronic programs).

3.3. Determine the importance of using Internet of Things technologies in education: Table 6 shows the respondents' answers about the importance of using Internet of Things technologies in education. Where it represented the highest importance (providing students with academic courses and their sources) with a number (147) and a rate of 75.77%. Of great importance, is number (35) with a rate of 18.04%. The least important (guaranteeing students' participation in various electronic and interactive educational activities) was represented by the number (81), with a rate of 41.75%. Of great importance, with a number (of 22) and a rate of 11.34%, it is not important.

Table 6. Respondents' answers about the importance of using Internet of Things technologies in education

No.	The Importance of Using IoT	Very Important		Medium Importance		Not Important	
		No.	%	No.	%	No.	%
1	Providing students with courses and their resources	147	75.77	35	18.04	12	6.19
2	Giving electronic lectures at the appropriate times	141	72.68	38	19.59	15	7.73
3	Effective presentation of educational content using modern presentation technologies	135	69.59	44	22.68	15	7.73
4	Ensuring speedy performance of assessment tests and obtaining immediate results	135	69.59	38	19.59	21	10.82
5	Effectively presenting electronic lectures	134	69.07	54	27.84	6	3.09
6	Recording electronic lectures and making them available to students	122	62.89	63	32.47	9	4.64
7	Digital simulation for all students regardless of where they are	112	57.73	63	32.47	19	9.79
8	Ensuring the participation of all students in the lectures and preparing lists for that	106	54.64	69	35.57	19	9.79
9	Ensuring the participation of students in groups and making the educational material available to them	106	54.64	72	37.11	16	8.25
10	Ensuring students' participation in various electronic and interactive educational activities	81	41.75	91	46.91	22	11.34

3.4. Determine the role of using Internet of Things technology in solving education problems: Table 7 shows the respondents' answers about the role of using Internet of Things technology in solving education problems, as the highest paragraph (giving lectures in light of crises, especially the spread of infectious diseases in light of the Coronavirus crisis) represented a significant role with several (156) and a percentage of 80.41% and represented the highest paragraph (the ability of the professors to adapt to the students and identify their levels and assign each student a special learning style). Of the paragraphs that have no role in solving problems, a number (28) and a percentage of 14.43%.

Table 7. Respondents' answers about the role of using Internet of Things technology
in solving education problems

No.	The Role of Using IoT Technology in Solving Education Problems	Major Role		Medium Role		Has No Role	
		No.	%	No.	%	No.	%
1	Giving lectures in light of crises, especially the spread of infectious diseases in light of the Coronavirus crisis	156	80.41	35	18.04	3	1.55
2	Availability at the local and global level, whether with the appropriate content or choosing professors anywhere in the world	119	61.34	72	37.11	3	1.55
3	The lectures are presented interactively, recorded, and made available to students at any time, unlike traditional education which is limited to a specific time	116	59.79	63	31.96	16	8.25
4	The Internet of Things helps students access and share their content with peers and facilitate collaboration	100	51.55	78	40.21	16	8.25
5	The ability of teachers to adapt to students, recognize their levels, and assign each student a special learning style	63	32.47	103	53.09	28	14.43

4   Conclusion

The IoT means all the devices and tools that we use in our daily lives that can connect to the Internet and are managed through the application of smartphones or computers and others. It is a modern, global technology based on the Internet whose purpose is to provide an information technology infrastructure. Among the most prominent benefits of the Internet of Things and its importance, organizations can use this technology to reduce costs, and introduce products through advertising and promotion with ease. It is an effective way to overcome some problems and strengthen the relationship between the student and the teacher. Also, it saves a lot of time and data, in addition to being low in cost, and frees people from the restrictions of time and place. Among the most important characteristics of the Internet of Things: Interaction, heterogeneity, dynamic changes, intelligence, sensing, massive capacity, communication, and others. The IoT architecture consists of the device layer, the gateway and network layer, and the management service layer. Among the most important structural components of the Internet of Things architecture are identity verification, sensors, and a central server. Among the most important components of the Internet of Things: are solid materials, Internet of things software, technology, and Internet of Things protocols. Among the most prominent Internet of Things search engines are Shodar, Thingful, and Wais. Among the most important applications of the Internet of Things in education: are smart education, proof of attendance, emergency management, improving operational efficiency, increasing efficiency for students, and the Edmodo educational network. One of the

most important contributions of the Internet of Things to sustainable development is building smart cities and protecting the environment. IoT technology appeared in the year 2000 AD to improve sales management and monitoring. As a result of the rapid developments, this technology has been used in all areas of life, including education by relying on electronic devices, equipment, and software, including smartphones, handheld devices, smart boards, electronic classes, and high-definition television, etc. Internet of things technology has several characteristics, the most important of which are (environmental interaction, dynamic changes, intelligence, sensing, interconnection, huge capacity, safety, etc.). One of the advantages of using the Internet of Things technology in education is that it is an effective way to overcome some of the problems facing the learner and helps him to overcome the barriers of time and space and enables him to successfully control the learning management from a distance. The use of IoT technology in education helps students learn new things by supporting educational goals and helps them communicate with teachers using different methods. Among the applications of the Internet of Things in education (smart education, smart classes, proof of attendance, text message alerts, emergency management in educational institutions, improving operational efficiency in educational institutions, educational applications, etc.).

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