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The Use of the Internet of Things (IoT) Applications by Public School Teachers in Kuwait: Perspectives

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Abstract: The study aimed at identifying the degree of using the Internet of Things (IoT) applications by public school teachers in Kuwait; moreover, it sought to find out how their use of IoT impacts the learning and teaching process from teachers' perspectives. In order to achieve this aim, the study adopted the descriptive survey approach, where the sample was selected based on the simple random sampling approach. The sample included 350 teachers working at the public schools of the General Department of Capital Educational Area in Kuwait. To collect data, the researcher set a questionnaire as a tool for the study.

The findings of the study showed that there is a high degree of using IoT applications by public school teachers in Kuwait. In addition, there is not a statistically significant difference at the level of (α =0.05) concerning the degree of using IoT applications by public school teachers in Kuwait in terms of the study variables: Gender, Academic Qualification, Teaching Experience, Educational Stage, School Subject.

In light of the findings, the study recommended that schoolteachers should promote the use of IoT applications to take into account individual differences among students.

Keywords: public school teachers in kuwait, IoT applications, internet of things (IoT), public schools.

1 Introduction

During the second half of the 21st century, the world experienced progressively enormous developments in the means and technologies of education and information. For instance, the advent of satellites, the Internet, globalization, and digital transformation, has led to turn our world into a small village. In other words, information, news, and experiences could be transmitted and exchanged from anywhere in the world to anywhere else faster, easier, and more effective by the virtue of the progress in means and technologies of communication and learning.

It is crystal clear such developments had a great effect on learning and its different types and stages, whether the basic education, university, college, or distance learning. After the rise of the Fourth Industrial Revolution (4IR), the world has witnessed rapid changes in various fields, for example, education. Consequently, educators necessarily deliberated this revolution as a goal for helping graduates to meet the international labor market's needs, not only to focus on the local market. This type of education has become the roadmap to the challenges designated in the revolution. Accordingly, it was deemed that the professionals, in particular, working in the field of the technical and industrial education need to restructure the education for the progress and interest of the whole country as seen as the most important challenge (Farjoon, 2019) [1].

In view of those fundamental developments and changes of the 4IR, schools should carry out untraditional procedures and practices for their survival and continuity, perform their tasks in the best possible way, and reach their looked-for educational goals surrounded by an environment full of changing and complex technology. In Kuwait, public schools also need to reasonably use modern technologies so as to play a prominent role in building educational institutions with a high performance and high-quality services. Surely, it will have a positive result on students, and make the public schools in Kuwait take a place in the ranks of international schools. Hence, this study came to identify the degree to which public school teachers in Kuwait use IoT applications based on their perspectives.

Statement of the Problem:

Nowadays, schools are facing enormous challenges; perhaps most importantly, the failure of traditional means in

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education that are used to keep up with the developments and digital transformation. In fact, although these means have diverse learning resources, they are unable to contain the huge quantity of information. Then, schools need to depend on more advanced educational means that connect education and quality. Al-Dahshan (2019) [2] stressed the need to keep pace with developments in education due to the lack of awareness in digital transformation techniques that could develop the services of educational institutions. Recently, various applications could help to improve education. In addition, the more discussion panels and specialized seminars are to be held, the more promising opportunities are to be discovered. As an educator, the researcher observed the need of teachers to improve and develop their technical use in light of such digital developments, of which schools should be the first to take advantage.

Questions of the study:

This study tries to answer the following questions:

1. What is the degree of using IoT applications by public school teachers in Kuwait?
2. Are there any statistically significant differences at the level of (α =0.05) concerning the degree of using IoT applications by public school teachers in Kuwait in terms of the study variables (Gender, Academic Qualification, teaching experience, educational stage, school subject)?

Objectives of the study:

The study aims to:

1. Identify the degree of using IoT applications by public school teachers in Kuwait.
2. Find out if there are statistically significant differences at the level of (α =0.05) regarding the degree of using IoT applications by public school teachers in Kuwait in terms of the study variables (Gender, Academic Qualification, teaching experience, educational stage, school subject).

Significance of the study:

1. Add theoretical insights to field of the use of IoT applications at public schools in Kuwait from the perspectives of teachers.
2. The study is consistent with the objective of the Ministry of Education in Kuwait on the subject of the integration of modern technologies in public schools.
3. The study may help teachers, principals, and curriculum designers through providing them with feedback and a deep understanding of the degree of using IoT applications by public school teachers in Kuwait, and the variables surrounding their use in order to take the necessary actions to develop and improve teachers' technical competences in the future.
4. The results of the study may contribute into finding out the important problems faced by public school teachers in Kuwait once dealing with IoT applications and proposing some recommendations to develop their use of IoT applications.

Limitations of the study:

This study is identified within the following limitations:

1. Content Limitations: The study is limited to identifying the degree of using IoT applications by public school teachers in Kuwait from their point of view.
2. Human limits: The study is limited to the teachers of the three educational stages (elementary stage - intermediate stage - secondary stage) who teach all school subjects at public schools in Kuwait.
3. Spatial limitations: This study was conducted at the public schools of the General Department of Capital Educational Area in Kuwait.
4. Time limitations: The study was implemented in 2022.

Study terms and procedural definitions:

The terms of the study were technically and procedurally defined as follows:

The degree of using IoT applications:

Technical definition: It is the extent to which public school teachers use IoT applications through connecting different devices together in order to exchange data, information and ideas and store them in more accessible ways in public schools

in Kuwait.

Theoretical review of literature and previous studies

Theoretical review of literature: The researcher presents the theoretical review of literature on IoT applications as follows:

The concept of Internet of Things (IoT):

The Internet of Things (IoT) is one of the modern terms that focus on the future of the Internet and how to use it. Kevin Ashton, founder of the first research center at Massachusetts Institute of Technology, was the first to introduce this concept in 1999. (Al-Sheikha, 2015) [3].

There are a variety of definitions of IoT though most of them include similar criteria. For example:

a. Badawy & Belal (2021) [4] define IoT as a physical network of things including sensors, actuators, and smart phones that could communicate with each other to exchange data quickly and communicate outside the network with servers to process and store data.

b. Rahmani, et al (2022) [5] define IoT as a technology enabling smart devices and sensors to communicate with each other remotely for exchanging and controlling data and information distantly on the Internet.

Based on the above, the researcher sees that these definitions focus on the capability of technology of IoT in collecting data and connecting devices together. In addition, these definitions vary in terms of the ways of communication between devices with each other; the obvious development of the IoT concept, and its relevant technologies help to keep up with the modern industrial revolution.

The researcher defines it as a technology, which reformulates the physical world in order to be a successful alternative for serving human beings through developing the programming and physical technologies sustainably to keep up with the developments of the modern industrial revolution and serve the humanity.

When mentioning IoT, it is necessary to address its relevant concepts such as big data, and artificial intelligence.

The concept of Big Data: Chen, et al, (2014) [6] define the concept of big data as those data which can only be obtained, stored, or managed through advanced programs appropriate for the huge databases for which they are searched. The researcher defines it as a collection of huge data through which correct decisions can be made after analyzing, classifying and processing it by using the techniques and applications of artificial intelligence. Human beings find it difficult to deal with these data.

The concept of Artificial Intelligence: It is one of the branches of computer sciences, and classified as one of the concepts on which the fourth industrial revolution depends. It includes computing applications that simulate the capabilities of human mentality (Mahmoud, 2020) [7].

The researcher defines it as the way in which technology becomes able to simulate intelligence processes and predict a group of solutions to make correct decisions by utilizing many devices surrounding humans and managing them by using artificial intelligence applications after studying the surrounding situations.

Relation between internet of things, big data and artificial intelligence:

With its special sensors, The IoT collects huge data that need to be organized, and processed through the big data whose function is to analyze data quickly by using modern technologies. After that, artificial intelligence needs big data to obtain meaningful results to take the right decision. (Misuaer, 2017) [8].

Importance of IoT:

Organizations currently need to choose between two options. The first is to adopt the IoT, and set a clear action plan, a budget, and necessary operations. The second is to lose in a labor market that is rapidly changing towards development and progress.

Concerning the importance of IoT, it connects objects such as machines, animals and plants in a digital way with all digital communication features. Data is easily reproduced and provides integration with other digital systems in addition to wireless communication that creates automatic telepathy as a machine wirelessly communicates from any distance. As a result, the technology of IoT impacts the quality of work of all organizations and institutions since it is equipped with an easy and automatic control on the devices and tools to do tasks and functions remotely.

The IoT is one of the interesting concepts in the current time, and at the same time it's a big challenge in education. This led many academics and experts to discuss it through many various conferences, and scientific journals. (Oclc, 2015) [9].

The basic architecture of IoT:

It consists of four layers as indicated by Zeeshan, et al (2022) [10] as follows:

1- Physical layer: It includes sensors, wearable devices, actuators, and Radio Frequency Identification (RFID). It is formed of devices that collect data, and actuators that transmit power into movement.

2- Network layer: It includes wireless satellite networks (5G, 4G, 3G), Ethernet networks, or cloud networks. It performs various functions, such as managing mobility, authentication and authorization for IoT applications, and provides communication between networking devices and physical objects. In other words, the sensor receives data from the perception layer, and then the collected data to be transmitted and processed for identifying possible changes in the state. The connection point is the gateway that obtains the information sensed by the perception layer sensors.

3- Process layer: It processes data received from the network layer. It consists of databases, data processors, and servers with high-powered data processing.

4- Application layer: It delivers smart services to users.

Elements of IoT:

IoT technology has various definitions and concepts that may differ based on the field and the perspective of using such technology, as used in applied, industrial, commercial, or technological field.

Based on the variety of definitions, a group of basic elements of the IoT technology could be extracted according to the study of Abdullah (2019) [11] as follows:

1- the capability of devices to connect to the Internet.

2- the capability of sensors for measuring the existing effects.

3- Meditating the communication among devices that are connected to the Internet.

4- the capability to store and analyze data for valuable information.

Mechanism of IoT:

The IoT connects entities and objects, such as mobile phones, home devices or any other devices together through a protocol. As being connected to the Internet, they are capable of sensing and transmitting data and interacting with each other or with people.

AlSadi (2021) [12] pointed out the adopted technology of IoT includes the following mechanisms:

1. Data collection through communication devices and related devices.

2. The data is sent to the big data for analyzing it and taking the right action.

3. Artificial intelligence is used to take the necessary actions.

Organizing IoT Applications:

Abbasy & Quesada (2017) [13] and Rahmani, and others (2022) [5] argued IoT applications are seen as a phenomenon surrounding all aspects of human life, and it is difficult to imagine the life without smart applications, sensors, or smart devices as being existed in every walk of life. They also stated the IoT applications are organized as follows:

1- Smart sensors of IoT can identify themselves, create a network, and generally transfer the information they collect to cloud servers for storage and analysis. The RFID system consists of two parts. The first one is a tag placed or integrated with materials that could be tracked. Additionally, this system includes data that identifies the product, date of manufacture and of validity, and other types of data. The reader is the second part which sends radio waves to simulate the tag that in turn sends the identification data stored inside it through radio waves. Then, it receives them again and translates them into data. This is why RFID tags are used in materials by factories that have a massive production since this will help in better management. As information is automatically received into the data network environment from RFID tag readers during manufacturing these materials, that information can activate a new intelligent system.

2- Sensor units communicate via wired networks, programmable digital control devices (PLC) and systems utilized in production. Supervisory Control and Data Acquisition (SCADA) or Distributed Control Systems (DCS) control these systems, which are mostly independent of local area network systems or the Internet.

3- Machine-to-Machine (M2M) networks are a type of network formed by direct communication over a channel between two devices, wireless or wired. Studies show that soon the number of M2M networks will reach about 8.5 billion, half of which will be generated by automation devices, tracking applications, and security monitoring.

Specifications of the IOT-based smart classroom:

The IoT-based smart classroom depends on developing an environment equipped with advanced learning methods as well as the latest technologies, such as cameras, microphones, and various sensors, which are used to measure the satisfaction of students in their learning or other aspects. These smart applications offer better and more efficient and convenient classroom management. In addition, the use of the IoT in the classroom may provide a better teaching and learning environment. The specifications of the IOT-based smart classroom are indicated by (Gul, et al, 2017; Schorman, 2019) [14][15] as follows:

1- Smart Classroom Management: The term “classroom management” is a method or approach utilized by teachers to control the management of their classroom. By virtue of smart devices, teachers could decide when to speak louder if students lose interest, or their level of concentration decreases. The use of IoT devices for teaching and learning is a growing trend among organizations around the world that provides a new and innovative approach to teaching and classroom management. These tools are already being used.

Some commonly used IoT devices in the classroom are:

Interactive whiteboards - 3D printers - Student ID cards - Security and video cameras - Electrical lighting and maintenance - Attendance tracking systems - Tablets and mobile devices - E-books - Temperature sensors - Room temperature sensors - Smart air conditioning systems - Door locks wireless.

Smart Classrooms allow teachers to find out their learning needs and desires. Moreover, they help the students to understand the real goal of using technology which also makes the learning process easier. Advances in technology in the field of education have made it easier for teachers to design more productive, informative and collaborative IoT-run classrooms. The literature review shows that most of the recent studies suggest different models for smart classrooms and propose many innovative concepts in education such as the introduction of IoT technology with crowdsourcing in e-learning that can be useful for improving learning and teaching processes. Zhang's study (2021) [16] examined the experience of managing the smart classroom in some schools of China. This experience proved its effectiveness. The researcher conducted interviews with teachers and found out that IoT made classroom management smart.

2- Smart Class Attendance System: Class attendance is a time-consuming task, but the use of IoT can save both time and effort. One study proposed an efficient Smart Classroom Roll Caller System (SCRCS) using IoT architecture to collect or record students' attendance after each session accurately and in a timely manner. RFID tags are attached to student ID cards. A SCRCS device can be installed in each classroom and students' ID cards can be read collectively. It shows total attendance on an LED display at the beginning of any class, and also shows all ID cards on multiple SCRCS venues. The student's attendance record is also kept in the academic office. Another study proposed a web-based attendance system using Near-field communication (NFC) technology in Android smartphones. The student will swipe the student ID card towards the NFC-enabled Android smartphone, and the attendance will be saved on the server automatically. Teachers and students can check attendance from their smartphones. The study of El Mrabet & Moussa, (2020) [17] carried out an experiment at a school in Morocco. They utilized an IoT-based smart classroom attendance system through providing a student (RFID) tag and a reader while students attend classes, so that this system provides the attendance of students’ data and make it available to the school administration, teachers and parents. To achieve the aim of the study, the experiment was conducted on two independent groups, an experimental group and a control group. The experimental group was subject to the attendance system using IoT technology, and the control group was subject to the regular attendance method. The results of this seven-week experiment showed the attendance of the control group was normal, with no change as it was in the previous weeks before the experiment, while in the experimental group, the number of absent students decreased significantly. This reflects the success of using the IoT technology in the smart classroom.

3- Real-time feedback on classroom quality: The comprehension of students and their academic achievement is relevantly connected to the quality of classroom as the student feedback plays an essential role in improving classroom quality. The study of Gligorić and others (2012) [18] suggested a creative environment to monitor and control students' reactions inside the classroom using sensing and monitoring technology. For example, the microphone is used to measure the noise level in the classroom, the camera is used to track the students' movement during the classroom, and the sound sensor is used to measure the level of noise in the classroom. These IoT will help to provide real-time feedback on classroom quality so that the quality of the smart classroom could be improved.

Previous Studies:

Alalouny (2022) [19] conducted a study on "Employing the Internet of things in Saudi universities from the viewpoint of faculty members." This study aims to identify the opportunities and challenges about employing the Internet of things in Saudi universities from the point of view of the faculty members. This study used a descriptive approach and applied on a sample of faculty members (23) in Saudi universities. The study divided the Internet of things into seven areas, including the field of education and learning, human resources, energy, transportation, public facilities, security and safety, and data

analysis. The results showed that multiple opportunities of the Internet of things in universities, which could contribute to effectively develop learning and teaching environment and process. It also recommends that various seminars and training programs are to be offered on the uses of IoT in the university environment at all levels. Hereby, this will raise awareness among university's staff, and know promising opportunities of IoT, and challenges that universities may face.

Alawdat and Al-Jaradat (2021) [20] did a study so-called "the effect of using the Internet of Things applications in developing the skills of reading comprehension and written expression in the Arabic language for seventh grade students in Jordan". It aimed to study the effect of using IoT applications in developing the skills of reading compression and written expression in the Arabic language for seven grade students, and their attitudes towards these applications. The quasi-experimental approach was adopted for this study. To achieve the goal of the study, the Internet of Things application was prepared, the listening skill development test, and the written expression skill development test in addition to a measurement of student's attitudes towards IoT applications. The study sample consisted of (50) students. Two classes were chosen and randomly divided into two groups, an experimental group which included (25) students studying using the Internet of Things application (IoT) and the other group, control group, included (25) students studying as normal. The results of the study indicated that the experimental group greatly favors teaching through IoT applications more than the traditional way of teaching. The study recommended carrying out more studies on legalizing and preparing IoT applications in various educational disciplines and for all educational stages.

Ganawi (2019) [21] conducted a study titled "IoT Applications in some Egyptian libraries: analytical study and future vision". The study aimed to shed light on Internet of Things in Egyptian libraries in order to develop their services, and identify the reality of using IoT applications in libraries. The study adopted the analytical descriptive approach, and the questionnaire was used as a tool for the study, which included different types of libraries (Academic, general, specialized, and national libraries). The sample consisted of 521 qualified staff. The results showed the most famous IoT application is BBluu, and the most famous IoT platform is Zetta. The library of American University is considered the first to apply RFID in the process of library sorting and borrowing in 2007. Most of the staff of the Egyptian libraries (60%) supported the use of IoT applications to enhance the beneficiaries' services. It is found out that the most challenges that the staff face upon applying IoT is the lack of awareness towards IoT applications. This comes in first (44.9%). The second challenge is the financial problems with a rate of 30.1%. One of the IoT future trends will have been the link of 50 million devices by 2020.

Jasim, etl al (2021) [22] studied the IoT applications in the assessment of learning. The study aimed to propose a low-cost, effective and flexible platform to monitor preliminary data on student access to, and participation in, virtual classroom environments and activities. It also sought to enable parents to monitor their children. The researchers used a quasi-experimental approach, as the sample included 20 students from the electrical engineering department at Wasit University. In terms of its findings, the study stressed the necessity of integrating IoT applications in the educational process. This contributes to preparing a digital generation and motivate the students to learn effectively and broader their knowledge and skills. The results of the study indicated that parents played a great role in the learning process through simulating and monitoring their children's achievement by using smart devices, or computers.

Al-Malah, et al (2020) [23] studied how to improve educational services by using IoT applications at smart schools. The study adopted the analytical descriptive approach and used a questionnaire to achieve its aims. The results of the study showed that IoT applications contributed into leveraging the administrative competency at these schools to be replaced by electronic management and to find means and methods to save time and reduce effort and invest it in increasing the educational product by creating interactive content for students and it is provided through their smart devices and tablets. Teachers in smart education schools are witnessing a slight spread of the use of the Internet of Things in the educational and learning process. The study recommended the need to enhance the smart school environment for IoT applications and the possibility of applying them on a broader and comprehensive scale to achieve the quality of the educational process.

Pervez and Alandjani (2018) [24] had a study on role of internet of things (IoT) in higher education. They aimed to measure the productivity level of IoT on the educators and learners of modern era to learn from results of processed data in the UK, which shows different learning trends and with success ratio of those applied methods. the researcher used the analytical descriptive approach, and the sample consisted of a group of school and university students, and the study tool was observation, and the results of the study showed that the Internet of Things provided teachers with an easier educational life, due to their access to lesson materials, publishing tests on the Internet, online meetings with parents, and their ability to develop The level of students' self-learning skills to save time by using Internet of Things applications. The study also recommended integrating Internet of Things platforms into science and engineering curricula to help students develop digital literacy skills and innovation.

Commenting on the previous studies:

After reviewing the previous studies, the following points have been noted:

- The current study is similar to the previous studies that address the topic of IoT applications, such as Al-Awadat and AlJaradat (2021), Felicia, et al, (2021), AlMalah, et al (2020), and Ghanawi (2019).
- The current study is similar to the previous studies in the use of methodology, which is the descriptive approach, such as Alalouny (2022), AlMalah, et al (2020), Ghanawi (2019), and Pervez and Alandjani (2018), while it is different from the previous studies in the use of Quasi-Experimental, such as Al-Awadat and Al-Jaradat (2021) and Fathan, et al (2021).
- The current study has a similarity with the studies of AlMalah, et al (2020) and Ghanawi (2019) in the use of the study tool, questionnaire; nevertheless, it is different from other studies in the tool, such as:

- Alalouny's study used the interview tool.
- Alawdat and AlJaradat's study used tests and measurement of trends.
- Pervez and Alandjani's observation.

- The current study differs from other studies in terms of the population as it addresses the public-school teachers in Kuwait, in particular the Educational Area of Capital, whereas the previous studies addressed different populations. In addition, it has a difference from other studies in terms of the objective as the current study aimed at finding out the degree of using IoT applications by public school teachers in Kuwait from their perspective. Therefore, it is deemed to be locally pioneer in this field in Kuwait in 2022.

2 Methodologies

The researcher adopted the descriptive survey approach to achieve the study's objectives.

Study population: The study population includes 14721 teachers working at the public schools of the General Department of Capital Educational Area in Kuwait. 70% of them are females (10304), while 30% are males (4417) according to the statistical and data services on the website of the Ministry of Education in Kuwait (Ministry of Education, 2022) [25].

Study Sample: The study sample was selected through a simple random sampling method. It comprises 375 teachers from the public schools of the General Department of Capital Educational Area in Kuwait in 2021/2022. The error rate is (5%). The researcher distributed an electronic questionnaire and (350) responses were obtained, with a rate of (93%).

Study Tool: In the light of previous studies related to the problem of the study, the researcher created a questionnaire to find out the degree of using IoT applications by public school teachers in Kuwait from their point of view.

Validity of the study tool:

In order to verify the validity of the study tool's content, the researcher presented a draft for the questionnaire to a panel of experts including 14 faculty members specialized in Educational Technology, Curricula, Teaching Methods, Measurement and Evaluation, and Arabic language from the University of Jordan, Al al-Bayt University, Irbid Private University, Kuwait University and the College of Basic Education-Kuwait. They checked the accuracy of the statements, and gave feedback on them, and checked the accuracy of the language and the suitability of each statement to achieve the objectives of the study. Based on their feedback, 85% of the panel agreed to amend the demographic variables to include (gender, academic qualification, teaching experience, educational area, educational stage, and school subject), a well as some statements were modified in order to be measurable and clearer to the respondents. Then, the final version of the questionnaire was approved, and it consists of 15 statements, which are distributed into to the field of IoT applications.

Reliability of the study tool:

To ensure the reliability of the study tool, the questionnaire was distributed to a survey sample including 30 teachers. The reliability was measured through the internal consistency in accordance with Cronbach's Alpha. The internal consistency measurement is 0.93, which means the study tool has a high reliability.

Correction of the study tool: to calculate the total degree for the tool, a respondent could choose one of the five choices set in the questionnaires. These choices express about the opinions of respondents on the degree of using IoT applications by schoolteachers in Kuwait. The marks (1,2,3,4,5) are given to the five choices respectively for the statements. The mark 5 is given to the choice "Very big", the mark 4 is given to the choice "big", the mark 3 is given to the choice "medium", the mark 2 is given to the choice "low", and the mark 1 is given to the choice "very low". To judge the level of means of statements, domains and the total as whole, the statistical standard was adopted using the following:

$$\text{Category length} = \frac{\text{upper limit} - \text{lower limit} = 1\text{-}5}{\text{Numbers of default categories}} = \frac{4}{3} = 1.33$$

Then adding the answer (1.33) to the end of each category. Table (2) shows:

Table 1: The statistical criterion to determine the degree of public-school teachers' use of IoT applications from their point of view in the current study:

Mean	Degree
from 1.00 to 2.33	low
from 2.34 to 3.67	Medium
from 3.68 to 5.00	High

3 Results

Results of the first question: What is the degree of using IoT applications by public school teachers in Kuwait?

To answer this question, the means and standard deviation of the study sample's estimates on the degree of using IoT applications by public school teachers are calculated. Table (2) shows them:

Table 2: Means, Standard Deviations, and Ranks of the estimates of the study sample on "the degree of using IoT applications" ranked in descending order.

No	Statement	Mean	Standard Deviation	Rank	Degree
2	IoT applications help to easy access to information in a specific time.	4.26	0.78	1	High
7	IoT applications assist teachers to access high-quality educational resources.	4.26	0.80	2	High
8	IoT applications provide teachers with the feature of changing traditional ways of teaching	4.25	0.80	3	High
1	IoT are utilized to exchange knowledge among teachers.	4.21	0.84	4	High
4	IoT Applications improve the students' learning and transcend the limits of place and time.	4.20	0.86	5	High
11	IoT applications provides the technology of smart board that facilitates the lesson delivery	4.19	0.84	6	High
13	Teachers need training on how to use IoT applications.	4.19	0.83	7	High
15	IoT applications improve students' motivation to learn in the classroom.	4.16	0.85	8	High
9	IoT applications help to automate education.	4.12	0.84	9	High
5	IoT applications help parents to monitor their children's achievement.	4.10	0.90	10	High
14	IoT application are used to save financial costs in educational institutions.	4.09	0.92	11	High
3	students interact with each other through IoT applications in a way supporting the learning and teaching process.	4.08	0.90	12	High
10	IoT applications improve the achievement of students.	4.07	0.88	13	High
6	IoT applications are used to keep the security of both students and teachers.	3.99	0.93	14	High
12	IoT take into account the individual differences among students.	3.87	1.00	15	High
	Total Degree	4.13	0.75		High

Table (2) shows that the total degree of the first domain "IoT Applications" is high as its mean is 4.13, and its standard deviation 0.75.

The means of the statements range between (4.26-3.87) with high degrees. Statement (1) " IoT applications contribute to access information at a specific time" is ranked first with a mean of 4.26 and a standard deviation of 0.78, and its degree is high. Then, statement (7) "IoT applications assist teachers to access high-quality educational resources." comes in the second rank with a mean of 4.26, a standard deviation of 0.80, and with a high degree. Next, statement (8) "IoT applications provide teachers with the feature of changing traditional ways of teaching" is placed in the third rank. Its degree is high as its mean is 4.25 and its standard deviation is 0.80. Statement (12) "IoT take into account the individual differences among students" comes in the 15th and last place as its mean is 3.87, its standard deviation is 3.87, and its degree is high.

Results of the second question: Are there any statistically significant differences at the level of (α =0.05) regarding the degree of using IoT applications by public school teachers in Kuwait attributed to the study variables (Gender, Academic Qualification, teaching experience, educational stage, school subject)?

To answer the previous question, the researcher tested five hypotheses as follows:

The first hypothesis, which states (there is no statistically significant difference at the level (0.05 = α) in the means of the sample's responses on the degree of using IoT applications by public school teachers in Kuwait in accordance with the variable of gender).

To test the first hypothesis, the researcher used T-test for two independent groups, as the below table indicates:

Table 3: T-test on the degree of using IoT applications by public school teachers in Kuwait in accordance with the variable of gender.

Gender	number	Mean	Standard deviation	Degree of Freedom	calculated value (T)	Level of significance
Male	103	4.05	0.688	348	-1.33	0.185
Female	247	4.17	0.780			

The results in table 3 show there is no statistically significant difference at the level (0.05 = α) in the means of the sample responses on the degree of using Iot applications by public school teachers in Kuwait in accordance with the variable of gender. The calculated value (T) is 1.33-, and the level of significance is greater than 0.05 (Accepting the null hypothesis)

The second hypothesis, which states (there is no statistically significant difference at the level (0.05 = α) in the means of the sample's responses on the degree of using IoT applications by public school teachers in Kuwait in accordance with the variable of academic qualification.)

To test the second hypothesis, the researcher adopted One Way ANOVA, as the below table indicates:

Table 4: One Way ANOVA test on the degree of using IoT applications by public school teachers in Kuwait in accordance with the variable of academic qualification.

Source of Variation	Sum of Squares	Degree of Freedom	Mean Square	Value F	Level of Significance
Between groups	1.365	2	0.682	1.197	0.303
Within groups	197.769	347	0.570		
Total	199.134	349			

The results in table 4 show there is no statistically significant difference at the level (0.05 = α) in the means of the sample responses on the degree of using IoT applications by public school teachers in Kuwait in accordance with the variable of academic qualification. The calculated value (F) is 1.197, and the level of significance is greater than 0.05 (Accepting the null hypothesis)

The third hypothesis, which states (there is no statistically significant difference at the level (0.05 = α) in the means of the sample's responses on the degree of using IoT applications by public school teachers in Kuwait in accordance with the variable of years of teaching experience.)

To test the third hypothesis, the researcher adopted One Way ANOVA, as the below table indicates:

Table 5: One Way ANOVA test on the degree of using IoT applications by public school teachers in Kuwait in accordance with the variable of years of teaching experience.

Source of Variation	Sum of Squares	Degree of Freedom	Mean Square	Value F	Level of Significance
Between groups	0.268	2	0.134	0.234	0.792
Within groups	198.866	347	0.573		
Total	199.134	349			

The results in table 5 show there is no statistically significant difference at the level (0.05 = α) in the means of the sample responses on the degree of using Iot applications by public school teachers in Kuwait in accordance with the variable of years of teaching experience. The calculated value (F) is 0.134, and the level of significance is greater than 0.05 (Accepting the null hypothesis)

The fourth hypothesis, which states (there is no statistically significant difference at the level (0.05 = α) in the means of the sample's responses on the degree of using Iot applications by public school teachers in Kuwait in accordance with the

variable of educational stage.)

To test the fourth hypothesis, the researcher adopted One Way ANOVA, as the below table indicates:

Table 6: One Way ANOVA test on the degree of using IoT applications by public school teachers in Kuwait in accordance with the variable of educational stage.

Source of Variation	Sum of Squares	Degree of Freedom	Mean Square	Value F	Level of Significance
Between groups	1.156	2	0.578	1.013	0.364
Within groups	197.977	347	0.571		
Total	199.134	349			

The results in table 6 show there is no statistically significant difference at the level (0.05 = α) in the means of the sample responses on the degree of using Iot applications by public school teachers in Kuwait in accordance with the variable of educational stage. The calculated value (F) is 1.013, and the level of significance is greater than 0.05 (Accepting the null hypothesis)

The fifth hypothesis states (there is no statistically significant difference at the level (0.05 = α) in the means of the sample's responses on the degree of using Iot applications by public school teachers in Kuwait in accordance with the variable of school subject.)

To test the fifth hypothesis, the researcher adopted One Way ANOVA, as the below table indicates:

Table 7: One Way ANOVA test on the degree of using Iot applications by public school teachers in Kuwait in accordance with the variable of school subject.

Source of Variation	Sum of Squares	Degree of Freedom	Mean Square	Value F	Level of Significance
Between groups	16.430	20	0.822	1.479	0.086
Within groups	182.704	329	0.555		
Total	199.134	349			

The results in table 7 show there is no statistically significant difference at the level (0.05 = α) in the means of the sample responses on the degree of using IoT applications by public school teachers in Kuwait in accordance with the variable of school subject. The calculated value (F) is 1.479, and the level of significance is greater than 0.05 (Accepting the null hypothesis)

4 Discussions

The results show that the total degree of using IoT applications by public school teachers in Kuwait is high in all the 15 statements.

After ordering the statements based on the results of the mean and standard deviation, statement 2, which states " IoT applications help to easy access to information in a specific time" is ranked first and has a high degree of use. The researcher attributes this to the easy access to information by teachers through their use of IoT applications that are cloud-stored by devices or websites helping the teachers in achieving the educational objectives.

Statement 7, which is "IoT applications assist teachers to reach high-quality educational resources", comes second and in a high degree of use. The researcher attributes this to the availability of tools for creating interactive content to students and sending it directly through their smart devices and tablets.

Statement 8, which is " IoT applications provide teachers with the feature of changing traditional ways of teaching" is ranked third and comes with a high degree of use. The researcher found the cause of this is the provision of interactive environment to teachers inside classrooms. This leads to improve the efficiency and quality of teachers.

Statement 3, "students interact with each other through IoT applications in a way supporting the learning and teaching process", is ranked in the 12th place, and statement 10 "IoT applications improve the achievement of students" is ranked 13th, while statement 6 "IoT applications are used to keep the security of both students and teachers" comes in the 14th place. Statement 12 "IoT consider the individual differences among students" is ranked the last one, and the researcher attributes the last ranks of these statements to the perspective of the study sample through benefiting of students from the teachers' use of IoT applications. This is a worthy point to be enhanced and developed, and to take a greater share in educational research since it addresses the students, which are seen as the focus of the learning and teaching process.

The second question: Are there any statistically significant differences at the level of (α =0.05) regarding the degree of using IoT applications by public school teachers in Kuwait attributed to the study variables (Gender, Academic

Qualification, teaching experience, educational stage, school subject)?

1. With regard to the gender variable: the results show that there is no statistically significant difference at the level of ($\alpha = 0.05$) regarding the gender variable. The degree of using IoT applications by public school teachers, females and males, in Kuwait forms a strong point. The researcher attributes this to the aim of all teachers who seek to deliver information in a modern way and select the right method of delivery consistent with modern technologies.
2. With regard to the academic qualification variable: the results show that there is no statistically significant difference at the level of ($\alpha = 0.05$) on the degree of using IoT applications by public school teachers in Kuwait regarding the academic qualification variable. The degree of using IoT applications by public school teachers in Kuwait indicates there is no effect of academic qualification. The researcher attributes this to that universities and colleges are interested in using modern application within their academic programs at the level of bachelor's degrees and post-graduate degrees, and these programs are within everyone's reach.
3. With regard to the years of teaching experience variable: the results show that there is no statistically significant difference at the level of ($\alpha = 0.05$) on the degree of using IoT applications by public school teachers in Kuwait regarding the years of teaching experience variable. The degree of using IoT applications by public school teachers in Kuwait does not vary with the years of experience because this depends on teachers' readiness, capabilities, investigation and broader knowledge on what enhances the tools and strategies of teaching as well as their try to reach the optimal level of capability and efficiency. It is recommended that when a fresh teacher engages the profession of teaching with enthusiasm and a spirit of change, he/she will be able to create an effect on students' cognitive, emotional, and skill domains.
4. With regard to educational stage variable: the results show that there is no statistically significant difference at the level of ($\alpha = 0.05$) on the degree of using IoT applications by public school teachers in Kuwait regarding the educational stage variable. This reflects the degree of using IoT applications by public school teachers in Kuwait does not differ in accordance with the educational stage because the ministry of education raises the digital awareness among teachers of all educational stages.
5. With regard to school subject variable: the results show that there is no statistically significant difference at the level of ($\alpha = 0.05$) on the degree of using IoT applications by public school teachers in Kuwait regarding the school subject variable. Therefore, this degree of use does not differ in accordance with the school subject since the educational curricula contain an application that encourages teachers to use it in the teaching process; accordingly, students receive information in a creative way consistent with the digital generation.

5 Conclusions

The current study aims to identify the degree of use of Internet of Things applications by public school teachers in the State of Kuwait.

The results of this study may be directed to researchers and graduate students to conduct other future studies as well as to enrich the theoretical aspect and benefit them. The results of this study can be considered important to researchers as it will be a reference for them on these two topics. It will also enrich this educators, researchers, and Libraries, despite the limited number of topics that were collected in this study under this title.

The findings from this study may enlighten educators, teacher trainers, educational officials, and educational district administrations by providing clear results to determine the degree to which public school teachers use Internet of Things applications in the educational learning process from their point of view, which in turn contributes to setting standards, strategies, and training programs for teachers. Enriches technological skills that enable teachers to use IoT applications efficiently.

The Internet of Things can help us make education more accessible in terms of geographical location, status and ability. There are limitless opportunities to integrate IoT solutions into school environments.

6 Recommendations

In light of the findings, the researcher recommends the following:

1. Encouraging schoolteachers to enhance the use of IoT applications in order to take into account individual differences among students.
2. Legalize the use of IoT applications in building educational curricula.

Suggestions:

1. Carry out studies on the degree of IoT applications in improving and developing educational curricula.
2. Study challenges of the use of IoT applications in schools.

Conflicts of Interest Statement

The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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