Research Article

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The Degree of Familiarity of Female Teachers at Secondary Schools in Al-Kharj Governorate, Kingdom of Saudi Arabia, with the Technologies of the Fourth Industrial Revolution and Their Applications in the Curriculum of Natural Sciences

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Abstract

The current study measured secondary school teachers' (female) familiarity with "Fourth Industrial Revolution" technologies and their applications in the Natural Science curriculum. The study followed a descriptive-analytical technique. A test was constructed with three themes: fourth industrial revolution technologies, fourth industrial revolution in teaching and learning of sciences, and fourth industrial revolution in the science curriculum. The study sample included 140 Al-Kharj secondary school, science teachers. The results of the study showed that secondary school teachers' (female) familiarity with "Fourth Industrial Revolution" technologies is low, at 43%, with "Fourth Industrial Revolution" technologies in teaching and learning science is very low, at 42%, and with "Fourth Industrial Revolution" technologies that can be included in "Natural Sciences" curricula is very low, at 37%. The study found no variations in secondary teachers' (female) acquaintance with the "Fourth Industrial Revolution" and its applications in the natural sciences curriculum based on specialization and experience. Considering the results, many recommendations have been made. The most important is science teachers need in-service "training programs" to educate them on the fourth industrial revolution technologies and how to use them in the curriculum. The fourth industrial revolution requires "Teachers Preparation Programs" for science teachers and the science curriculum.

Keywords: *Fourth Industrial Revolution, Technologies, Applications of Technologies, Secondary Schools, Al-Kharj Governorate*

1. Introduction

The fourth industrial revolution has become one of the elements influencing the rapid pace of change in all aspects of life in the contemporary world. Spatial and temporal boundaries have been eliminated due to the new advancements and difficulties that the transformations have brought about. In addition to 3D printers, a convergence of numerous technologies spanning a broad range of fields, including but not limited to artificial intelligence, the Internet of things, nanotechnology, robotics, big data, biotechnology, quantum computing, blockchain, and manufacturing, led to this revolution, which resulted in an unprecedented transformation of all human activities (Khoza, 2020, p.248).

Al-Dahshan (2020, p. 54) asserts that there must be a revolution in education and that concrete measures must be made to redesign the educational system to meet the demands of the industrial revolution. In this regard, Al-Sayyid and Mahmoud (2019, p. 8) highlighted that benefiting from the technologies of the Fourth Industrial Revolution necessitates the provision of competent education and training systems and an atmosphere conducive to these technologies. Therefore, it has become important to make significant modifications to the curriculum to improve student's abilities and knowledge of the technologies of this revolution and their diverse uses (Penprase, 2018, p.214).

The research of Hadadah (2019), Ellahi et al. (2019), and Al-Omairi and Al-Talhi (2020) highlighted the significance of incorporating the technologies of the Fourth Industrial Revolution into a variety of curricula. Al-Abbasi and Al-Ghamdi, 2020, p. 64; Al-Dahshan, 2019, p. 78; Pai et al., 2018, p. 279; Al-Abbasi and Al-Ghamdi, 2020, p. 64; Al-Dahshan, 2019, p. 78); Al-Abbasi and Al-Ghamdi, 2020, p. 64; Al-Dahshan, 2019,

Incorporating technologies of the Fourth Industrial Revolution and their applications into the science curriculum necessitates teacher training to improve their skills to the point where they can teach the applications and provide assistance to students to achieve the goals of those technologies and their applications (Aliyu&Talib, 2020, p.858). Therefore, the changes and advancements that preceded the Fourth Industrial Revolution necessitate introducing new educational techniques to prepare and rehabilitate people for this digital era (Imran, 2021, p. 13). In addition, instructors in the digital era must possess digital skills and self-and lifelong-learning abilities that enable them to explain the technologies of this revolution and integrate their applications into educational activities (Afrianto, 2018, p.1).

Ally (2019) indicates that the Fourth Industrial Revolution necessitates the preparation of "digital" teachers, that is, teachers with a variety of digital skills, as Sharma's study (2019, P. 3561) indicated that teachers must be familiar with the technologies of the Fourth Industrial Revolution to meet the future needs of learners at all levels of education.

2. Previous Studies

The study's objective (Al-Balshi, 2022) was to provide a model that would allow secondary school teachers to implement the technologies of the Fourth Industrial Revolution. The study employed a descriptive methodology and emphasized the need to equip educators to meet the demands of the Fourth Industrial Revolution. In addition, the study emphasized the significance of "professional development programs." In light of the study's findings, a concept has been developed to enable the instructor to implement the technologies of the Fourth Industrial Revolution.

In light of the Fourth Industrial Revolution requirements, Al-Dahshan and Mahmoud's study attempted to provide a vision for teachers' "Professional Development Programs." The research employed a "descriptive method."

According to the report, for educators to stay up with the Fourth Industrial Revolution, "professional development programs" for instructors must meet stringent requirements. In addition, the study revealed little gender-based difference between the opinions of the respondents. Keeping in view the requirements of the revolution, the study provided a vision and idea for professional development programs in light of its findings.

Al-study Quaim's emphasized the importance of identifying the training needs of science instructors in light of "Fourth Industrial Revolution" applications. The study employed a descriptive methodology. According to the study's findings, in light of the Fourth Industrial Revolution applications, the study sample agreed that there is a compelling need for training. In addition, the results revealed that there was no statistically significant variation in the responses of the study sample members based on gender or developmental stage. The objective of Mpungose's (2020) study was to determine the level of teachers' and students' familiarity with the technologies of the industrial revolution and their many uses. The study employed a descriptive methodology. According to the study's findings, neither the sample nor the "academic preparation programs" in education colleges adequately prepare teachers for the Fourth Industrial Revolution.

Hariharasudan & Kot (2018) did a methodological analysis of all research dealing with the curriculum-based instruction of the Fourth Industrial Revolution technologies. The most important finding of the study is that the requirement for digital culture and the lack of understanding among teachers about the technologies of the Fourth Industrial Revolution is one of the greatest obstacles to the teaching and learning of these technologies.

After reviewing the above-mentioned prior studies, we determined that the present study concurs with all the studies that emphasize the need to pay attention to the Fourth Industrial Revolution. Also, the present study employs a descriptive method and a study sample (teachers), similar to studies by Al-Balshi, 2022, Al-Dahshan and Mahmoud, 2021, and Al-Qutaim, 2021; nevertheless, it differs from the study by Mpungose, 2020 in that it includes student teachers (practice teacher). Also, the present study's objectives are distinct from those of all prior research. According to the researcher's knowledge, no study has been undertaken in Saudi Arabia to determine the level of familiarity of secondary school teachers with the technologies of the Fourth Industrial Revolution and their applications within the curriculum of natural sciences.

3. Research Problem

Since the world's industrialized nations are shifting the direction of education towards the fourth industrial revolution, the Kingdom of Saudi Arabia is likewise accelerating its efforts in this area as part of its National Transformation Program - Vision 2030. The World Economic Forum (2016) indicated that there is an urgent need to prepare teachers who can effectively teach the technologies of the fourth industrial revolution and their applications and that it has become imperative to revise "teachers preparation programs" or "professional development programs" for teachers so that they can be provided with information and skills related to the technologies of the fourth industrial revolution and their various applications (et al., 2017, p.11).

In addition, the "Education and Challenges of the Fourth Industrial Revolution" conference held in Egypt in 2019 emphasized the significance of sustainable growth for teachers to keep up with the demands of this revolution. Allam and Ahmad (2020) concluded that it is required to construct "science teacher preparation programs" in consideration of the requirements of the fourth industrial revolution to prepare teachers for the age of the fourth industrial revolution. Considering the preceding statement, it is observed that studies of this nature are uncommon in the Kingdom of Saudi Arabia. To the best of the researcher's knowledge, no study has ever attempted to determine the extent to which science teachers are particularly familiar with the technologies and applications of the Industrial Revolution.

4. The Purpose of this Study was to Respond to the Following Questions:

How familiar are the science teachers with the fourth industrial revolution technologies and their applications in the science curriculum?

From the above question, the following sub-questions are derived:

1. How familiar are the natural science teachers with the technologies of the fourth industrial revolution?
2. How familiar are the natural science teachers in secondary education with the fourth industrial revolution technologies?
3. How familiar are the teachers of natural science in secondary education with the usage of the technologies of the 4th industrial revolution in the pedagogy of sciences?
4. Is there any significant statistical difference in the extent of familiarity of science teachers (female) with the technologies of the "Fourth Industrial Revolution" and their applications

in science curriculum according to the following variables: specialization and the number of years of experience?

4.1 Study Hypothesis

1. There is no significant statistical difference ($\alpha \leq 0.05$) between the degree of familiarity of natural science teachers in secondary school with the technologies of the 4^{th} Industrial Revolution and its applications in the science curriculum according to the specialization variable.
2. There is no statistically significant difference ($\alpha \leq 0.05$) between the degree of familiarity of natural science teachers in secondary school with the technologies of the Fourth Industrial Revolution and their applications in science curriculum according to the number of years of experience.

4.2 Study Objectives

This research intends to accomplish the following objectives:

1. To determine the level of knowledge of secondary school natural science instructors with the technologies of the Fourth Industrial Revolution.
2. To determine the familiarity of secondary school natural science instructors with the application of the technologies of the 4th industrial revolution in the pedagogy of science.
3. To determine the level of familiarity of secondary natural science teachers with the fourth industrial revolution technologies that can be included in the natural science curriculum.
4. To understand the relevance of inequalities in the familiarity of natural science teachers in secondary school with the technologies of the Fourth Industrial Revolution and their applications in science curricula, based on specialization and years of experience.

4.3 Importance of the Study

The significance of this work is summed up as follows:

1. The significance of the Fourth Industrial Revolution, its relationship to the growth of the educational system, and the necessity to determine the level of familiarity of science teachers with this revolution, its technologies, and its different applications.
2. Illuminating the Fourth Industrial Revolution and its applications in the science curriculum, as this issue was inadequately handled in prior research.
3. The study results will contribute to the development and design of "training programs" intended to raise the knowledge of female secondary school teachers regarding the technologies of the Fourth Industrial Revolution and their applications in the science curriculum.

4.4 Limitations of the Study

- **Subjective Limitations:** The fourth industrial revolution technologies and their applications in the natural sciences curriculum.
- **Spatial Limitations:** All girls' secondary schools are in Al-Kharj Governorate.
- **Human Limitations:** All-female teachers of natural sciences in secondary schools located in Al-Kharj Governorate.
- **Time Limitations:** The study tool was applied in the third semester of the Academic Year 2022.

5. Terminologies of the Study

5.1 Fourth Industrial Revolution

In 2016, in the Swiss city of Davos, the World Economic Forum designated the "Fourth Industrial Revolution" or the "Second Digital Revolution" as the name given to the final link in a sequence of industrial revolutions that is projected to alter how we live and work fundamentally. This revolution results from the tremendous achievements of the "Third Industrial Revolution," particularly the Internet, massive data storage capacity, and limitless access to knowledge (Hadada, 2019, p. 3). The researcher characterized the fourth industrial revolution as a "revolution in industry and digitization," which extends the first digital revolution and entails the widespread incorporation and integration of digital, communication, and information technologies. It entails incorporating and integrating digital, communication, and information technologies in several domains, which are not confined to industry but comprise many human activities and rely on the employment and incorporation of numerous technologies.

5.2 Technologies of the Fourth Industrial Revolution

Hasan (2019, p. 2914) says that the Fourth Industrial Revolution includes numerous technologies, such as artificial intelligence, robots, cloud computing, the Internet of Things, nanotechnology, 3D printing, biotechnology, and autonomous vehicles. The researcher defines these technologies as "technologies that comprise the Fourth Industrial Revolution, whose applications can be incorporated into the teaching and learning of science and the science curriculum, such as the Internet of Things, augmented reality, 3D printers, nanotechnology, educational robots, artificial intelligence, and biotechnology."

6. Research Methodology

The study adopted a "descriptive-analytical approach".

6.1 Study Population and its Sample

The study population consists of all instructors of natural sciences in Al-Kharj Governorate government secondary schools during the third semester of Academic Year 2022. There were 140 professors. The Table below depicts the distribution of teachers based on the variable of scientific specialization.

Table 1: Number of Female Teachers of Natural Sciences in Al-Kharj Governorate by their academic specialization

Specialization	Number	Percentage
Biology	49	35%
Physics	48	34%
Chemistry	43	31%
Total	**140**	**100%**

A stratified random sample of 88 female natural science teachers in secondary schools in Al-Kharj Governorate comprised the study sample. Table 2 displays the distribution of sample members by technological factors and years of experience.

Table 2: Distribution of sample members by variables of specialization and the number of years of experience

Variables	Levels of Variable	Number	Percentage
Specialization	Biology	31	35%
	Chemistry	30	34%
	Physics	27	31%
Number of Years of Experience	Less than 5 Years	24	27%
	From 5 to 10 Years	30	34%
	More than 10 Years	34	39%

6.2 Study Tool

A 30-item test was developed to assess the level of knowledge of high school female natural science teachers about the technologies of the fourth industrial revolution and their applications in the Natural Sciences curriculum. Following is a description of the steps taken to design, develop, and validate the test's psychometric qualities.

6.2.1 Identify the objective of the test

The purpose of the examination was to assess the familiarity of female secondary school teachers of natural science with the 4th industrial revolution technologies and their applications in the curriculum of Natural Sciences, as well as with the technologies of the fourth industrial revolution that can be incorporated into the curriculum of natural science.

6.2.2 Resources to prepare for the test

Several earlier studies on the technologies of the Fourth Industrial Revolution and their applications and inclusion in school curricula, notably the science curriculum, have been referenced. These studies were conducted by Al-Dahshan (2019); Al-Abbasi and Al-Ghamdi, 2020; Mpungose, 2020; Aliyu and Talib, 2020. In light of the information obtained from these studies and after conducting interviews with several specialists in preparing the curriculum for natural science, the theme of the test was determined to include technologies of the "Fourth Industrial Revolution," applications of technologies of the "Fourth Industrial Revolution" in the pedagogy of science, and technologies of the fourth industrial revolution that can be incorporated into the curriculum.

6.2.3 Description of Test and Its Type

The test was created using a multiple-choice format, and correctness and clarity were considered when composing the questions. Each item was restricted to a single technology. It was ensured that each item corresponds to the concept it measures. The test items and recommended alternatives for each item were exact and accurate scientifically and linguistically. The test consisted of 30 items in its original version, each with four possible answers.

6.2.4 Test Correction

Each correct answer was awarded one point, bringing the total test score to 30, and a key was created to rectify the exam questions.

6.2.5 Verifying the Face Validity of Test

After preparing the test in its first form, it was handed to a panel of arbitrators for their evaluation of the scientific and linguistic accuracy of the test items/phrases. In addition, the goal was to determine the degree to which the products are related to the topic so that any necessary adjustments could be made. Important comments received included reformulation of some things and adjustment of some alternatives. Their comments were considered, and changes were made accordingly. The test was then presented to arbitrators again. It became apparent that most test items were accurate following the modifications, and there was a high degree of arbitrator consensus. Thus, the exam was determined to have face validity.

6.2.6 Validation of Internal Consistency

The correlation coefficient between the degree of each item on the test and the degree of the theme to which it belongs was determined, and the findings are displayed in Table 3.

Table 3: Correlation coefficients between the degree of each item and the theme to which it belongs to test the technologies of the Fourth Industrial Revolution and their applications in science curricula

First Theme		Second Theme		Third Theme	
Item No	Correlation coefficient	Item No	Correlation coefficient	Item No	Correlation coefficient
1	0.412*	11	0.749**	22	0.775**
2	0.754**	12	0.806**	23	0.837**
3	0.638**	13	0.462*	24	0.700**
4	0.671**	14	0.749**	25	0.644**
5	0.693**	15	0.551**	26	0.480*
6	0.605**	16	0.613**	27	0.650**
7	0.737**	17	0.787**	28	0.780**
8	0.386*	18	0.804**	29	0.706**
9	0.792*	19	0.787**	30	0.762**
10	0.758**	20	0.773**	**correlation coefficient at significance level 0.01	
		21	0.771**	* correlation coefficient at significance level 0.05	

Table 3 demonstrates that all correlation coefficients for all items are statistically significant at the 0.01 and 0.05 levels of significance, indicating that all items have good internal consistency validation with the overall test result. The results of calculating the correlation coefficients between the degree of each axis and the total test score are presented in Table 4.

Table 4: Correlation coefficients between the degree of each theme and the total score of the test

Axes of Test	Correlation Coefficients
Technologies of the Fourth Industrial Revolution	**0.942
Applications of Technologies of Fourth Industrial Revolution in Teaching and Learning of Sciences	**0.907
Technologies of the Fourth Industrial Revolution which can be included in the curriculum of science	**0.890

**The correlation coefficient is at a significance level of 0.01

The correlation coefficients at a significance level of 0.01 between the degree of each theme and the total test score are correlated with prior results. In addition, past results demonstrate that the test has a high degree of internal consistency validation.

6.2.7 Verifying the Consistency of Test Scores

The results of calculating the Cronbach's Alpha stability coefficient for each theme and the entire test are provided in Table 5.

Table 5: Stability coefficients for the theme "technologies of the fourth industrial revolution and their applications in the science curriculum" and the whole test.

Theme of Test	Number of Items	Stability Coefficients
technologies of the fourth industrial revolution	10	0.847
Applications of Technologies of Fourth Industrial Revolution in Teaching and Learning of Sciences	11	0.903
Technologies of the Fourth Industrial Revolution which can be included in the curriculum of Science	9	0.771
Test as whole	30	0.934

The previous results demonstrate a high degree of stability of the test, as the value of stability coefficients for the four dimensions of the test ranged from 0.771 to 0.903, and the value of stability coefficients for the test reached 0.934; all of these values are high, confirming the test's stability.

6.2.8 Preparing the Final Test Copy

The final version of the examination consists of two sections:

First Part: This section includes the test's definition, objective, and information about the female teacher, including her name (optional), specialization (physics - chemistry - biology), number of years of experience (less than five years, between five and ten years, and more than ten years), and test date.

Second Part: This section consists of 30 multiple-choice questions spread among three themes, as shown in the Table below.

Table 6: Distribution of questions related to the fourth industrial revolution and their applications in the curriculum of science

Theme of Test	Number of Items	Items
Technologies of the fourth industrial revolution	10	1-10
Applications of Technologies of Fourth Industrial Revolution in Teaching and Learning of Sciences	11	11-21
Technologies of the Fourth Industrial Revolution can be included in the curriculum of science	9	22-30

7. Statistical Methods

The following statistical approaches were employed: Frequencies and percentages were used to calculate the average responses of the sample to the study instrument.

1. One-way analysis of variance to determine the significance of differences in sample member responses based on variables of specialization and number of years of study.
2. Pearson correlation coefficient to validate the consistency of the research instrument.
3. Cronbach's Alpha coefficient to evaluate the reliability of a learning instrument.

To identify the acceptable level of familiarity with the technologies of the Fourth Industrial Revolution and their applications and inclusion in the science curriculum, the arbitrators were tasked with determining this acceptable limit, and their opinions agreed on the following percentages of the degree of familiarity:

- 80% or more is a very high score.
- 70% - 79.9% is high score.
- 60% - 69.9% medium score.
- 50% - 59.9% is low score.
- Less than 50% is a very low score.

8. Results of the Study and Interpretation

The results of the responses to the first question which is:

1. How familiar are the natural science teachers with the technologies of the fourth industrial revolution?

To address this question, the frequencies and percentages of the sample responses to the first topic of the study instrument were determined. Table 7 displays the number of accurate replies and percentages for each item and the familiarity level according to the previously set levels.

Table 7: Results of responses of the sample members to the first them of the test

#	Items of First Them	Number of Correct Answers	Percentage of Correct Answers	Degree of Familiarity
1	The fourth industrial revolution is called....	13	15%	Very low
2	The technology that allows communication between electronic devices or electrical devices via the Internet enables the user to control these devices remotely....	13	15%	Very low
3	A technology that displays virtual objects and additional information such as multimedia, films and 3D images in the learner's real environment.....	68	77%	High
4	Using a network of remote computer servers to store personal data on the Internet instead of on a personal computer.	26	30%	Very low
5	Protection of information systems connected to the Internet from the risks of cyber attacks....	65	74%	High
6	Acquisition of smart devices for knowledge by processing vast amounts of data to know the recurring patterns, identify common relationships and apply pre-defined rules....	17	19%	Very low
7	Converting information into a form that enables a computer to read it and use it in its arithmetic and logical operations	51	58%	Low
8	The technology allows the analysis and interpretation of the huge amounts of information received in a very large and accelerating way through digital information sources.	13	15%	Very low
9	A form of artificial intelligence is related to performing clear and specific tasks such as self-driving or speeches and image recognition.	31	35%	Very low
10	Technology-based on nano-particles and control it to create new products	80	91%	Very high
First axis as a whole		377	43%	Very low

The response of the sample members to the first theme indicates that just 43% of high school female science instructors are knowledgeable about the technologies of the Fourth Industrial Revolution. Their score was exceptionally high in one item, although it was also high in the other two. One item received a low score, while six items received a very low grade. These data can be understood in light of the Fourth Industrial Revolution's 2016 inception as a freshly emergent concept. This revolution is also known as the "second digital revolution" or "fourth industrial revolution." As the revolution incorporated numerous technologies, it became difficult for sample members (secondary female natural science teachers) to differentiate between its words. The results are congruent with the findings of Mpungose (2020) and Hariharasudan and Kot (2018) since both studies suggested that teachers must understand the technologies of the Fourth Industrial Revolution in particular and "digital culture" in general.

The results are drawn from the response to the second question, which is:

2. How familiar are the natural science teachers in secondary education with the fourth industrial revolution technologies?

To address this question, the frequencies and percentages of the results of the sample replies to the second theme of the study instrument were computed, and the outcomes are presented in the Table No. 8 below.

Table 8: Results of responses of sample members to the second theme of the test

#	Items of Second Them	Number of Correct Answers	Percentage of Correct Answers	Degree of Familiarity
11	Follow-up of students' attendance and their participation in classroom activities and practical activities in the laboratory	44	50%	Low
12	Perform chemical reactions virtually	62	70%	High
13	Providing a maximum degree of protection and safety for students during laboratory experiment procedures	18	20%	Very Low
14	Monitoring students' performance in laboratory experiments without being physically present with them in the laboratory	8	9%	Very Low
15	Display of organic samples and composition of different cells in a stereoscopic image	47	53%	Low
16	Simulating natural phenomena and exploring the relationships between them	49	56%	Low
17	Design models that facilitate learning of various scientific concepts	41	47%	Very Low
18	The application "Elements 4D" works to display the elements in four dimensions, and it can be used to explain the chemical elements in the periodic Table according to the technology	35	40%	Very Low
19	The technique that can be employed to explain some physical laws, such as Newton's laws	24	27%	Very Low
20	Explore the work of the different organs of some organisms.	45	51%	Low
21	Technology that can be used to conduct independent laboratory experiments.	39	44%	Very Low
The second axis as a whole		**412**	**42%**	Very Low

The response rate of the sample members to this topic was 42%, which is a relatively low percentage. The responses to six questions were extremely low, with percentages ranging from 9 to 47%. The responses to four questions are modest, with percentages ranging from 51% to 56%. However, the responses to one item are quite high, with a 70% response rate; this item relates to one of the applications of augmented reality technology.

In addition, the objects associated with this technology achieved relatively higher grades than those associated with the other technologies. The Internet of Things-related items (13, 14) were extremely low quality. Considering the Fourth Industrial Revolution's 2016 inception, these data can be understood as a freshly emergent concept. This revolution is also known as the "second digital revolution" or "fourth industrial revolution." Additionally, the results can be viewed in light of the prominence of "conventional approaches" in lesson teaching and learning. Using these technologies necessitates thorough training for instructors to increase their understanding of these technologies and equip them with the proper expertise in utilizing them according to educational objectives and study materials. In addition, "teacher preparation programs" do not consider new technologies in science instruction and learning.

The outcomes mentioned above were revealed in Allam and Ahmad's study (2020). In addition, the study of Aliyu and Talib (2020) emphasized the significance of training and skill development for teachers so that they are conversant with "Fourth Industrial Revolution" technologies and their applications in science education. The research conducted by Ally (2019) revealed that the use of technologies of the "Fourth Industrial Revolution" in the padagogy of science necessitates the preparation of "digital teachers" to stay up with these technological advancements. The research by Al-Qutaim (2020) revealed that the study sample largely concurred with the training requirements in light of the Fourth Industrial Revolution's applications.

Al-Dahshan and Mahmoud's study (2021) concluded that "professional development programs" must be designed for instructors to keep up with the Fourth Industrial Revolution. In light of this Revolution, the study by Al-Balshi (2022) showed that "professional development programs" are crucial.

Results of the responses to the third question:

3. How familiar are the teachers of natural science in secondary education with the applications of the fourth industrial revolution technologies in the teaching and learning of sciences?

To answer this question, the frequencies and percentages of the sample responses to the third theme of the study instrument were computed, and the findings are presented in the Table below 9.

Table 9: Results of responses of the sample members to the third theme of the test

#	Items of Second Theme	Number of Correct Answers	Percentage of Correct Answers	Degree of Familiarity
22	The field of education of environmental protection from pollution and water purification	23	26%	Very Low
23	The applications of stem cells and gene therapy	60	68%	Average
24	Understand how smart devices work	13	15%	Very Low
25	Explain the concept of additive manufacturing	8	9%	Very Low
26	The field of self-cleaning technology	16	18%	Very Low
27	Display the molecular structure of different substances, chemical bonds, and the composition of the elements in a stereoscopic image	41	47%	Very Low
28	The field of treating incurable diseases	60	68%	Average
29	View the latest developments in the bio-industries, alternative energy and pharmaceutical manufacturing	57	56%	Low
30	Explains the applications related to STEM	16	18%	Very Low
Third theme as a whole		**294**	**37%**	**Very Low**

The results indicate that sample members' acquaintance with the fourth industrial revolution technologies that can be incorporated into the natural science curriculum is extremely low (female teachers of natural sciences in the secondary schools). The percentage of occurrences of this theme reached 37%. The responses to six things were extremely low, with percentages ranging from 9% to 47%, while the responses to one item were low at 56%, and the responses to two items were 68.2% for reach.

These results can be understood in light of various circumstances, including those already discussed and those relating to the fact that Fourth Industrial Revolution technologies are among the newly emerging technologies and that digital literacy among teachers is low. In addition, the curriculum of natural sciences includes some applications of Fourth Industrial Revolution technologies, such as augmented reality and nanotechnology. Still, it lacks the interpretation of numerous technologies, such as 3D printers, the Internet of things, educational robots, and other technologies.

This aspect has been the subject of numerous studies, such as Al-Abbasi and Al-Ghamdi (2020), which recommended that the science curriculum be modified and updated in light of the revolution, and Hadadah (2019), which demonstrated that the curriculum did not account for the applications of the technologies of the Fourth Industrial Revolution. The prior responses of the sample members to the themes of the study instrument and the instrument are summarized in the Table 10.

Table 10: Results of responses of the sample members to the themes of the test

#	Themes of Test	Number of Items	Number of Correct Answers	Percentage	Degree of Familiarity
1	Technologies of Fourth Industrial Revolution	10	377	43%	Very Low
2	Applications of Technologies of Fourth Industrial Revolution in teaching and learning of science	11	412	42%	Very Low
3	Technologies of the Fourth Industrial Revolution can be included in the curriculum of Science	9	294	37%	Very Low
Test as whole		**30**	**1083**	**41%**	Very Low

These results are compatible with the recommendations made by numerous studies, which emphasized the necessity to reform the educational system in general and prepare instructors according to the Fourth Industrial Revolution's advancements. These include Omran (2019), Al-Sayyid and Mahmoud (2019), Hasan (2019), Al-Dahshan and Mahmoud (2021), (Al-Qutaim, 2021), Al-Balshi (2022).

Results of the response to the fourth question:

4. Are there significant statistical differences in the degree of familiarity of science teachers (female) with the technologies of the "Fourth Industrial Revolution" and their applications in science curriculum according to the following variables: specialization and the length of teaching experience?

To address the above question, the validity of the first and second hypotheses of the study was verified, and the following are the results for each hypothesis:

The first hypothesis states that "there is no statistically significant difference at the significance level (α ≤ 0.05) between the degree of familiarity of "natural science teachers" in secondary schools with the technologies of the Fourth Industrial Revolution and their applications in science curriculum according to the specialization variable."

To test the validity of this hypothesis, a one-way variance analysis was performed to determine the magnitude of the differences in the sample members' responses to the study instrument based on the specialization variable, and the following results were obtained:

Table 11: Results of verifying the differences between the responses of the sample members according to the specialization variable

Source of Variance	Sum of Squares	Degree of Freedom	Mean Squares	F Value	Significance Level	Significance
Between groups	14.35	2	7.165	0.448	0.640	No function
Within groups	1358.386	85	15.981			
Total	**1372.736**	**87**				

These results indicate that there is little statistical difference that is significant (α ≤ 0.05) between the degree of familiarity of "natural science teachers" in secondary schools with the Fourth Industrial Revolution technologies and their applications in science curriculum according to the specialization variable.

The Second Hypothesis states that "there is no statistically significant difference at the significance level (α ≤ 0.05) between the degree of familiarity of "natural science teachers" in secondary schools with the technologies of the Fourth Industrial Revolution and their applications in science curriculum according to the variable of the number of years of experiences.

To verify the validity of this hypothesis, a one-way analysis of variance was used to identify the significance of the differences between the responses of the sample members to the study tool according to the variable of several years of experience, and the results came as follows:

Table 12: Results of verifying the significance of the differences between the responses of the sample members according to the specialization variable

Source of Variance	Sum of Squares	Degree of Freedom	Mean Squares	F Value	Significance Level	Significance
Between groups	13.918	2	6.959	0.435	0.648	No function
Within groups	1358.79	85	15.986			
Total	1372.708	87				

These results indicate that there is no statistically significant difference at the significance level ($\alpha \leq 0.05$) between the degree of familiarity of "natural science teachers" in secondary schools with the technologies of the Fourth Industrial Revolution and their applications in science curriculum according to the variable of the number of years of experiences.

These results can be interpreted as "Academic Preparation Programs" for male and female teachers of natural science in general, which do not include special preparation for the technologies of the Fourth Industrial Revolution, in addition to the scarcity of reference to these technologies in the natural sciences curriculum. The results agree with the studies conducted by Allam and Ahmad (2020).

9. Conclusion

The current study sheds light on the significance of natural science teachers' familiarity with the technologies of the Fourth Industrial Revolution and their applications in the science curriculum, which is crucial knowledge for keeping up with developed nations in education and teaching requirements in the digital age. Notably, Saudi Arabia aspires to attain this target under its 2030 vision.

The study found that the degree of familiarity of natural science teachers (female) in secondary schools with the technologies of the Fourth Industrial Revolution is very low (43 percent). In comparison, the applications of these technologies in teaching and learning Science are low (42 percent). The technologies of the Fourth Industrial Revolution that can be incorporated into the natural sciences curriculum are also low (37%).

The study results indicate that there are no differences in the level of familiarity of female secondary school teachers with the technologies of the Fourth Industrial Revolution and their applications in the curriculum of natural sciences that can be attributed to the variables such as specialization and the length of experience.

In view of the "fourth industrial revolution", the results of this study may assist in focusing the attention of policymakers on developing "teachers' preparation programs" and science curricula, as well as offering "continuous professional development" programs to teachers to qualify them for teaching.

10. Recommendations

Based on the study's findings, it is feasible to create several recommendations, the most significant of which are:

1. Developing "Science Teacher Preparation Programs" and incorporating the principles and theoretical underpinnings of the Fourth Industrial Revolution into the curriculum of these programs.
2. Developing several "specialist training courses" for in-service science instructors to acquaint them with the technologies of the Fourth Industrial Revolution and how to incorporate them into the science curriculum.

3. Providing teachers of natural sciences with specific training materials through the Madrasati (My School) platform to introduce them to the technologies of the Fourth Industrial Revolution and their applications in scientific education.
4. Reconsidering the natural sciences curriculum with its numerous specialities. The curriculum should contain an "introduction to the technologies of the Fourth Industrial Revolution" and an explanation of the ideas and theoretical underpinnings of these technologies and their relationship to science education and the teaching of science.
5. Conducting additional research to identify, from the perspective of teachers and school administrators, the need to use the "Fourth Industrial Revolution" technologies to teach and learn science. In addition, the research should evaluate the impact of these technologies on the development of variables relevant to the educational process, such as "the development of academic accomplishment" and specific thinking skills.

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