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Awareness of green chemistry concepts among secondary school students

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Abstract--The objective of the research is to identify the extent of awareness of the concepts of green chemistry, the research objective was from (4043) students of the fifth scientific grade in the schools affiliated to the Education of Fallujah in Anbar Governorate, the research sample consisted of (400) students, and the research tools consisted in preparing and building a scale A science of chemistry concepts, which is used, consists of (42) items distributed into (12) concepts of green chemistry, and their validity and reliability were verified. In addition, there is no effect of the gender variable (male - female) on awareness of green chemistry concepts. In light of the results of the research, the researchers recommended several recommendations, including: Paying attention to the concepts of chemistry and including them within the fifth grade scientific curriculum.

Keywords---awareness, green chemistry concepts, students.

First: the research problem

Our age is characterized as the era of cognitive acceleration and scientific and technological race in the various fields of scientific knowledge, and this results in a significant increase in the volume of scientific knowledge, as the individual has to deal with what is going on around him of skills and valuable scientific information that makes him able to adapt to the environment in which he lives.

As a result of the aggravation of the environmental crisis and the risks resulting from the irrational use of technology and what we suffer from today from the dangers of environmental pollution of all kinds, the increasing consumption of natural resources and human disruption of the ecological balance, there was a

necessary and urgent need to prepare a person who understands his environment and is aware of the concepts of green chemistry and who improves the use of science and technology in a way that preserves his environment It protects it from the dangers of pollution and deterioration

Given the need to provide students with chemical information that helps them to live effectively in this life and to keep pace with the modern scientific and technological development in the scientific fields in general and in chemistry in particular, it is necessary to know the extent of their awareness of the basic concepts of green chemistry, which is one of the new branches in chemistry. Learning these concepts may help in Raising the chemical culture for high school students.

Given that the Ministry of Education serves the community in general and students in particular, it is responsible for preparing the student academically, which requires him to be familiar with emerging concepts and this was reinforced by a survey of the opinions of a sample of 10 teachers of chemistry by answering two questions that included the following:-

1-Do secondary school students have awareness of the concepts of green chemistry?

2- Do you think it is necessary to know the level of awareness of secondary school students in the concepts of green chemistry?

Therefore, the research problem is determined by answering the following question:

Do secondary school students have an awareness of the concepts of green chemistry?

Second: the importance of research:

Many modern sciences that are concerned with the environment have spread in the late twentieth century, and many of them still have not taken their right to spread, especially with regard to sciences that are concerned with chemistry and its relationship to the environment. It is the science that is concerned with the human image, clean environment and safe food at the same time. It is worth mentioning that the science of green chemistry affects economics from the concept of its impact on the clean environment at a lower cost, so many factories have taken care during the industrial chemistry program. There is no doubt that many sciences such as science Environment, agriculture, economics, bio and organic chemistry, health and food sciences are closely or remotely related to the science of green chemistry. Therefore, many conferences have contributed to the definition of the importance of green chemistry. It has included several goals, including industrial and governmental programs that sponsor education, educational materials, tools, safe scientific resources, tips, guidelines and directions, and the existence of projects serving education. New and educational spaces serving green chemistry (Shaker 2009: 8)

Hence, the interest in the environment has increased, because it is considered an important entry point for teaching chemistry to achieve important goals, which is to increase the relationship between the chemical information that is provided to students and their environment in which they live in order to face the real

problems of the environment, as chemistry is considered one of the important branches in the natural sciences (Awad 2004:5)

The researchers believe, through what has been presented and reviewed, that the importance of the research is summarized in several points that can be referred to as follows:

- 1-The research is a response to recent trends and developments in green technology
- 2 -Presenting a perception of the concepts of green chemistry and the basic principles of green chemistry
- 3 -Preparing a scale of awareness of green chemistry concepts that researchers in the field of green chemistry can benefit from in evaluating secondary school students.
- 4- Arousing the interest of curriculum planners and developers to the necessity of including green chemistry concepts in new courses that keep pace with the rapid and newly developed development in chemistry in the secondary school curricula.

Third: Research objectives

The current research aims to identify:

- 1 -The degree to which secondary school students possess awareness of the concepts of green chemistry.
- 2- The significance of the statistically significant differences in the awareness of green chemistry concepts according to the gender variable (male and female students)

Fourth: Research questions

To achieve the research objectives, the researchers formulated the following questions:

- 1 -Do secondary school students have awareness of the concepts of green chemistry?
- 2- What is the difference between the mean scores of the research sample in the scale of awareness of green chemistry concepts according to the gender variable?

Fifth: Limitations of Research

The current search is determined by the following:

- 1 .Basic concepts of green chemistry
- 2 .Secondary and middle school students for the fifth grade biology
- 3 .Anbar Education Directorate, Fallujah and its suburbs education department
4. Conducting the study in 2021-2022

Sixth: search terms

First: Awareness: defined by (Abu Al-Diyar et al.: 2012)

The individual's awareness of what surrounds him directly. Awareness involves the individual standing on a new idea and feeling that he needs more information about it.

(Abu Al-Diyar, Al-Buhairi, Mahfuzi, 2012, p. 215)

defined (Ibrahim: 2009)

•The student's ability to perceive and understand concepts and terms.

(Ibrahim, 2009. p. 1139)

The researchers adopt the definition (Ibrahim, 2009) as it fits the current study

The researchers define awareness procedurally: it is the individual's ability to understand, perceive, and encompass scientific and human concepts and terms and everything that surrounds him, which we can infer by answering some paragraphs of the awareness scale.

Second: Green Chemistry: It was defined by:

Doxsee and Huchison- (2004): - As one of the strategies that can be taken for environmental sustainability (Environmental Sustainability).

(Doxsee and Huchison ,2004)

Anastas (2000) defines it as:

Green chemistry is a new way to reduce chemical risks, along with more efficient and economical product production methods. Green chemistry is an essential part of a comprehensive program to protect human health and the environment.

Al-Janahi, 2021 defines awareness of the principles of green chemistry as:

The knowledge required to adopt the twelve principles that reduce or prevent the use or generation of by-products resulting from chemical reaction, solvents or catalysts that are hazardous to human health or harmful to the environment.

The researchers adopted the definition (Al-Janahi, 2021) because it fits the current study

The researchers define awareness of the concepts of green chemistry: it is a way to reduce the risks caused by environmental pollution, which students should be familiar with terms related to green chemistry in order to contribute to spreading awareness of the safe use of chemicals and reduce the damages resulting from these materials that affect humans and their environment. The student must answer according to the scale prepared for that.

The researchers define awareness of the concepts of green chemistry procedurally: perception and memorization of the terms contained in green chemistry that help in developing the cognitive structure of students in green chemistry, which is an emerging branch of chemistry that works on the safe use of chemicals and reduce the damages resulting from these materials that affect the human environment, which It can be inferred by answering the paragraphs of the scale of awareness of green chemistry concepts

Theoretical aspect and previous studies:

The first axis: the theoretical side

First: awareness:

Intelligence and rationality come to the fore when lower-level emotional situations are bypassed. The mind is able to deal with a large amount of complex information and difficult data in addition to making the right and quick decision through awareness and awareness of the complex relationships and the sequence of concepts and nuances between them through the expert manipulation of symbols as abstract concepts of increasing importance and this level is the level of technological sciences. Therefore, knowledge and culture are highly valued (Hawkins, 2018: 257).

On the basis of that, there are some words such as (thought, mind, culture, experience) that are used in the fields of civilization, and sometimes the

connotations of these words are confused, and this is normal. What concerns us is to highlight the significance of awareness of the implications of these words. On this basis, some scholars and specialists point out that consciousness means the sum total of what is obtained from feeling and perception. Consciousness is the sum total of complex mental and emotional processes. (Bakar, 2000: 9)

• **Concept of awareness:**

The concept of awareness is one of the topics of great importance in the fields of psychology and there are many scientific and psychological theories that lay down the basic principles and concepts that explain and clarify psychological phenomena, and thus took the word awareness of development and advancement in our intellectual and cultural life. At the present time, however, scientists define awareness as the feeling of a living being of himself and his surroundings (Aziz, 2015: 13).

Hamdan (2007) defines it as:

The characteristic of emotional activity and the absence of awareness is the criterion of unconscious forces, and one is aware of the requirements of reality, and he may be aware of the moral obligation that modifies his behavior, but he is not aware of the nature and extent of his primary motives, perhaps because his awareness of what frightens him and cannot be satisfied (Hamdan, 2007: 10).

As Ober (1977) defined it as a link between a subject and a subject, one of which is separated from the other in a precise way, and one of them opposes the other and unites one of the other (Aziz, 2015: 10).

• **Types of awareness:**

Awareness in its comprehensive concept includes a number of cultural, religious, economic and political dimensions. Awareness in general includes informing the individual of various social, economic, political issues and even scientific issues that are related to society. These forms include the following:

1. Cultural awareness: It is a form of awareness that enables the individual to understand his society and its issues from a comprehensive historical perspective.

2. Religious awareness: It is a form of awareness that enables the individual to understand and perceive religious knowledge according to a comprehensive comprehensive vision in which the individual is not isolated from the context of history and the society in which he lives.

3. Moral awareness: It is a set of ideas and perceptions of required and recommended behavior and immunization of the individual with good morals, which pushes his behavior towards the right path.

4. Economic awareness: It is directed to the system of economic life of the members of society and its control and reflects the links between them within the framework of the process of production, distribution, exchange and consumption, and studies on ways to develop and advance the economy.

5. Health awareness: It is the community members' knowledge of health information and facts and their sense of responsibility towards their own health and the health of others.

6. Political awareness: It is a set of values, trends, and political foundations that are formed by the individual and enable him to effectively participate in the issues and problems of his society through analyzing and judging them, determining his position on them and working to change and develop them.

(Sagittarius, 2018: 10)

Second: Basic Concepts in Green Chemistry

There are many concepts related to green chemistry, including for example (green chemistry, principles, raw materials, atomic economics, energy, solvents, catalyst extraction methods, products, evaluations, precise laboratory experiments, green awareness, and energy awareness) and that each concept Of these concepts, it contains other related sub-concepts, but the most important of these basic concepts in green chemistry are the principles developed by Anas Warner (Juanjuan & Shengli, 2018: 210)

Therefore, the references refer to the agreed basic concepts, which must be taken into account when talking about green chemistry. Shaker (2010), Kazem (2012), Al-Shehri (2019) and Al-Hajjaj (2020) mention that among the most important basic concepts of green chemistry are:

1 -**Prevention**: It means not to form waste better than treating it or disposing of it after its formation

2- **Corn Economy**: It is the planning of methods for producing compounds so that all the reactants are combined in a chemical reaction to form the desired product

3 -**Safe chemical synthesis**: These are reactions that contain safe, non-harmful reactants and product materials for human health and the environment.

4 -**Safe chemical products**: They are chemical products and materials that have the highest degree of functional efficiency and less toxicity

5 -**Safe solvents**: It means to carry out reactions without using additional materials such as solvents, separation materials or other dangerous auxiliary chemicals.

6 -**Green energy**: It means carrying out chemical reactions with the lowest possible energy so that they take place at normal temperatures and using energy in the narrowest limits due to its cost and environmental impact.

7 -**Renewable resources**: This means that the reactants in the chemical reaction are renewable and they are of biological or plant origin, so that non-renewable raw materials are not depleted from fossil fuels.

8 -**Reducing derivatives**: It is to avoid unnecessary physical processes and chemical reactions, such as making temporary modifications in molecules or deriving certain groups.

9 -**Safe catalysts**: They mean green catalysts that accelerate the chemical reaction without being consumed or combined with the product.

10 -**Solubility**: It means the production of chemical products that are unstable in the environment after performing their function, i.e. decomposing into simple harmless substances.

11 -**Real-time monitoring**: It means the development of chemical analysis methods so that they control the reaction before harmful substances are formed, and the use of accurate analyzers to keep pace with the course of the reaction in real time.

12 -**Preventing accidents**: Safe chemical materials and methods must be chosen in terms of type and composition so as to reduce the occurrence of chemical accidents from the release of gases, explosions or fires.

(Abdul Moez, 2017: 358)

Awareness of green chemistry concepts:

One of the most important aspects of the prosperity and development of nations is the advancement of the knowledge aspect of the members of society in general and students and scholars in particular, and from here comes the role of awareness, as it works in the development of thinking, the development of career work, the application of knowledge in life aspects and keeping pace with modern technology and scientific and cognitive progress, in addition to all that increasing interest And the students' desire to acquire information that helps them in their daily lives (Al-Janahi, 2021: 52).

Green chemistry is considered one of the main scientific solutions to problems related to the environment, so it is necessary for students to have sufficient awareness of green chemistry and the basic concepts that belong to this term. It includes three important dimensions (Caruana, 2015:25).

1 -The cognitive dimension

This dimension is represented in the student's ability to obtain a sufficient amount of information and concepts that enable him to use and apply this information in practical life. Therefore, chemistry can be included in the community, as it contributes to improving the quality of life and has a beneficial effect on the environment and controlling the production and release of toxic substances to the environment as It can make our difference in our lives and is instrumental in the progress made by humanity (Caruana, 2015:155).

Many studies have emerged in knowing the importance of learning chemistry in school by measuring students' attitudes towards school chemistry by analyzing their cognitive responses to chemistry theoretical lessons and their importance and usefulness in daily life. Therefore, the study of chemistry should improve students' abilities in other sciences. So that if they perform well in chemistry, they do well in other sciences, and here the chemistry curriculum needs to be updated to replace current topics with new ones to better reflect the current and future contribution of chemistry to society and daily life (Salta & Tzougraki, 2004:10).

The researchers believe that increasing awareness of green chemistry concepts will have a positive impact on students' daily lives and works to secure a sustainable future for future generations. Through understanding and applying these concepts, the student can solve environmental problems facing the individual and society, and that awareness of green chemistry concepts protects future generations from past mistakes and seeks To improve safety in human health and the environment

2 -The emotional dimension:

The emotional or emotional aspect is one of the important aspects that should be taken into account by students in general, and accordingly, this dimension measures students' emotional attitudes towards chemistry as a study subject, and these attitudes are an expression of admiration or dislike for chemistry, so chemistry lessons must be interesting And enjoyable, more interesting and

exciting, especially on the practical side than on the theoretical side (Saada, 2001: 497)

The researchers believe that the study of green chemistry is of increasing importance, and through it, students acquire a more attractive image of general chemistry, and it will become more relevant to students and their daily lives if they understand the basics of the color green. The word green chemistry does not mean color as much as it indicates purity and safety for human health and environment and a return to safe natural resources.

3 -The skill dimension:

The skill dimension is no less important than the cognitive or emotional dimension. There is a close relationship between these dimensions. The successful individual in life is the one who has a background that helps him to interact with things and deal with others, but this needs a strong and correct body and accordingly the student can develop the skills and motor abilities that The student is expected to acquire it after passing through the educational learning experience (Al-Samarrai, 2014: 15)

The skill dimension is included to search for any link between learning the concepts of green chemistry and any student work directions. It is necessary to increase awareness of the concepts of green chemistry so that they have the ability to understand the basic concepts of green chemistry and have chemical ideas in chemistry laboratories and apply those concepts in the students' future professional aspirations and make The student is more interested in choosing a profession that includes chemistry, whether it is in the field of medicine, health care, pure sciences, or chemical engineering (Caruana, 2015: 164).

Through what has been presented, the researchers see that awareness expresses the state in which the mind is aware and communicates directly with the external environment through the outlets of consciousness represented by the five senses, through which a person forms concepts, views and ideas related to the life surrounding him. Awareness of the concepts of green chemistry has an impact It greatly affects the lives of high school students in terms of thinking, scientific development and keeping pace with modern technology in green chemistry, its interactions and products. The students' gaining an amount of awareness of the concepts of green chemistry contributes to increasing the desire for chemistry and reduces the aversion of secondary school students towards this science, and then that Awareness of green chemistry concepts increases their drive to conduct chemical experiments in a safe and harmless way to their health and environment. Through this, awareness of green chemistry concepts indicates three dimensions (cognitive, skill, and emotional).

The second axis: previous Arab and foreign studies related to green chemistry

1 .Juanjuan&Shengli Study (2018): This study aimed to examine high school students' understanding of concepts related to green chemistry, including raw materials, solvents, and atomic economics. The interviews were conducted with

ninth through twelfth grade secondary school students to gain their descriptive understanding of the corresponding concepts. Based on the systematic analysis of the collected data, a two-tiered semi-structured diagnostic tool was proposed, which was then given to high school students. Some options that were not often chosen by respondents were omitted. Using the revised tool, an empirical survey was conducted among high school students, and a similar exclusion procedure was followed. The final instrument was used to conduct a survey among 9th to 12th grade high school students to examine their understanding of various concepts related to green chemistry. The results showed that high school students' understanding of concepts related to green chemistry and the term "green chemistry" was low. However, the older students' understanding of the corresponding concepts was much better than that of the younger students. No significant differences were found between male and female students. The results of this study can help teachers study the knowledge that their students have better mastery and assess progress in learning green chemistry.

2- Al-Janahi study (2021): The aim of the research is to identify the awareness of the principles of green chemistry and the trend towards sustainable development for chemistry teachers, for the preparatory stage, and to identify the relationship between awareness of the principles of green chemistry and the trend towards sustainable development for them. A descriptive, correlative research method was adopted, and a community of chemistry teachers was identified in the middle schools of the Directorate of Education in the Qadisiyah Governorate, which numbered (250) teachers and schools, and the research sample consisted of (130) teachers and schools who were chosen randomly, and the researcher built two tools To achieve the objectives of the research, one of them is: the measure of awareness of the principles of green chemistry, and the other tool is the measure of the trend towards sustainable development. The research reached a number of results. The teachers of chemistry possess an average level of awareness of the principles of green chemistry and a positive trend towards sustainable development and the existence of a direct relationship between both variables and the absence of an effect The gender variable in the awareness of the principles of green chemistry and the trend towards sustainable development, as well as the relationship between them.

Research Methodology and Procedures:

First: the research methodology

The descriptive associative research method was adopted because this method is considered an essential pillar of scientific research that depends on the study of the phenomenon as it exists in reality and is concerned with its description as accurate and expressed qualitatively or quantitatively. Conclusions and generalizations that contribute to the interpretation of phenomena, allowing them to be changed and directed towards desired goals (Al-Mashhadani, 2019: 128).

Second: the research community:

The current research community consists of all the students of the fifth grade of biological sciences in the middle and secondary schools of the Anbar Education

Directorate / Fallujah Education Department in the morning government schools, and their number is (4043) students, Table (1):

(1) Table

*Education and by sex Research community by Fallujah Directorate of

the total	Number of Fifth Grade Biology Students (Female)	Number of Fifth Grade Biology Students (Male)	Directorate
4043	2298	1745	Fallujah Education *Directorate

Third: The research sample:

The sample can be defined as a model that includes and reflects an aspect or part of the units of the original community concerned with the research, and is representative of it, so that it bears its common characteristics (Alyan and Ghoneim, 2000: 138).

In order for the results of the research to be valid and generalizable, the sample must be an accurate and correct representation of the complex and include the following research samples:

1 -**The initial exploratory sample:** The exploratory sample consisted of (40) male and female students (20) male and female (20) male students from the Central Preparatory School for Boys and Wadi Al-Aqiq Preparatory School for Girls of the Fallujah Education Directorate. This sample was used to determine the clarity of the paragraphs and the time taken to answer paragraphs Scale and test.

2- **The statistical analysis sample:** It consisted of (200) male and female students, and the sample was taken from two schools, one of them is a preparatory school for boys and the other for girls affiliated to the Fallujah Education Directorate distributed as in Table (2) and this sample was used to know the psychometric characteristics of the tests.

(2) table

Statistical analysis sample

the number	sex	The school
100	male	Mansour High School -Abu Jaafar Al for Boys
100	female	Links Prep for girls

3- The basic research sample: the basic research sample was randomly selected from the schools affiliated to the Directorate of Education in Fallujah, as it was calculated according to (Steven Thompson) equation, and it amounted to (400) male and female students distributed over (4 schools) for males and females, i.e. a ratio of 10 % of the research population, Table (3).

* Education in Fallujah, Community numbers were obtained from the Statistics Department of the Directorate of Education in Fallujah, Community numbers were obtained from the Statistics Department of the Directorate of Education according to the book facilitating the task issued by the University of Baghdad / College of Education for pure Haytham / No. D. 7037 on 1/12/2021-sciences / Ibn Al

(3) Table
basic research sample

Preparing the students of the fifth scientific	schools 'girls	Preparing the students of the fifth scientific	boys schools	Anbar Education Directorate
65	Aqiq High -Wadi Al School	49	Jaber Bin Hayyan Preparatory School for Boys	Fallujah breeding
67	Al Qawarer High School for Girls	65	Central Preparatory School for Boys	
68	Freedom High School for Girls	86	Awfaa -Al Preparatory for Boys School	
200		200		the total

Fourth: search tools

To achieve the objectives of the research, it is necessary to have a set of tools to measure the research variables, which prompted the researchers to review the literature and previous studies related to the research variables.

1 -Awareness scale of green chemistry concepts:

In the absence of a suitable and ready-made scale to measure the information of the fifth-grade bioscience students, the researcher built and prepared a scale according to the following steps:

1-1 -Determining the objective of the scale:

The scale aims to measure awareness of green chemistry concepts among secondary school students of the fifth grade of biological sciences.

1-2 -Defining the concepts of green chemistry:

Through a review of the educational and scientific literature and previous studies, it was found that there are a large number of concepts related to green chemistry, which were mentioned in several researches. Therefore, (12) concepts were identified, which mainly express green chemistry, namely pollution prevention, corn economy, safe interactions, chemical products. Safe, Safe Solvents, Design to Reduce Energy, Renewable Materials, Reduce Derivatives, Catalysts, Unstable Products, Instant Decomposition, Prevent Accidents

1-3 -Formulating the scale items:

The items of the scale were formulated to match the level of secondary school students for the fifth grade of Biology. The items were formulated in clear and easy language, as the scale consisted of (42) items distributed over twelve concepts shown in Table (4).

(4) Table
Distribution of the scale items among the concepts of green chemistry

number of paragraphs	Paragraph number that measures the concept	concept	T
3	3,2,1	pollution prevention	1

3	6,5,4	corn economy	2
3	9,8,7	Reduce the risk of chemical synthesis	3
3	12,11,10	Safe product design	4
3	15,14,13	Safe solvents	5
4	19,18,17,16	reduce energy	6
4	23,22,21,20	Renewable materials	7
3	26,25,24	reduce derivation	8
4	30,29,28,27	motivating factors	9
4	34,33,32,31	biodegradable design	10
4	38,37,36,35	instant decomposition	11
4	42,41,40,39	Safe chemistry to prevent accidents	12

1-4 -Drafting the instructions for the scale items:

Presenting the paragraphs to the arbitrators (apparent honesty):

Honesty is one of the most important psychometric characteristics compared to other characteristics, because of the link between honesty and the objectives expected of the measuring tool to achieve.

Initial survey application:

The two researchers applied the scale in its initial form to a sample of students of the fifth scientific grade in the Central Preparatory School for Boys and Wadi Al-Aqiq Preparatory School for Girls, corresponding to 12/12/2021, and their number was (40) male and female students distributed among (20) students (20) female students. The extent of the clarity of the scale items and the clarity of the scale's instructions, in addition to calculating the time taken to answer the scale items, as the average time for all students' answers was calculated, and the average answer was (30) minutes.

•Applying the scale to the sample of statistical analysis:

•Statistical analysis of paragraphs:

The statistical analysis of the items of the scale or the test is one of the important stages through which the scale can become close to achievement, as this stage is to avoid errors in the items of the scale, which the responding students will fall into (Al-Yaqoubi, 2013: 105), and for the purpose of statistical analysis of the scale and after Verifying the possibility of its application and the clarity of its instructions and determining the time taken to answer through the initial exploratory sample. It was applied to a sample consisting of (200) male and female students distributed between (100) male and (100) female students for two preparatory schools Al-Rabet for girls and Abi Jaafar Al-Mansour middle schools for boys for a period of 4 -6/1/2022.

Calculation of the discriminative power factor of the paragraphs:

Discrimination is one of the important characteristics that should be available in the vocabulary of the scales, and by this we mean the extent to which individual differences can be measured using the vocabulary and items of the scale (Allam, 2000: 277).

Clauses validity (internal consistency):

Paragraph validity, or the so-called hypothetical formative validity, deals with the relationship between the results of tests and measures and the theoretical concept that the scale aims to measure. (Allam2000: 215)

Scale stability:

Reliability refers to the consistency of the results recorded on the same tool and the stability in general. The degree of stability between two scales of the same type, that is, the consistency of the results collected by re-applying the same tool to the same sample and in the same or similar conditions (Al-Zuhairi, 2017: 233). Therefore, the researchers calculated the stability of the scale by relying on:

Retest method:

In this method, the scale or test to be found is applied to a specific group of individuals, preferably 30 or more, then the scores of each individual from the group are calculated and after a period of time ranging from two to four weeks at most, the scale or test is re-applied on the same The group and in the same circumstances as much as possible to reach the scores of the individuals in the second application, and then the stability can be calculated through the Pearson correlation coefficient, which represents the stability of that test (Al-Zamili et al., 2009: 257).

The researchers retested the statistical analysis sample after two weeks, then the Pearson correlation coefficient was calculated between the scores of the first and second applications, and the value of the test reliability coefficient was (0.77), which is a good indicator of the scale's stability (Al-Assaf, 2003: 237).

A method of analysis of variance using the alpha-Cronbach equation:

This method is used to find the reliability coefficient of tests and measures in order to confirm the stability of the scale (Al-Zuhairi, 2017: 237), and through that, the Alpha Cronbach equation was applied to the degrees of statistical analysis, as it confirms the homogeneity and consistency of the answers for all test items (Al-Kubaisi, 2010: 297).) Where stability was calculated in this way through the scores obtained from the statistical analysis sample of (200) forms, and the alpha coefficient reached (0.73), which is a good stability coefficient and confirms this (Al-Assaf, 2003: 237) and table (5) shows the values of the coefficient of constancy

function	1.96	35.701	126	14.201	151.350	400	awareness of concepts green chemistry
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The second objective: to identify the significance of the statistical differences in the awareness of green chemistry concepts according to the gender variable (male and female students).

The second question:

What is the difference between the mean scores of the research sample in the scale of awareness of green chemistry concepts according to the gender variable?

For the purpose of verifying this goal, the two researchers took the responses of the research sample amounting to (400) male and female students on the scale of awareness of green chemistry concepts. 151.00) with a standard deviation of (13.808), and the average score of the female students (152.06) with a standard deviation (14.69), and to find out the significance of the differences between male and female students, the t-test was used for two independent samples, and the results were as shown in Table (7) showing this.

(7) Table

The average scores of the sample members on the scale of awareness of green chemistry concepts variable values according to the gender-and their standard deviations and T

noitacidni	eulav T		naem laciteroehT	dradnats noitaived	naem citehtirA	eht elpmas	elbairav xes
	_ralubaT	detaluclac					
noitenufnon	1.96	0.747	126	13.80	151.00	200	stneduts eht
				14.69	152.06	200	elamef stneduts

It is clear from the above table that there are no statistically significant differences between male and female students in the awareness of green chemistry concepts because the calculated t-value (0.747) is smaller than the tabular t-value of (1.96) at the significance level (0.05) and the degree of freedom (398).

Discussion and interpretation of the results

The results showed that secondary school students in the fifth scientific grade have some intuitive concepts of green chemistry, but this awareness did not reach the full mastery of these concepts. Al-Janahi: 2021), but it differs in the type of society that was chosen, which is male and female middle school teachers, and this is due to several reasons:

- Lack of follow-up to the scientific development that occurs in the field of chemistry, as well as the lack of knowledge or follow-up of scientific articles and

research in the field of green chemistry, which led to their possession of the concepts of green chemistry in an acceptable manner.

- The secondary school curricula do not contain the concepts of green chemistry, so that students can familiarize themselves with this field.
- Lack of activities, training and scientific field trips for students in chemical laboratories inside and outside the school.
- Green chemistry and its scientific applications can be considered a new challenge to the science of chemistry and the environment, in a way that we cannot say that green chemistry is "chemical-free materials", but rather green chemicals, to reassure all society that the science of chemistry is a companion of safety and health.

Conclusions

In light of the research results, the following can be concluded:

- 1 -Students of the fifth scientific secondary stage have a tangible awareness of the concepts of green chemistry as a result of their study of chemical concepts, in addition to that, because these concepts are related to the student's life.
- 2 -There is no effect of the gender variable (male-female) on awareness of green chemistry concepts.

Recommendations

Based on the results of the research, the researcher recommends the following:

- 1 -The necessity of developing chemistry curricula at the secondary stage in line with the concepts of green chemistry
- 2 -The necessity of holding workshops and seminars on the environmental problems and issues raised in our country and the necessity of applying these concepts to reality.
- 3 -Selection of experiments that take place in school laboratories so as to preserve the environment and human health, especially experiments that follow the concepts of green chemistry
- 4 -Directing secondary school students to make flyers and posters to spread the culture of green chemistry among students.

Proposals

Supplementing the current research suggests the following:

- 1 -Preparing a proposed concept for the chemistry curriculum for the secondary stage based on the concepts of green chemistry.
- 2 -Conducting a study dealing with the awareness of green chemistry among male and female teachers of chemistry at the secondary level.
- 3- Conducting similar research to the current research to deal with other variables such as (environmental chemistry, scientific culture, environmental awareness, environmental enlightenment).

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