



A proposed unit based on industrial exploratory activities via the web for developing industrial education students' awareness of climate change and professional responsibility

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Abstract

The research aimed to identify the effectiveness of a proposed unit based on industrial exploratory activities via the web for developing industrial education students' awareness of climate change and professional responsibility towards the environment. To achieve the research aims, the proposed unit based on industrial exploratory activities via the web was prepared as well as a climate change awareness test and a situations scale of awareness of professional responsibility. The two research groups were selected from second-grade students at Al-Maragha Industrial Secondary School for Boys and divided into a first experimental group (the proposed unit is taught using the normal explanation method) and a second experimental group (studying the proposed unit using industrial exploratory activities via the web). The results showed the advantage of teaching the proposed unit using industrial exploratory activities via the web in developing awareness of the risks resulting from climate change and professional responsibility of the students of the second experimental group over the students of the first experimental group who studied the proposed unit in the normal explanation method in the post-application.

Keywords

Industrial Exploratory Activities, Web, Industrial Education, Climate Change, Professional Responsibility.

Introduction

Climate change is a global environmental issue that results in serious changes that threaten the human future. The reasons for these changes are due to increasing rates of human activity, including industrial activity, which has led to an increase in the concentration of certain gases in the atmosphere and the occurrence of what is called global warming. Therefore, educational institutions are to be one of the most important effective tools in enhancing awareness of the risks resulting from industrial activities that cause climate change. Activities represent one of the basic pillars that contribute to achieving many educational, psychological, social and environmental goals and help prepare students to learn, consolidate concepts and information and transmit the impact of what they learn into their public and professional lives.

The main cause of the global environmental crisis is the emission of environmentally polluting gases. This is why we must shift towards clean and green technology (Church, 2013). The Intergovernmental Panel on Climate Change (IPCC, 2014) report indicated that human interventions have become clear in the negative impact of the climate and that greenhouse gas emissions resulting from the combustion of fossil fuels and increasing industrial uses represent the main cause of climate change. So individuals must change their lifestyle and their professional behaviors to mitigate those emissions.

Emissions resulting from the industrial sector represent (12.5%) of the total greenhouse gas emissions in 2015, which is a very large percentage that increased by (49%) compared to 2005 (Updated Report of the Arab Republic of Egypt, 2018, 45). Al-Halawani (2021, 54-55) pointed out that industrialized countries represent the primary source of pollution and climate change. Sababha's study (2014) found a decrease in awareness of climate change among

young people and the study recommended the necessity of disseminating awareness of the danger of climate change with the optimal use of resources.

This is what made many researchers research and direct towards improving individuals' positive behaviors towards the environment because an individual who has professional awareness is more keen to follow preventive measures in professional work which would contribute to protecting and preserving the environment from climate change. Therefore, individuals must be qualified at different stages of education (Dudziak. et al, 2016, 734).

The report of the Egyptian Ministry of Environment (2021) stressed the importance of disseminating awareness of the seriousness of climate change and uniting for a better future for humanity. The Minister of Education and Technical Education stressed the importance of providing environmental topics, especially those related to climate change, to increase teachers and students' awareness of environmental problems, so that this is reflected in society's behaviors to preserve natural resources and mitigate pollution (Egyptian Ministry of Environment, 2021, 7).

The study by Al-Sibai, et al. (2021, 100) suggested integration between different sectors of society to raise awareness of climate change while modifying school curricula to be compatible with developing awareness of environmental pollution problems. Additionally, Ghanem's study (2021, 531) indicated the importance of educating students on how to protect the environment and take responsibility for confronting climate change.

Educators call for the necessity of including the environmental dimension within the objectives of educational institutions in order to preserve the environment and its natural components, and the Dubai Cares Foundation called at the climate conference in Egypt for teaching everything related to the environment and climate change within the framework of the school curricula because of the great importance it represents (Conference COP27, 2022).

In the same vein, Ammar (2011, 34) pointed out the importance of linking curricula to modern developments and using technological learning strategies that contribute to enhancing students' abilities to research and discover so that they are able to confront societal issues.

Industrial education is of great importance in enhancing the abilities of its students with the concepts, knowledge, information, and skills necessary to achieve the goals and objectives of learning because its impact is transmitted to life situations in society (Obaid, 2012, 5). That is why El-Kholy (2014, 216) emphasized the importance of developing programs and curricula in light of the interaction between science, technology, and society to connect the learner to the reality of their environment and society to contribute to confronting environmental problems and issues that hinder the process of progress in society. Similarly, Al-Bitar (2015) and Khalifa (2016) pointed out the importance of activities in the curriculum to stimulate the motivation of industrial secondary education students to learn, develop aspects of learning, and meet their needs to confront and interact with educational and societal situations. Furthermore, El-Kholy and Ghoneim (1998, 59-78) focused on industrial environmental education, which is responsible for preparing technicians who preserve the environment from the negative effects of factories. The study recommended the importance of providing learning materials within its educational plans to disseminate environmental awareness among students and increase their knowledge of how to deal with the environment and preserve it as well as strengthening the link between various industrial and productive institutions and educational institutions to preserve the environment.

Web-based learning transforms content into interactive activities (Azmi et al., 2014, 242). The Web helps in building and discovering knowledge, solving problems, and assisting in learning (Fares, 2019, 14). This is why educational institutions seek to make the educational task unrelated to time or a place with innovation of new learning methods that contribute to preparing the individual for society (Abdel Jalil, et al., 2021, 4). Web-based

activities contribute to self-learning through practice, improving understanding and application, and reducing time and effort in communicating information (Azab, 2015, 6).

Professional responsibility represents the basic foundation of any legal system that guarantees respect and commitment to work principles within institutions to prevent harm to environmental abilities that result in harm to society. Professional individuals take the responsibility for the emission of greenhouse gases that cause the deterioration of the natural environment. Abdel Fattah's study (2020) showed the importance of raising environmental awareness in its three dimensions (environmental concepts, environmental decision-making, and responsible environmental behavior) as well as developing environmental responsibility.

The responsibilities are many but they intersect with each other. This is why the current research focused on professional responsibility, including professional awareness that is reflected in industrial education students' behaviors in their professional activities to preserve the environment from climate change. Saleh (2017, 96) pointed out the important role of vocational secondary school teachers in developing environmental responsibility among vocational education students. This is why Al-Yazal et al. (2014, 643-650) emphasized the importance of activities to identify factors affecting the environment; Students use materials that do not negatively affect them in their artistic works in order to lead a healthy and safe life. Also, Shaheen's study (2014) recommended the importance of paying attention to cognitive aspects and their values and situations as well as the need to focus on classroom and extracurricular environmental activities to develop environmental values.

In addition, the study by Al-Dosari (2018, 297) indicated that practicing electronic activities contributed to providing environmental field visits via the internet to discover the environment and study its various problems. The results of Al-Otaibi's study (2014) confirmed the effectiveness of a proposed study unit including suggested activities in environmental education to develop concepts and environmental situations among female

students. Likely, the study by Sobhi et al. (2020) concluded that the activities are effective in developing environmental enlightenment regarding green technology concepts among students and recommended the necessity of preparing activity booklets.

We note from previous studies that climate change represents a global threat that must be addressed because of its negative impact on society and national economy as climate changes have led to the following:

- High temperatures that will affect the increased demand for refrigeration and air-conditioning devices charged with Freon gas that produces greenhouse gases as well as increasing the consumption of electrical energy resulting from the burning of petroleum materials that cause greenhouse gases emission.
- Wind movement is negatively affected by climate change and this will affect Egypt's national projects of producing and generating clean electrical energy from wind energy.
- Industrial production has been negatively affected and this will be reflected in the production system in all sectors and will lead to an increase in prices. People will pay the price and take responsibility for this.

Because the climate is an integral part of the environment that qualifies for the production process which represents the most important stages of the national economy, the importance and role of industrial education institutions represents in raising the level of awareness of climate changes and professional responsibility towards the environment. Previous studies have proven the positive impact of activities in achieving various learning objectives. So, the current research confirms the necessity of environmental planning in all areas of industrial production, including the development of positive professional behaviors among industrial education students to establish a sense of responsibility towards society to preserve the environment and protect it from the dangers resulting from industrial activities

that cause climate change. Therefore, industrial education curricula must contain specialized topics to disseminate awareness of the dangers of climate change resulting from industrial activity causing the emission of greenhouse gases as well as making students aware of their professional duties and responsibilities towards this.

Identifying the research problem stemmed from the following:

- The reality in which we live and the resulting climate changes that the world has never witnessed before makes each of us responsible for positive action towards the environment in our field of work. This is what made the researcher propose a unit based on industrial exploratory activities via the web to develop the awareness of industrial education students about climate changes and professional responsibility towards the environment.
- The local and global challenges that the world faces as a result of climate change and its risks to the environment and society which require us to educate industrial education students about the industrial sources and causes that have led to climate change and how they can be overcome and confronted to prevent them. This is what the results of many previous studies have confirmed about the importance of including content that contributes to awareness of environmental and climate risks in the curricula such as the study of El-Kholy and Ghoneim (1998), Sababha (2014), Al-Otaibi (2014), Al-Sakini (2015), Al-Sibai, et al. (2021) and Ghanem (2021). This research differs from previous research by presenting a proposed study unit to develop awareness of climate changes resulting from industrial activity and their professional responsibilities towards that.
- What was confirmed by the results of previous research and studies, and recommended by local and international conferences of the importance of preserving the environment from climate change and the necessity of taking rapid executive measures to limit

climate changes such as the study of Church (2013), Al-Sakini (2015), Egyptian Ministry of Environment (2021), recommendations of the COP27 Conference (2022) in addition to the scarcity of previous research that focused on developing the awareness of industrial education students in its various specializations about the industrial causes that have led to climate change and their professional responsibilities towards that.

- What was also confirmed by the results of previous research and studies of the importance of activities in the educational process to achieve various learning aims, while recommending the importance of including activities in school syllabi to develop values and environmental awareness such as the study of Al-Yazal et al. (2014), the study of Shaheen (2014), Al-Bitar (2015), Khalifa (2016), Al-Dosari (2018), Sobhi et al. (2020), but the researcher notes the scarcity of previous research and studies that benefited from employing web-based activities in dealing with climate change issue resulting from industrial activity. Therefore, the current research proposes the use of industrial exploratory activities via the web to develop industrial education students' awareness of climate change and professional responsibility towards it.
- The researcher and two refrigeration and air-conditioning teachers, an expert teacher in theoretical technical subjects and an expert teacher in practical training, analyzed the content of the curricula for the refrigeration and air-conditioning technician specialization program (three-year system) in industrial education in light of climate changes to identify strengths and weaknesses and determine the extent to which that program includes topics or activities in their content that address awareness of climate change or professional responsibility. The analysis sample consisted of nineteen books for the three grades of the Refrigeration and Air Conditioning Technician program. The analysis results agreed by a percentage of (94%) on the following:

- The content of the study topics doesn't include the causes of atmospheric pollution from Freon gas and industrial activities.
- A lack of sufficient information of the danger refrigerant compounds of chlorofluorocarbons (CFCs), which consist of carbon, fluorine, and chlorine (without hydrogen), such as (R12 - R114 - R11) used in old refrigeration units, as well as hydro chlorofluorocarbons (Hydro Chlorofluorocarbons or HCFCs), which consist of carbon, fluorine, chlorine, and hydrogen) such as (R123 - R22) used in air conditioners, because when these compounds reach the ozone layer, ultraviolet rays work to liberate the chlorine atoms from these compounds, and the chlorine element works to destroy the ozone layer, which leads to the leakage of ultraviolet rays to earth. This causes harmful effects on the air and living organisms on Earth.
- Lack of awareness of safe procedures and methods that must be followed when discharging old gases (Freon gas) or leaking new refrigerant charges, and how this can be avoided.
- The negative effects on the environment, atmosphere, ozone layer and other gases resulting from discharging and charging various refrigeration circuits.
- Lack of information on safe methods for cutting the capillary pipe to safely dispose the refrigerant compound coming out of the refrigeration circuit and consumable gases by using a unit to withdraw and recycle the refrigerant compound in safe and environmentally friendly ways to mitigate the resulting gases that cause atmospheric pollution.
- Lack of sufficient information about environmentally friendly welding materials, how to safely clean welding places, and how to extract fumes generated from welding operations in a safe and sound way.

- Lack of information on the impact of electrical wires used in refrigerant circuits, as well as the grounding system and how to be protected from lightning strikes, weather and environmental factors, and climate change.
- Lack of awareness of how to safely dispose used spare parts and damaged refrigerant circuit components, such as coils, condensers, and the old gasket lining the double wall of the desert air conditioner which has formed mold, fungi, and salts that prevent the passage of air through it in healthy, sound and safe ways for the environment and the atmosphere.
- The researcher conducted an interview with the students of the three grades of the refrigeration and air conditioning technician specialization program (three-year system) in industrial education and conducted a dialogue with them on the topic of climate change. The following became clear from the meeting:
 - Students' poor knowledge of industrial materials and gases that cause global warming.
 - Students' engagement in many negative life and professional behaviors that affect the environment.
 - Students' weak awareness of the positive professional behaviors that must be undertaken.
 - School syllabi negligence of climate change issue.

Research problem

The was identified in a deficiency in the content of refrigeration and air conditioning technician program curricula in industrial education in providing sufficient information about climate change (its causes - effects - how to mitigate them - positive professional behaviors

that must be undertaken) despite their importance because this specialty is linked to the causes that have led to climate change. This has led to students' weak awareness of the risks resulting from climate change and professional responsibility towards the environment in light of the expansion of the refrigeration and air conditioning industries and the increased demand for them. Hence, the current research seeks to present a proposed unit based on industrial exploratory activities via the web to develop industrial education students' awareness of climate change and professional responsibility towards the environment.

Research questions: In light of the above, the current research answers the following questions.

1. What is the form of the proposed unit based on industrial exploratory activities via the web in developing industrial education students' awareness of the risks resulting from climate change and professional responsibility towards the environment?
2. What is the form of industrial exploratory activities via the web in developing industrial education students' awareness of the risks resulting from climate change and professional responsibility towards the environment?
3. What is the effectiveness of the proposed unit based on industrial exploratory activities via the web in developing industrial education students' awareness of the risks resulting from climate change and professional responsibility towards the environment?
4. What are the proposed mechanisms to meet climate change and professional responsibility towards the environment to mitigate the negative effects of industrial activity?

Importance of the research

- Presenting a proposed unit based on industrial exploratory activities via the web in providing industrial education students with correct industrial work behaviors and

professional responsibility towards the environment to mitigate risks resulting from climate change.

- Presenting a proposed unit based on industrial exploratory activities via the web that enables industrial education teachers to benefit from it in achieving the country's goals, contributing to reducing the risks of climate change resulting from industrial activity and develop professional responsibility towards the environment.
- Presenting a proposed unit based on industrial exploratory activities via the web for those responsible for designing programs and curricula in the field of industrial education which can be used in preparing similar activities for other industrial education specializations and programs to develop industrial education students' awareness of the causes and occupational industrial risks causing climate change and professional responsibility towards the environment.
- Directing the attention of officials at the Ministry of Education and Technical Education and those responsible for designing curricula to pay attention to academic topics and activities related to developing awareness of the risks resulting from climate change and professional responsibility towards the environment for industrial education specializations.
- Devising a situations scale for awareness of professional responsibility towards the environment for industrial education students which can be used in other studies.

Research objectives

- Building a proposed unit based on industrial exploratory activities via the web to develop industrial education students' awareness of the risks resulting from climate change and professional responsibility towards the environment.

- Building industrial exploratory activities via the web to develop industrial education students' awareness of the risks resulting from climate change and professional responsibility towards the environment.
- Identifying the effectiveness of the proposed unit based on industrial exploratory activities via the web in developing industrial education students' awareness of the risks resulting from climate change and professional responsibility towards the environment.
- Providing a set of proposed implementation mechanisms to meet the risks resulting from climate change and professional responsibility towards the environment to mitigate the negative effects of industrial activity in light of the research results.

Research terms

Proposed unit

The unit proposed is defined operationally as a planned and organized educational project that includes information, knowledge and various activities that affect students' knowledge and behaviors and contribute to mitigating the problem of climate change.

Industrial exploratory activities via the web

Industrial exploratory activities via the web is operationally defined as a set of integrated programs planned for students to practice research, discovery, and interaction via the web in a way that suits the needs, abilities and speed of each student while sharing and discussing the information and experiences they have reached with their colleagues to provide students with experiences, skills and values that help them become aware of the causes of climate change related to their specialization and how they can be overcome and met by modifying their professional behaviors.

Climate changes

Climate changes is defined operationally as everything that occurs in the climate natural phenomena such as a change or imbalance in the atmosphere that is noticeable and has an impact in the short or long term on life style on Earth, one of the causes of which is due to the direct or indirect emission of industrial gases.

Professional Responsibility

Professional responsibility is defined operationally as an individual's awareness of the activity or work they perform within society through his acquisition of behaviors, actions and work principles that will preserve the environment from any causes of climate change.

Research Methodology

The research used the descriptive analytical method in analyzing the content of the topics of the Refrigeration and Air Conditioning Technician program, and the constructivist method in building the proposed unit based on industrial exploratory activities via the web to raise awareness of the risks resulting from climate change and professional responsibility towards the environment. The experimental method was also used to measure the effectiveness of industrial exploratory activities via the web to develop industrial education students' awareness of the risks resulting from climate change and professional responsibility towards the environment.

Research variables

The research relied on the independent variable represented in a proposed unit based on industrial exploratory activities via the web and the dependent variable represented in awareness of the risks resulting from climate change and professional responsibility towards the environment.

Experimental design

The researcher used the experimental design for measurement (pre-post) with the two research groups. The following table shows this:

Table 1

Experimental design

Research groups	Pre-measurement	Experimental treatment	Post- measurement
The first experimental group	<ul style="list-style-type: none">• Climate Change Awareness Test.• Situations Scale for Awareness of Professional Responsibility towards the Environment.	<ul style="list-style-type: none">• Using the traditional method in studying the proposed unit	<ul style="list-style-type: none">• Climate change awareness test.• Situations Scale for Awareness of Professional Responsibility towards the Environment.
The second experimental group		<ul style="list-style-type: none">• Using web-based industrial exploratory activities in in studying the proposed unit	

Research tools

- A proposed unit entitled (Industry and Climate Change) based on industrial exploratory activities via the web, <http://zunal.com/webquest.php?w=787947>.
- An educational design model of the proposed unit based on industrial exploratory activities via the web.
- Climate change awareness test.
- Situations scale of professional responsibility awareness towards the environment.

Research limitations

- A proposed unit entitled (Industry and Climate Change) based on industrial exploratory activities via the web in a way that suits the needs, abilities and speed of each student according to the results of the analysis and the needs of industrial education students and society.

- A group of second-year students in industrial education, specializing in refrigeration and air conditioning technician, at Maragha Military Industrial Secondary School for Boys, Maragha Educational Directorate in Sohag Governorate. Their number reached (64) students. They were divided into two groups, one a first experimental group and the other a second experimental group according to the researcher's place of residence and the experimental design of this research.
- Implementing the research experiment during the first semester of the academic year (2023-2024) after completing the preparation of the necessary tools for the application and obtaining the necessary approvals.

Research hypotheses

- There are no statistically significant differences between the mean scores of students in the first experimental group in the pre- and post-applications of the awareness test of risks resulting from climate change and situations scale of awareness of professional responsibility towards the environment.
- There are no statistically significant differences between the mean scores of students in the second experimental group in the pre- and post-applications of the awareness test of risks resulting from climate change and situations scale of awareness of professional responsibility towards the environment.
- There are no statistically significant differences between the mean scores of students in the first experimental group and the second experimental one in the post-test of awareness of risks resulting from climate change and situations scale of awareness of professional responsibility towards the environment.

Research Procedures

The research procedures followed the steps that will be discussed below.

Theoretical framework of the research

The researcher dealt with a theoretical framework for the research that included three main pivots as follows:

- The first pivot dealt with industrial exploratory activities via the web. It included (introduction, objectives of industrial exploratory activities via the web, the importance of industrial exploratory activities via the web, features of industrial exploratory activities via the web, classification of industrial exploratory activities via the web, characteristics of industrial exploratory activities via the web, selection and design criteria of industrial exploratory activities via the web, the role of the teacher in learning based on industrial exploratory activities via the web).
- The second pivot dealt with climate change. It included (an introduction, the causes of climate change, industrial development and its effects on climate change, the effects of climate change on society, the role of educational institutions in climate changes awareness, the role of society in meeting climate change, visions, ideas and proposed solutions to meet climate change).
- The third pivot dealt with professional responsibility. It included (an introduction, the importance of professional responsibility, professional responsibility for industrial education institutions, climate change and responsibility towards the environment, elements of professional responsibility, dimensions of awareness of climate change and professional responsibility).

Justifications for choosing the research sample:

Second year students specializing in (refrigeration and air conditioning) were selected to study the proposed unit topics for the following reasons:

- Counting on the results of a sample analysis of nineteen school books in three grades of the Refrigeration and Air Conditioning Technician program.
- Choosing second-year students specifically because they have approximately (30%) information about the specialization and are in the stage of mastering the specialization and learning professional behaviors. They are the first to be taken care for sound professional upbringing that preserves the environment. As for the first-year students, they are in the stage of learning about and comprehending the specialization and its content. The third-year students mastered the specialization and became accustomed to certain behaviors while practicing industrial activity.
- Refrigeration and air conditioning students' use of refrigerant gases, compounds, and welding tools during practical training in workshops and professional work has a negative impact on the environment.

Experimental treatment tools:

- *Preparing an design model for the proposed unit based on industrial exploratory activities via the web:*

After viewing, reviewing the literature and analyzing previous studies, the content of the proposed unit entitled (Industry and Climate Change) was devised. Previous research and studies that dealt with educational design models and targeted design and development via the web were also analyzed until the proposed model, its importance, objectives and components were reached. The proposed model included the following stages (the proposed unit preparation stage - the activities design stage - the production stage - the

evaluation stage - the development stage) in a way that suits the needs, abilities, thinking styles and speed of each student to be aware of the risks resulting from climate change and professional responsibility towards the environment. The proposed model and its components have been presented to experts. The proposed model of the current research differs from previous models in several points summarized below:

- Adding a model for how to use websites to provide educational content to industrial education students.
- Adding a model that combines design based on (a proposed educational unit and industrial exploratory activities via the web).
- Adding some sub-stages that are not present in previous models while shortening and merging some stages and steps of previous design models in a way that suits the nature of the current research.
- Changing some terms used to suit the nature of the current research and the website.
- Developing detailed steps for the educational design of the proposed unit based on industrial exploratory activities via the web in a way that suits the needs, abilities, thinking styles and speed of each student.
- Establishing foundations and rules that facilitate the process of optimal employment of exploratory activities across the web in a way that suits the needs, abilities, thinking styles and speed of each student within the educational content on websites.

After completing the evaluation of the model and the proposed unit and making all the modifications referred to by the experts and pilot experiment students, the final form of the content of the proposed unit was devised. It consisted of five topics. The specifications for the topics of the proposed unit were determined, and the appropriate

website quest was determined to display and present it. The content of the proposed unit was designed to achieve its objectives. The pages of the website quest included the content of the proposed unit topics based on industrial exploratory activities via the web and included main lists. The following figure shows one of the main pages of the interaction interface of the website quest.

Figure 1

Interactive interface page for the website Quest



- *Preparing the climate change awareness test:*

The initial form of the test was formulated after reviewing the literature and previous studies that prepared similar tests, as well as reviewing the dimensions of awareness that were identified in the theoretical framework of the research. The specifications of the test questions were determined from each of the topics of the proposed unit (industry and climate change), according to the operational objectives of each topic to be consistent with the nature and aim of the current research. The questions were formulated in a

scientific manner to be clear and do not require more than one answer. The test consists of eighteen multiple-choice questions to measure four cognitive levels (understanding, remembering, interpreting and applying). Each question has been followed by three responses including one (answer/response) representing the correct answer. Test instructions were put before the questions to guide the student of what should be done before and during answering the test. To control the test, it was presented in its initial form to the experts. The modifications they referred to were made. The test consisted of fifteen questions to measure industrial education students' awareness of the risks resulting from climate change. To verify the validity and reliability of the test, it was applied in its modified form on the technicians' sample. Its number is (26) students in the second year specialized in (refrigeration and air conditioning) from the Maragha Industrial Secondary School, Maragha Educational Directorate in Sohag Governorate during the second semester of the academic year (2022/2023). The test was applied twice on the students of the technicians' sample with an interval of (30 days). The reliability value of the test using the "Cronbach's Alpha" equation reached (0.92) at a significance level of (0.01) which is a high reliability value. The ease and difficulty factor was measured and ranged from (0.49) to (0.77). The discrimination coefficients of the test questions ranged between (0.49 - 0.73). This indicates that all the test questions are distinctive. By calculating the test time, the results showed that the average test time was approximately twenty minutes. The test was devised in its final form. It consists of fifteen multiple-choice questions and the total score for the test was fifteen points, with one point for each correct (answer/response) of the test questions.

- *Preparing a situations scale for awareness of professional responsibility towards the environment:*

The situations scale was formulated in a way that describes an event in which the student must do in a practical manner that is appropriate for each situation according to the research topic in the form of realistic industrial professional situations that meet the students in practical life. They were formulated carefully simply, clearly, and in a scientific manner consistent with the content of the proposed unit topics (industry and climate change). The scale situations cover the five dimensions identified in the research and related to climate change awareness, professional responsibility towards environment according to the content of the proposed unit topics, the operational objectives of the content of each of the proposed unit topics, and the nature of the research, so that the situations are clear and do not bear more than one interpretation as well as its suitability for students of industrial education and its achievement of what should be measured. The scale contains, in its initial form, fifteen situations that describe a specific event that must be dealt with behaviorally according to the students' professional needs, the nature of their future work and the content of the proposed unit. Each situation includes a task that must be performed in dealing with the situations. The situations were distributed randomly within the scale. The scores of (answer/situation) of the situations scale were assessed according to each situation as follows:

- (The answer/situation), which indicates a lack of awareness, takes (zero).
- (The answer/ situation), that indicates the presence of acceptable awareness takes, (one point).
- (The answer/ situation), which indicates the presence of average awareness takes, (two marks).

- (The answer/ situation), which indicates the presence of high awareness, takes (three degrees).

This is in accordance with the model of correcting the situations scale of industrial education students' awareness of professional responsibility towards the environment. The instructions of the scale, which specify the purpose of the scale and its situations, were developed.

To standardize the scale, it was presented in its initial form to experts. The modifications they referred to were made until the scale as a whole consisted of twelve situations to measure the awareness of industrial education students about professional responsibility towards the environment. To verify the validity and reliability of the scale, a standardization sample was applied. Its number is (26) students in the second year, specialized in (refrigeration and air conditioning) from the Maragha Industrial Secondary School, Maragha Educational Directorate in Sohag Governorate. This was done during the second semester of the academic year (2022/2023). The scale was applied twice on the students of the technicians' sample with an interval of (30 days). The scale reliability value as a whole reached (0.89) according to Cronbach's alpha coefficient at a significance level of (0.01). This indicates that the scale has a high degree of reliability. By calculating the time of the scale, the results showed that the average response time for the scale is (45) minutes approximately. The maximum score of the scale was (36), and thus the scale in its final form became valid for application.

Procedures for implementing the research experiment:

- Obtaining the necessary security and administrative approvals to do the research experiment.

- Holding a meeting with the school principal, specialization vice- principal, and the head of the refrigeration and air conditioning department, introducing them to the nature and objectives of the research, and coordinating with them to do the research experiment.
- The two research groups (the first experimental, the second experimental) were selected from Al-Maragha Military Industrial Secondary School for Boys - the Maragha Educational Directorate in Sohag Governorate (the researcher's place of residence). Their number reached (64), including (32) students from the first experimental group from class (2/3) and (32) students in the second experimental group of class (2/4) after ensuring their equality.
- Acknowledging the students of the two research groups at the application school.
- The pre-application of the climate change awareness test and the situations scale for awareness of professional responsibility toward the environment on the two research groups took place within the classroom at the application school for each group. The results showed that there were no statistically significant differences in the pre-application of the test and the situations scale between the scores of the students of the first experimental group and the scores of the students of the second experimental group. Therefore, the first and fifth hypotheses of the research were accepted.

Application of research experiment:

- Holding a meeting with the students of the experimental group (first, second) and introducing them to the topic of the proposed unit, the aim of the research, and how to implement the research experiment on them according to the aforementioned experimental treatment. The mobile phone numbers of the students of the second experimental group were taken to send them a link to the website Quest through which

the content of the topics of the proposed unit based on web-based industrial exploratory activities will be studied.

- Doing the research experiment during the first semester of the academic year (2023/2024), and it was applied and implemented according to the steps that will be explained in the following table:

Table 2

Steps to apply and implement the research experiment

Steps	The first experimental group	The second experimental group
Pre-application	It took place on Sunday, 1/10/2023, in the classroom for both groups	
Experimental treatment	The proposed unit topics were presented according to the aforementioned experimental design	
(duration/place) Application	Three weeks, five days per semester at school	Three weeks, five days via the website outside the classroom with the availability of the scientific material via the web
Application time	(14 classes) of seven and a half hours (two classes for each topic)	Seven and a half hours for the researcher's follow-up of the students on the website (an hour and a half for each topic), and the students have the website available at any other time for study
Scientific material for the proposed unit	It was printed on A4 paper and distributed to the students	Available on the website through the following link: http://zunal.com/webquest.php?w=787947
Post application	It took place on Sunday, 22/10/2023, in the classroom for both groups	

Research results

The climate change awareness test and the scale of situations of awareness of professional responsibility towards the environment were pre and post applied on the two research groups after the completion of teaching the proposed research unit (industry and climate change)

during the application period, then the scores were corrected and written down and statistical treatments were conducted using (SPSS) as well as recording the results.

Below is a presentation of the results of answering the third research question according to the research hypotheses.

• *To verify the validity of the first hypothesis, the following table the results:*

Table 3

The value of (T-Test) and its significance for the first experimental group students in the two applications (pre and post) at N=32

Application	SMA	standard deviation	The difference between the averages	df	Calculated (T) value	η^2	d
Pre - test	2.38	1.10	-2.00	62	-7.48**	0.47	1.88
post - test	4.38	1.04					
Pre - situations scale	7.13	1.48	-4.62	62	-9.62**	0.60	2.46
post - situations scale	11.75	2.00					

By looking into the results of Table (3), It is clear that there is a statistically significant difference at the level of (0.01) in favor of the post-application In testing awareness of occupational changes. The difference between the means was (-2.00). The calculated (T) value was (-7.48), and the Eta square value (0.47). On calculating the effect size, it turned out to be (1.88). This indicates that the proposed unit that was presented and introduced to the students of the first experimental group in the normal explanation method within the school classroom had a positive impact on developing students' awareness of the risks resulting from climate change. Therefore, It is also clear from the results that there is a significant difference at the level of (0.01) in favor of the students of the post-application of the measure of professional responsibility towards the environment, as the difference between the means

was (-4.62). The calculated (T) value was (-9.62), and the Eta square value was (0.60). On calculating the effect size, it turned out to be (2.46). This indicates that the proposed unit that was presented and introduced to the students in the normal explanation method within the classroom had a positive impact on developing the awareness of the students of the first experimental group of professional responsibility towards the environment. Therefore, the first hypothesis of the research was rejected.

• *To verify the validity of the second hypothesis, the following table the results:*

Table 4

The value of (T-Test) and its significance for the second experimental group students in the two applications (pre and post) at N=32

Application	SMA	standard deviation	The difference between the averages	df	Calculated (T) value	η^2	d
Pre - test	2.50	1.11	-9.84	62	-27.10**	0.92	6.85
post - test	12.34	1.73					
Pre - situations scale	7.84	1.63	-20.75	62	-43.10**	0.97	11.59
post - situations scale	28.59	2.18					

By looking into the results of Table (4), It is clear that there is a statistically significant difference at the level of (0.01) in favor of the post-application In testing awareness of occupational changes, as the difference between the means was (-9.84). The calculated (T) value was (-27.10) and the Eta square value (0.92). On calculating the effect size, it turned out to be (6.85). This indicates that the proposed unit that was presented and introduced to the students of the second experimental group using industrial exploratory activities via the web in consistent with the needs, abilities, thinking styles and speed of each student had a positive impact on developing their awareness of the risks resulting from climate change. For this

reason, It is also clear from the results that there is a significant difference at the level of (0.01) in favor of the students of the post-application of the measure of professional responsibility towards the environment, as the difference between the means was (-20.75). The calculated (T) value was (-43.10), and the Eta square value was (0.97). On calculating the effect size, it turned out to be (11.59). This indicates that the proposed unit that was presented and introduced to the students of the second experimental group using industrial exploratory activities via the web in a way that suits the needs, abilities, thinking styles and speed of each student had a positive impact on developing their awareness of professional responsibility towards the environment. For this reason, the second hypothesis of the research was rejected.

• *Verifying the validity of the third hypothesis, the following table the results:*

Table 5

The value of (T-Test) and its significance for students of the two experimental research groups (first - second) at N=32

Experimental group results	SMA	standard deviation	The difference between the averages	df	Calculated (T) value	η^2	d
The first in the test	4.38	1.04	-7.97	62	-22.30**	0.89	5.72
The second in the test	12.34	1.73					
The first in the situations scale	11.75	2.00	-16.84	62	-32.18**	0.95	8.86
The second in the situations scale	28.59	2.18					

By looking into the results of Table (5), It is clear that there is a statistically significant difference at the level of (0.01) in favor of the students of the second experimental group in the post-application In testing awareness of occupational changes. as the difference between

the average scores of the students of the two experimental groups (first - second) reached (-7.97). The calculated value of (T) was (-22.30), and the value of Eta square was (0.89). On calculating the effect size, it turned out to be (5.72). This indicates that the study of the students of the second experimental group of the proposed unit using industrial exploratory activities via the web is consistent with the needs, abilities, thinking styles, and speed of each student had a positive impact on the students in developing awareness of climate change, better than the students of the first experimental group studying the proposed unit in the normal explanation method within the classroom. This indicates the effective impact of industrial exploratory activities via the web on developing awareness of the second experimental group students of the risks resulting from climate change. For this reason, it is also clear from the results that there is a significant difference at the level of (0.01) in favor of the students of the second experimental group in the post-application of the measure of professional responsibility towards the environment as the difference between the average scores of the students of the two experimental groups (first - second) reached (-16.84). The calculated value of (T) was (-32.18), and the value of Eta square was (0.95). On calculating the effect size, it turned out to be (8.86). This indicates that the students of the second experimental group studied the proposed unit through industrial exploratory activities via the web, in a way that suits the needs, abilities, thinking styles, and speed of each student, had a positive impact on developing their awareness of professional responsibility, better than the students in the first experimental group studying the proposed unit using the normal explanation method inside the classroom. This indicates the effective impact of industrial exploratory activities via the web on developing awareness of the students of the second experimental group of the professional responsibility towards the environment. For this reason, the third hypothesis of the research was rejected.

Interpretation and discussion of the results:

The researcher attributes the results of the first hypothesis to the following:

- The proposed unit topics are related to the needs of students and society.
- Dividing the content of the proposed unit into simple and attractive topics.
- The content of the proposed unit topics includes information appropriate to the students' level and related to their academic specialization.
- The proposed unit topics helped to motivate students to search for information that have led to climate change, stimulate their thinking and interest, and make them more aware of the industrial causes that led to climate change.
- Formulating operational objectives for each topic of the proposed unit in a manner consistent with the research objectives.
- Organizing the content of the proposed unit topics in a logical, sequential manner that reflects consistency between its topics.
- Providing the content of the proposed unit topics with various activities, resources, and educational aids.
- The multiplicity and diversity of students' assessment tools during their study of the proposed unit topics content provide continuous feedback to overcome the weaknesses that students face while studying the content of the proposed unit topics.

The results of the first hypothesis are consistent with the results of several previous studies (i.e. Ghanem, 2021; Al-Sibai, et al., 2021; Abdel Fattah, 2020; Al-Sakini, 2015; Sababha, 2014; Al-Otaibi, 2014; El-Kholy and Ghoneim, 1998) that emphasized the importance of including concepts and information about the environment and climate

changes in school curricula to mitigate the negative factors affecting them and develop positive behaviors towards the environment.

The results of the first hypothesis differ from those of other previous studies (i.e. Ghanem, 2021; Al-Sibai, et al., 2021; Abdel Fattah, 2020; Al-Sakini, 2015; Al-Otaibi, 2014; El-Kholy and Ghoneim,1998) in the independent variable used to address the problem, and also in one of the dependent variables (professional responsibility) that was dealt with in the current research.

The researcher attributes the results of the second hypothesis to the following:

- Dividing the content of the proposed unit topics into simple and attractive topics via the website.
- The content of the unit topics proposed through the website quest contains important information that is appropriate for the students' level and related to their academic and professional specialization.
- Formulating operational objectives in a manner consistent with the content of each topic of the proposed unit based on industrial exploratory activities via the web and research aims.
- Organizing the content of the proposed unit topics via the website in a logical, sequential manner that reflects consistency between its topics.
- Providing the content of the proposed unit topics with exploratory activities, resources, and various educational aids related to students' needs for learning via the web.
- Diversity in the sources of industrial exploratory activities via the web, appropriate to the needs, abilities, thinking styles, and speed of each student allowed students to participate with their colleagues in constructive scientific conversations to exchange knowledge and make them more aware of the problems caused by climate change.

- The proposed unit topics based on industrial exploratory activities via the web encouraged students to take an interest in the research topic as it is a modern and important topic due to its connection to their specialization, the nature of their work, and its direct reflection on the environment surrounding them.
- The activities are linked to the students' specializations, lives, and their work environment encouraged students to adopt some positive behavioral situations during their practical training.
- Industrial exploratory activities via the web helped stimulate students' thinking and motivation to learn a lot about the industrial causes that have led to climate change and also helped students to innovate new scientific methods to mitigate the negative effects resulting from industrial work.
- The multiplicity and diversity of assessment tools for students while they study the content of the proposed unit topics based on industrial exploratory activities via the web provide continuous feedback to overcome the weaknesses facing students during their future work.

The results of the second hypothesis are consistent with the results of several previous studies (i.e. Al-Bitar, 2015; Al-Dosari, 2018; Azab, 2015; Khalifa, 2016; Shaheen, 2014; Sobhi, et al, 2020) in the importance of activities in the educational process to develop cultures, practical, research and social skills, environmental awareness, vocational attitude, achievement, environmental values and occupational safety.

The results of the second hypothesis differ from those of other previous studies (i.e. Al-Bitar, 2015; Al-Dosari, 2018; Azab, 2015; Khalifa, 2016; Shaheen, 2014; Sobhi et al., 2020) in proposing a study unit based on industrial exploratory activities via the web in a way that suits the needs, abilities, thinking styles and speed of each student, and also differs from them

in dealing with the dependent variable. This research focused on awareness of the risks resulting from climate change and professional responsibility towards the environment.

The researcher attributes the results of the third hypothesis to the following:

- Providing the content of the proposed unit topics for the second experimental group with a set of activities, resources, and various educational aids via the web in a way that suits the needs, abilities, thinking styles, and speed of each student. It allowed them to engage with their colleagues in constructive scientific conversations.
- The proposed unit topics based on industrial exploratory activities via the web are related to the needs of the students of the second experimental group due to various learning resources via the web.
- The proposed unit topics based on industrial exploratory activities via the web encouraged the students of the second experimental group to be interested in the research topic because it is related to the nature of their work and their professional behaviors towards the environment.
- The students of the second experimental group learned the topics of the proposed unit based on industrial exploratory activities via the web making it easy for every student to have the opportunity to search for various sources and information at any time and from any place connected to the web, in addition to doing many diverse activities related to the research topic that are consistent with the needs, abilities and thinking of every student. This helped give each student the independence to identify multiple options in the field of vocational work, a sense of professional responsibility, and forming a positive attitude towards their professional responsibility while doing vocational work.

- Industrial exploratory activities via the web helped in introducing a set of problems and practices that require students of the second experimental group thinking about them and search for various solutions to meet the threat of climate change.
- Industrial exploratory activities via the web helped stimulate the thinking and motivation of the students of the second experimental group to learn a lot about the industrial causes (local and global) that have led to climate change, attracting their interest and making them more aware of their professional responsibility and duty towards the environment as well as their awareness of professional behaviors that mitigate problems resulting from climate change.

The results of the third hypothesis are consistent with studies that used electronic activities in learning, such as the study of Azab (2015), Austin and Mescia (2019) and in developing research skills, awareness of climate change and producing interactive programs. They are also consistent with Saleh's study (2017) on the importance of the role of vocational education teachers in secondary schools in developing environmental responsibility among students. However, the results of the third hypothesis differ from those of other previous studies (i.e. Azab, 2015; Austin and Mescia, 2019) in the current research dependence on various industrial exploratory activities via the web in developing awareness of climate change and professional responsibility towards the environment. They also differ with them in the research sample as the current research relied on industrial education students.

By verifying the validity of the research hypotheses and discussing and interpreting the results, the third research questions have been answered.

Answering the fourth question of research:

In light of the results reached, the current research proposes the following implementation mechanisms to mitigate climate change:

- Providing the necessary technological infrastructure to disseminate awareness of climate change in a way that suits the needs, abilities, thinking styles and speed of every student in industrial education.
- Providing qualified human cadres in industrial education to raise awareness of local and global societal issues and problems and to contribute and participate positively in solving them.
- Making students know the implications of climate change as well as the economic and social outcome on the environment and society.
- Including climate change topics in industrial education curricula (its industrial and behavioral causes, its sources and how to meet it) as well as the professional responsibility towards the environment in policies, development plans, curricula and study programs in industrial education.
- Preparing and designing specialized courses related to climate change and developing awareness of professional responsibility towards the environment.
- Strengthening environmental values and professional responsibility by focusing academic curricula and the learning process in industrial education on natural environmental practices that preserve the environment and mitigate climate change.
- Students' use of various educational and environmental activities within the classroom, workshop, and school that develop their awareness of climate change and professional responsibility towards the environment.
- Making the students aware of climate changes and enabling them to participate effectively and make a positive change in their communities through their environmental protection by following the preventive scientific method in industrial work to mitigate

industrial causes and the negative effects of industrial activity that have led to global warming.

- Linking climate change and professional responsibility to school environmental education through curricula and activities that contain topics related to that.
- Linking realistic community climate problems to students' behaviors during practical training to improve their environmental awareness of climate change and professional responsibility towards it.
- Highlighting the importance of educational projects within the school classroom and workshop by addressing topics related to sustainability and climate change to preserve the environment from climate change.
- Devising a long-term strategic plan to develop professional responsibility towards the environment among industrial education students to meet industrial risks and mitigate climate change.
- Expanding industrial projects that rely on new and renewable energies in industrial education institutions to mitigate climate change.
- Disseminating awareness of climate change and how to meet it with positive vocational habits and behaviors among community members through school curricula, awareness programs, and industrial education activities.
- Disseminating awareness of the vocational behaviors that must be undertaken to deal with the risks of climate change resulting from negative behaviors through school curricula, awareness programs and activities.
- Optimal exploitation of school theater by contributing to the production of educational documentaries, presenting artistic works on the negative effects of climate change in the

world and Egypt in particular to mitigate negative behaviors that affect the climate and encourage professional responsibility towards the environment.

- Employing the best educational and technological media in providing (educational films, awareness videos, and practical activities) to raise awareness of climate change and the positive vocational practices that must be undertaken towards the environment.
- Strengthening the abilities of industrial education schools to provide practical scientific models for students that show mechanisms of meeting climate change in order to take scientific, practical and environmental measures to mitigate the effects of climate change resulting from negative industrial behaviors.
- Disseminating information and statistical data related to climate change through various means of communication via the web to raise awareness of the risks resulting from climate change.
- Complete integration, participation, communication, coordination and cooperation among all sectors of society, including governmental and non-governmental institutions such as educational and training institutions to work together in the areas of environmental conservation to meet the effects of climate change and enhance professional behaviors and responsibility to mitigate environmental risks.

Research recommendations

- Making industrial education students aware of the importance of taking into account the environmental dimension while carrying out industrial and vocational work.
- Directing those in charge of preparing curricula in industrial education to take into account the climate-environmental dimension when designing curricula in all specializations of industrial education in a way that is consistent with the trend towards preserving the environment from industrial processes that have led to climate change.

- Including industrial exploratory activities via the web in industrial education curricula to develop awareness of the environmental dimension and professional responsibility towards the environment.
- Directing those in charge of industrial education to the importance of employing and using industrial exploratory activities via the web to develop awareness of climate change and professional responsibility towards the environment.
- Holding training courses for industrial education teachers to develop their skills in how to use and employ industrial exploratory activities via the web while teaching technical syllabi.
- Commitment of Industrial education schools to preventive measures while students perform practical training in workshops and use materials that negatively affect the environment to urge students of professional responsibility towards the environment.
- Commitment of Industrial education schools to scientific and practical methods in preserving the environment from climate change by developing students' positive behaviors and their professional responsibility towards the environment.

Research suggestions

- The effectiveness of employing a program based on industrial exploratory activities to develop the professional skills of industrial education teachers.
- The effectiveness of industrial exploratory activities to develop scientific concepts among industrial education students.
- Using web activities to develop positive attitudes towards industrial education.
- Proposed concepts for exploratory activities that can be used in industrial education and their relationship to learning styles.

Conclusion

The results showed the advantage of teaching the proposed unit using industrial exploratory activities via the web in developing awareness of the risks resulting from climate change and professional responsibility of the students of the second experimental group over the students of the first experimental group who studied the proposed unit in the normal explanation method in the post-application.

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