Monitoring and Evaluating Climate Change Education in Egypt: Addressing Challenges(*)

Sahar M. Ghorab
Anthropology department, Faculty of African Postgraduate Studies, Cairo University, Cairo- Giza, Egypt

Samar H. Albagoury
Economic department, Faculty of African Postgraduate Studies, Cairo University, Cairo- Giza & Egypt

Wael M. Al- Metwaly
Geography and GIS department, Faculty of African Postgraduate Studies, Cairo University, Cairo- Giza, Egypt

Heba, M.R. Hathout
Natural Resources department, Faculty of African Postgraduate Studies, Cairo University, Cairo- Giza, Egypt

Kholoud M. AbdelMaksoud
Faculty of African postgraduate studies, Natural resources department, Giza, Cairo, Egypt

Abstract:

Climate change education has become a crucial element of Egypt's endeavors to address the multifaceted challenges of climate change. However, efforts to monitor and evaluate the effectiveness of these educational initiatives face significant challenges, hindering the ability to assess their impact and make necessary improvements. This paper investigates the current state of climate change education monitoring in Egypt by assessing the current status of climate change education through the use of an online questionnaire and conducting interviews to measure awareness, attitudes, and perceptions. In addition, it identifies significant obstacles and suggests strategies to improve its effectiveness. A statistical analysis was conducted, and the spatial distribution of the questionnaire sample was plotted. The results suggest several practical suggestions that could be implemented to improve climate change education in Egypt. We propose that organizing school-based workshops, where experts are hired to train teachers on effectively delivering the concepts of climate change to students, would be a practical approach to fulfill the mutual interest of both teachers and students to learn more about climate change. This paper serves as a means to assess the level of education quality, a component of the seventh objective of the Fourth Sustainable Development Goals. Quality education is defined as 'global citizenship education for sustainable development, with climate change as one of the most critical global concerns.

Keywords: Climate change; education; school students; Evaluating

رصد وتقييم تعليم التغير المناخي في مصر : معالجة التحديات

الملخص:

أصبح التعليم حول تغير المناخ عنصرًا حيويًا في جهود مصر لمواجهة التحديات المتعددة الأوجه لتغير المناخ. ومع ذلك، تواجه الجهود المبذولة لمراقبة وتقييم فعالية هذه المبادرات التعليمية تحديات كبيرة، مما يعيق القدرة على تقييم تأثيرها وإجراء التحسينات اللازمة. تهدف هذه الورقة رصد تعليم تغير المناخ في مصر من خلال تقييم الوضع الحالي لتعليم تغير المناخ باستخدام استبيان عبر الإنترنت وإجراء مقابلات لقياس الوعي والمواقف والتصورات. بالإضافة إلى ذلك، تحدد العقبات الكبيرة وتقترح استراتيجيات لتحسين فعاليتها. تم إجراء تحليل إحصائي، وتم رسم التوزيع المكاني لعينة الاستبيان. تشير النتائج إلى عدة اقتراحات عملية يمكن تنفيذها لتحسين تعليم تغير المناخ في مصر. نقترح تنظيم ورش عمل في المدارس، حيث يتم توظيف خبراء لتدريب المعلمين على تقديم مفاهيم تغير المناخ بفعالية للطلاب، كنهج عملي لتلبية المصلحة المشتركة لكل من المعلمين والطلاب في تعلم المزيد عن تغير المناخ. وتعتبر هذه الورقة وسيلة لتقييم مستوى جودة التعليم، وهو مكون من الهدف السابع للأهداف التنموية المستدامة الرابعة. يُعرف التعليم الجيد بأنه "تعليم المواطنة العالمية من أجل التنمية المستدامة، مع اعتبار أن تغير المناخ واحد من أهم القضايا العالمية الأن .

الكلمات المفتاحية : التغير المناخى – التعليم – طلاب المدارس – التقييم

I. Introduction:

Climate change is widely regarded as the most significant global environmental, economic, and political threat that humanity is currently confronting. In addition, this threat is projected to persist for a considerable period of time (Kuthe et al., 2019; Rahman et al., 2014). Climate change refers to the alternation in climate patterns primarily caused by natural systems and human activity-related greenhouse gas emissions. Human activities in the past have contributed to the co-occurrence of extreme temperatures in over half (56%) of 946 globally paired regions, with a specific focus on tropical areas. However, no statistically significant impact has been observed on the co-occurrence of extreme precipitation events throughout the 20th century (1901-2020). According to the high-emission scenario (SSP585), there will be a substantial amplification in the strength, intensity, and spatial extent of concurrent temperature and precipitation extremes (Zhou et al., 2023). Climate change is a significant ecological and social issue in society. Over the past 50 to 100 years, warming patterns have become more pronounced in Africa (Adenle et al., 2017). Both adults and children are motivated to protect our planet, which is experiencing an increasing number of catastrophic natural disasters and climate change. The adverse effects of climate change are a source of significant concern for impoverished nations (Calculli et al., 2021; Guo et al., 2021). The Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC) provides a concerning yet ambiguous overview of the consequences and dangers linked to expected climate changes over the course of the 21st century. The global climate model (GCM) simulations used in the AR6 assessment, depending on the chosen Shared Socioeconomic Pathway (SSP) scenario, suggest potential global surface temperature increases ranging from 1.3°C to 8.0°C by 2100. These projections highlight a critical temperature threshold, with estimated climate hazards categorized as “high” and “very high” for global surface temperature rises surpassing 2.0 °C and 3.0 °C above pre-industrial levels, respectively (Scafetta, 2024).

African communities demonstrate a remarkable capacity for innovation in addressing climate impacts at the local and regional levels, as evidenced by their responses to the effects of climate change, bolstered by the initiatives of civil society and international development organizations (Adenle et al., 2017). The main sectors in East Africa that are at high risk of the impacts of climate change include food security, water resources, biodiversity, human health, and extreme weather events (Apollo & Mbah, 2021). Climate change has demonstrably increased the frequency and severity of droughts, with their impacts further amplified by insufficient water storage infrastructure. There has been increased research on global-scale total water storage (TWS) changes and drought prediction. However, a critical knowledge gap exists regarding the interplay between basin-scale long-term hydrological droughts, TWS changes, and the El Niño–Southern Oscillation (ENSO) influence in East Africa (Seka et al., 2024).

Sociologists have greatly enhanced our comprehension of the human factors contributing to modern climate change. They have provided valuable insights into the dynamics of power and politics within the corporate sector and policy systems, the impact of social structure and political economy on a country's greenhouse gas emissions, and the various influences on individual citizens and consumers' behaviors (Dietz & Whitley, 2020). Increasing society's awareness of climate change is crucial, as it shapes and influences people's engagement in developing a climate-friendly society (WBGU 2011).

Climate change education is widely recognized as a critical component of achieving sustainable development. Incorporating climate change education into educational systems is crucial for achieving the fourth Sustainable Development Goal (SDG) of providing high-quality education. This alignment supports Target 7.3 within SDG 4, "Global Citizenship Education for Sustainable Development," which aims to improve adolescents' knowledge, attitudes, and behaviors related to environmental issues. By

integrating climate change knowledge into educational systems, we can enable young individuals to actively engage in the analysis and resolution of this critical global challenge (Carmi et al., 2015). In order to foster a more profound comprehension of climate change among young people, it is imperative to create comprehensive primary school curricula that effectively address this critical subject. By prioritizing this objective within primary education, we can raise a younger generation that is more aware of the environment and better prepared to tackle the challenges posed by the change in climate.

This study aimed to assess the awareness of both primary, preparatory, and secondary school children and their teachers regarding climate change. To better understand the environmental concerns of the younger generation, we conducted a study involving students aged nine to fourteen. A survey was conducted among students attending three different categories of schools: government, semi-government/autonomous, and private. The student survey instrument was structured into three distinct sections designed to assess: (i) Students' foundational knowledge and comprehension of climate change concepts. (ii) Students' personal viewpoints and perceptions regarding climate change. (iii) Students' attitudes and dispositions towards climate change education.

The findings of this study can assist in building new target-group-specific learning environments that are compatible with the socioeconomic, cultural, and age-group-specific needs of young learners. This may contribute to improved environmental education in general and climate change education in particular. The study model compromises five factors: knowledge, attitude, worry, responsibility, and activity. All these factors have a mutual effect on each other

II. Background:

II.1 Climate change

The paramount challenges confronting the global community at present encompass the elimination of poverty and hunger, fostering economic advancement, addressing social needs such as

employment opportunities, healthcare, social security, and education, addressing climate change, and preserving the environment. The 2030 Agenda for Sustainable Development compromises 17 goals aimed at "transforming our world and are an appeal to all nations to act" (United Nations, 2016).

According to Leicht et al. (2018), Goal 4 (Quality Education) recognizes the crucial role of higher education institutions in teaching, learning, knowledge production, and skill development to address present and future challenges. It acknowledges the importance of education for sustainable development. Several aspects of this goal require higher education institutions to undertake specific actions to enhance their contribution to sustainable development.

Environmental education (EE) is grounded in climate change (CC) related scientific concepts and aims to promote, stimulate, and cultivate pro-environmental values, attitudes, and behaviors. Several climate-literacy concepts have thus been proposed in recent years (Azevedo & Marques, 2017; Milé & Sládek, 2011). Climate literacy is generally viewed as the intersection between climate science and EE approaches and strategies (Park et al., 2020). Climate literacy has been defined in terms of three concepts concerning environmental education: knowledge, competencies (skills), and attitudes or values (Hung, 2014; Sipos et al., 2008). Due to the novelty of "climate literacy" and the existence of various definitions, there is currently no globally established set of core principles (Park et al., 22020). There is currently a lack of reliable definitions for climate literacy that include all three dimensions mentioned earlier. Additionally, the majority of studies on the topic have mainly focused on participants' knowledge of CC.

A recent study on climate change education was conducted by Hügel et al. (2024). Extensive research highlights the critical role of formal education in enhancing both the knowledge acquisition (learning) and cognitive abilities associated with adaptive capacity and its related capabilities. Nevertheless, there is still a lack of complete comprehension regarding the impacts arising from efforts to

implement such changes, particularly in the context of climate change adaptation planning. A study by Adobor (2024) examined how climate change education and sensemaking can promote climate engagement and adaptive behaviors in grassroots communities. The study examined how individuals in five rural communities in Ghana perceive and address the challenges posed by climate change. Rushton et al. (2024) investigated the role of teachers across both primary and secondary education phases and various career stages in highlighting the value of curricular and extracurricular spaces for climate change education within the UK context.

In this study, we utilized the definition provided by UNESCO (the United Nations Educational, Scientific and Cultural Organization) to define climate change education. According to UNESCO, climate change education aims to foster an *understanding of the impacts of the climate crisis, empowering students with the knowledge, skills, values and attitudes needed to act as agents of change.* Another important definition taken into account is responsible management education, which, according to UNESCO, is *'the mission to transform business and management education, and develop the responsible leaders of tomorrow, and to provide space for management-related higher education institutions around the world to share best practices.'*

II.3 Education in Egypt

This study specifically examined Egypt, the country chosen to host the 2022 COPE 27 Climate Summit. Hosting the event provided an opportunity to enhance the Egyptian public's understanding of climate change issues, which is considered one of the country's top priorities. Egypt is both a part of African contentment and a Middle Eastern country. The educational model's success could be readily replicated by other countries within the continent and in the region.

According to Ead et al. (2022), the UN predicted an Egyptian population of about 105 million by March 19, 2022, making it one of the most populous countries in Africa. Due to its primary reliance on the Nile River, which is essential to the population's needs for potable

water, agriculture, industry, fish farming, power generation, inland river navigation, mining, oil and gas exploration, cooling of machinery, and power generation, the nation is considered to be highly vulnerable to climate change and its adverse effects. Despite facing numerous risks, Egypt ranks 73rd globally in terms of its preparedness for climate change (Climate Change Profile, 2018). Water resources are under significant pressure due to the combined effects of population growth, urbanization, and climate change. Despite Egypt's vulnerability to the impacts of climate change, there is a dearth of research on climate change education in the country. A study conducted by Mousa et al. (2019) investigated the relationship between organizational commitment and climate change in the setting of Egyptian public hospitals.

Both Egypt and other countries encounter a multitude of threats posed by climate change. For instance, Egypt is confronted with a more significant challenge as a result of the construction of the new Grand Ethiopian Renaissance Dam. This dam has the potential to restrict a portion of the water that is typically considered to be part of Egypt's share of water from the Ethiopian tributaries of the River Nile, thereby impacting Egypt's main water source. The general public's awareness of these problems and their interconnectedness is of paramount significance.

School education serves as the primary reservoir of knowledge for the younger population, particularly in African countries. School students acquire both basic and essential knowledge during the school year. The primary objective of this study was to monitor and evaluate the impact of climate change education on both students and teachers. The study aims to establish the existing level of climate change education among students and teachers. The study aims to establish the current level of climate change education among students and teachers. This data will enable stakeholders to develop an educational strategy that promotes greater awareness and understanding of climate change among younger generations. Consequently, this may encourage stakeholders to advocate for a more environmentally

sustainable future.

III. The Theoretical Orientation of the Study (Worldviews)

Credit for introducing the concept of "worldviews" goes to the German philosopher Wilhelm Dilthey. He posits that the crux of studying people lies in uncovering their perspectives on the world; it involves delving beneath overt actions to unearth the ideas, emotions, sentiments, and knowledge, as well as the inclinations, desires, and other (internal) elements that contribute to a deeper and more accurate understanding of these actions and behaviours.

Thus, studying the worldview of any given society is tantamount to examining individuals' stances towards their surroundings from the perspective of those selected by the researcher for their study. Each Individual becomes the focal point, the axis around which the research revolves, as they reveal their unique perspective, valuation, or vision, which, in essence, and often unconsciously, reflects the underlying principles that inform these views. Consequently, the fundamental element in worldview studies is the Individual or the Self.

Dilthey contends that "worldviews" are intrinsically linked to individuals and their perceptions of their social, cultural, and cognitive realities, as manifested in their behaviours, actions, and interactions with others. In other words, individuals' every action, behaviour, and material or intellectual product stems from their worldview of their reality.

The "Worldviews" approach is one that will greatly assist researchers in their studies. It represents a coherent set of concepts, ideas, knowledge, and theories that collectively form a clear and comprehensive understanding of the world. Many individuals reflect on societies and the structures of the world. When researchers study a worldview, they examine it as a crucial aspect of what can be termed the dominant epistemological framework within the society under investigation. It also represents another facet of understanding society itself.

The term "worldviews" has become prevalent in modern and contemporary anthropological writings and studies. It offers an objective means of analysing and understanding societies grounded in people's self-interpretations. **In light of this, the "worldviews" approach will be applied in this study, focusing on the perspectives and evaluations of teachers and students (the study sample) regarding teaching climate change across different educational stages. The challenges and proposed perceptions of addressing climate change in Egyptian education, from their point of view, will be outlined.**

The 'Worldviews' approach will be used to gauge the level of awareness among students and teachers about climate change and related terminology. The study will also delve into how this knowledge has influenced students' perceptions of the world around them.

The "worldviews" approach is a theoretical framework that helps provide a deeper understanding of assessing and observing the issue of climate change within Egyptian education by focusing on the perspectives of those directly involved in education—namely, teachers and students. These individuals are the core of the study, and their insights serve as a guiding principle for leaders to follow in order to develop the educational process and raise awareness about climate change, which represents a critical issue threatening human existence.

I. Methodology and sample description

The study relied on anthropology's fundamental methodology, fieldwork., a **quantitative method** using a structured questionnaire, was employed alongside A **qualitative approach**, conducting interviews—both of which are standard practices in the human sciences.

Most of the population of Egypt is concentrated around the Nile Valley in the heart of Egypt (Figure 1). Sample distribution and size

were thus determined according to population density in each region of Egypt.

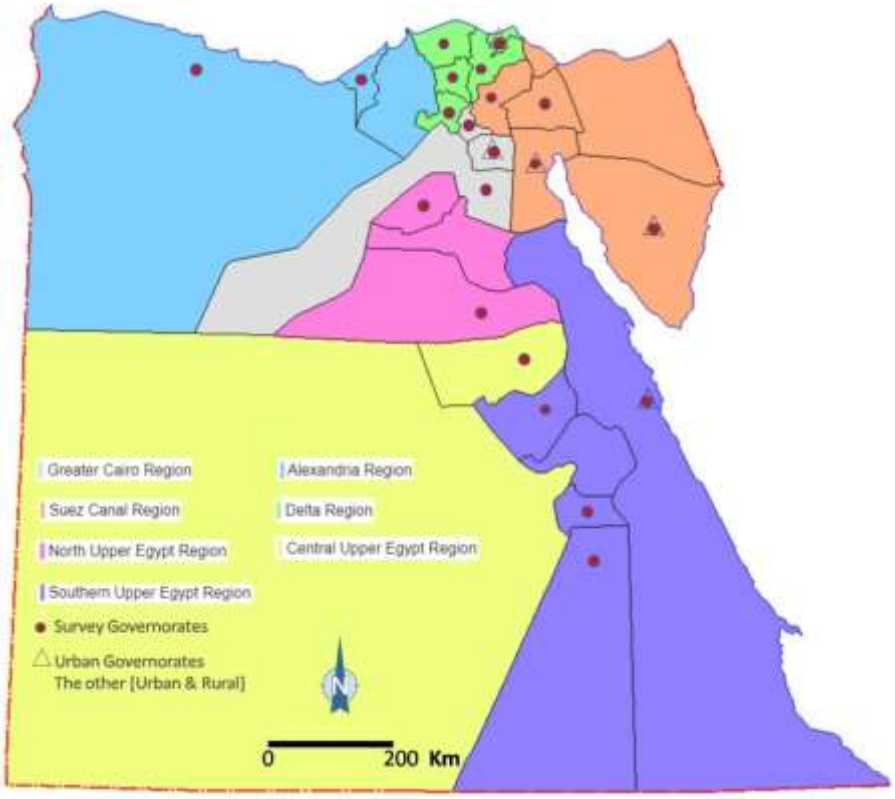

Figure 1: Map shows the division of the planning regions in Egypt and its division between rural-urban governorates and urban governorates and the distribution of the governorates from which the samples taken; this is to confirm that the sample is spatially representative of all the planning regions in Egypt.

Two different samples were gathered to analyze the status of climate change education in Egypt. The first sample consisted of a representative group of students from various geographical regions. The purpose was to examine students' overall knowledge, perceptions, and attitudes toward climate change and related concepts using a detailed questionnaire. A second survey was administered to educators at various educational levels and across different disciplines to

evaluate their perspectives on the actuality of climate change education in Egypt and to document any existing instructional resources employed for teaching climate change in Egyptian schools (Figure 2)

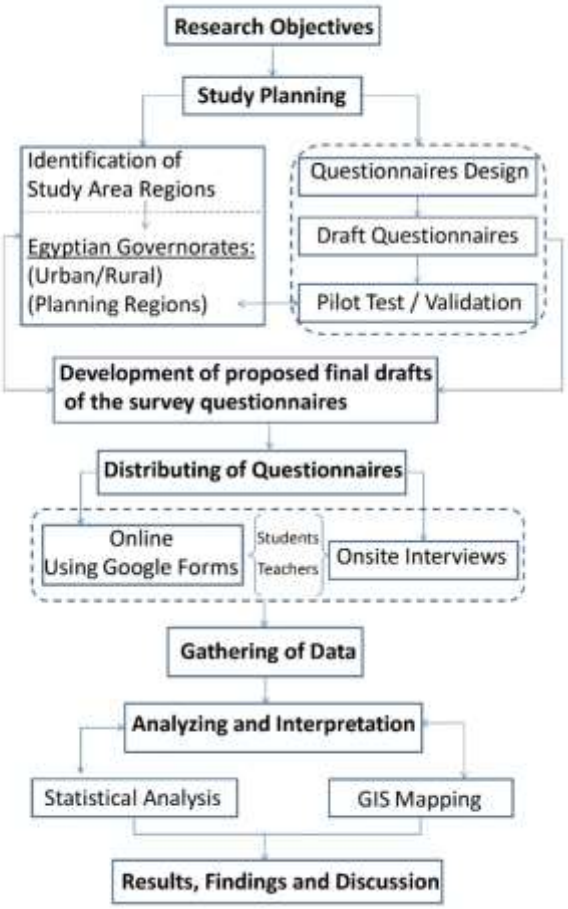

Figure 2: Chart showing the methodology used in the research.

The spatial distribution presented in Figures 3 and 4 indicates that the survey covered some regions of Egypt, and the sample was representative and comparative to variations in population density

within these regions.

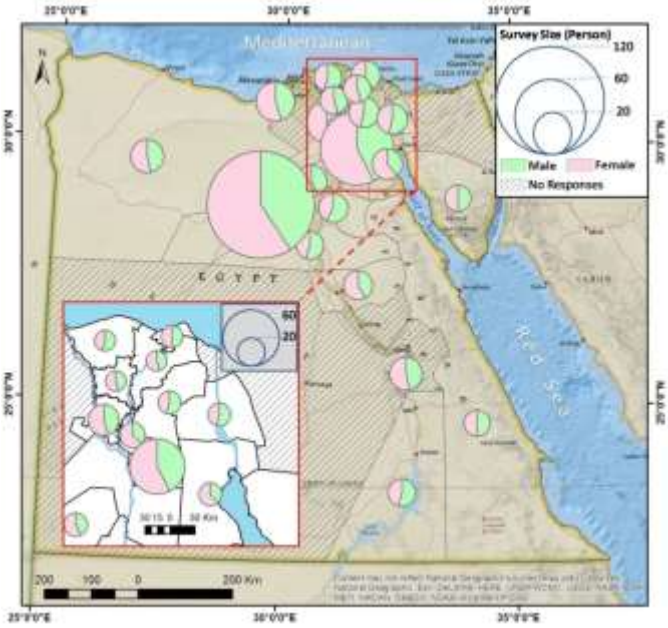

Figure 3: shows the spatial distribution for student's sample.

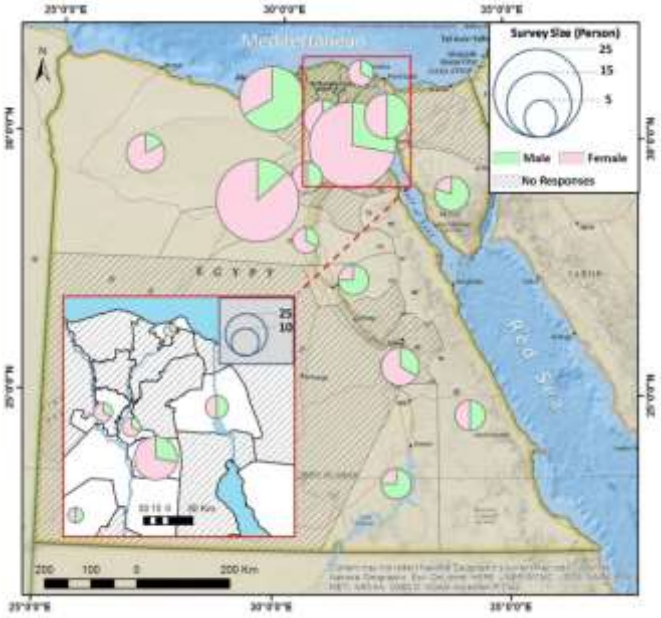

Figure 4: shows the spatial distribution for teacher's sample.

Questionnaires

A total of 563 online questionnaires were distributed to students and teachers from different regions of Egypt (440 students and 123 teachers). Questions were designed to assess knowledge, perceptions, and attitudes towards climate change education (Tables 1 and 2).

Table 1: details of sample size taken by the questioner.

Region	Governorate	Students Survey Size		Teachers Survey Size	
		Male	Female	Male	Female
Greater Cairo	Cairo	26	35	7	18
	Giza	50	72	3	20
	Qalyubia	8	12	2	4
Alexandria	Alexandria	9	11	10	5
	Behiera	Null	Null	Null	Null
	Matrouh	7	8	1	5
Delta	Damietta	6	6	1	3
	Mnoufia	10	12	2	4
	Gharbia	5	6	Null	Null
	Kfr Elsheikh	6	5	Null	Null
	Dakahlia	5	6	Null	Null
Suez Canal	Sharqia	7	6	Null	Null
	Port Saied	Null	Null	Null	Null
	Ismilia	7	6	4	4
	Suez	5	8	Null	Null
	North Sinai	Null	Null	Null	Null
	South Sinai	5	5	4	1
Northern Upper Egypt	Minya	6	5	1	2
	Beni Suef	8	5	Null	Null
	Faiyum	6	8	2	2
Middel Upper Egypt	Asyut	5	7	3	1
	New Velly	Null	Null	Null	Null
Southern Upper Egypt	Sohag	Null	Null	Null	Null
	Qena	Null	Null	Null	Null
	Luxor	7	8	2	4
	Aswan	6	5	1	3
	Red Sea	5	5	2	2
Total		440		123	

Table 2: Survey on Climate Change Education for Primary, Middle, and Secondary School Students

Purpose: This survey aims to assess the knowledge, perceptions, and attitudes of primary, middle, and secondary school students towards climate change education.

General Information about the Participant:					
Age:	(9-11)	(12-15)	(16-18)		
Gender:	Male	Female	Preferred not to say		
Education Level:	Primary	Middle -	Secondary		
School Type:	Public	Private	Azhari		
Governorate:	Cairo	Lower Egypt	Upper Egypt	Sinai	Red Sea
Knowledge:					
Have you heard of the term "climate change" before?	Yes	No	Unsure		
Have you heard of any of the following terms before: desertification, drought, global warming?	Yes	No	Unsure		
Do you believe that the aforementioned phenomena are related to climate change?	Yes	No	Unsure		
Have you learned anything about desertification, drought, global warming, or the concept of climate change in your school curriculum?	Yes in Social Studies	Yes in Geography	Yes in Science	Yes in English	No
Perceptions					

Do you believe that studying the aforementioned phenomena is important?	Yes	No	Unsure		
In your opinion, what is the importance of knowing about these phenomena? (Multiple answers possible)	Reduce global warming	Protect the environment from degradation	Protect human health		
If you have studied the aforementioned phenomena in your school curriculum, in your opinion, was it:	Useful and engaging	Useful	Not useful		
What methods were used to teach these phenomena? (Multiple answer)	Textbooks	Educational media "videos",	laboratory applications	Internet,	None
Attitudes					
Would you like to study more details about these phenomena?	Yes	No	Unsure		
In your opinion, what are the best methods for teaching these phenomena?	Textbooks	Educational media "videos"	laboratory applications,	Internet,	None
In your opinion, is it better to learn about these phenomena by:	Including them in the school curriculum	Extracurricular educational courses	Not studying them at all		

- **Questionnaire design and target sample:**

This study utilized a cross-sectional survey design administered entirely online. The target population comprised teachers from various school types across Egypt, as well as students from diverse geographical regions within the country. A multi-pronged recruitment strategy was employed to achieve a representative and heterogeneous sample.

- Emails were sent to schools identified through targeted searches on school websites, informing them about the research and requesting them to distribute the survey among their teachers and students.

- The survey invitations were distributed through social media groups targeting teachers and parents on platforms such as Facebook and WhatsApp.

- **Interviews**

A total of 80 interviews were conducted with teachers to gauge their perceptions and knowledge of climate change education. The authors personally visited 80 teachers at their respective schools, while the remaining were contacted through video calls. A number of these teachers were personal contacts of the authors of this study, while others were selected for interviews by their respective school administrations.

The interview data underwent a rigorous analysis process, incorporating individual reflection, collaborative discussions, and ongoing consideration throughout the writing phase. This multifaceted approach involved introspection on our professional journeys as both educators and education researchers. Through an extensive analysis of these experiences, we aimed to elucidate the extent to which these experiences impacted our interpretation and engagement with the interview content. Our discussions and reflections were framed by an

abductive analysis of the teacher dimensions (practical-evaluative and projective) articulated by Priestley et al. (2015). Using this perspective, our goal was to analyze the data and identify patterns that revealed how these dimensions overlapped and appeared in the real-life experiences of the teachers we interviewed.

In order to enhance our analysis, we took into account previous studies on climate change education in schools specifically in the Egyptian context. This included investigations into the perspectives and experiences of Egyptian teachers (e.g., Howard-Jones et al., 2021). In addition, we referred to the extensive academic literature that examines the attributes of successful climate change education, such as the study conducted by Monroe et al. (2019).

- Statistical analysis

Data were analyzed using the SPSS software, version 22.

In order to ensure the reliability of the data collection tool, a two-phased piloting process was implemented prior to the widespread dissemination of the questionnaire. The first phase focused on content validity. Three Egyptian experts in the field of educational research were recruited to evaluate the instrument's clarity, comprehensiveness, and alignment with the intended constructs of teachers' and students' knowledge, perception, and attitude toward climate change education. Their feedback was used to make minor revisions in order to optimize the questionnaire.

The second phase focused on assessing instrument reliability. A pilot sample consisting of 20 participants, representative of the target population, completed the questionnaire twice with a three-week gap between each submission. The collected data underwent internal consistency analysis using Cronbach's alpha coefficient, yielding a satisfactory result of 0.81. In addition, the test-retest reliability was evaluated using the intra-class correlation coefficient, which indicated a strong correlation of 0.96. These findings demonstrated the tool's ability to reliably assess the targeted categories.

- Geographic distribution using GIS.

The spatial distributions of the two samples were mapped using GIS based on the relevant databases generated from the responses of the two groups of participants.

I. Main results and discussion

In order to assess the current state of climate change education within the Egyptian context, the present study utilized a two-pronged survey approach. The first survey targeted students enrolled at two different levels of the national school curriculum. The second survey targeted teachers with different subject specializations, specifically those that aligned with the student grade levels covered in the first survey.

The student sample for this study comprised a total of 440 respondents. The distribution across educational levels was as follows: 24.1% were primary-level students (aged 9–10 years), 42.3% were preparatory-level students (aged 11–13 years), and 33.6% were secondary-level students (aged 14–16 years). In order to ensure representativeness, the survey included students from a variety of school types within the Egyptian educational system. These included private schools, public schools, Azhari schools (Islamic education schools), and other categories encompassing both ‘national’ and ‘international’ schools (Figure 5).

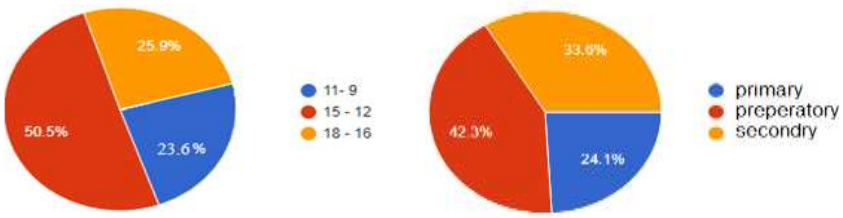

Figure 5: Students Age Groups and School Levels

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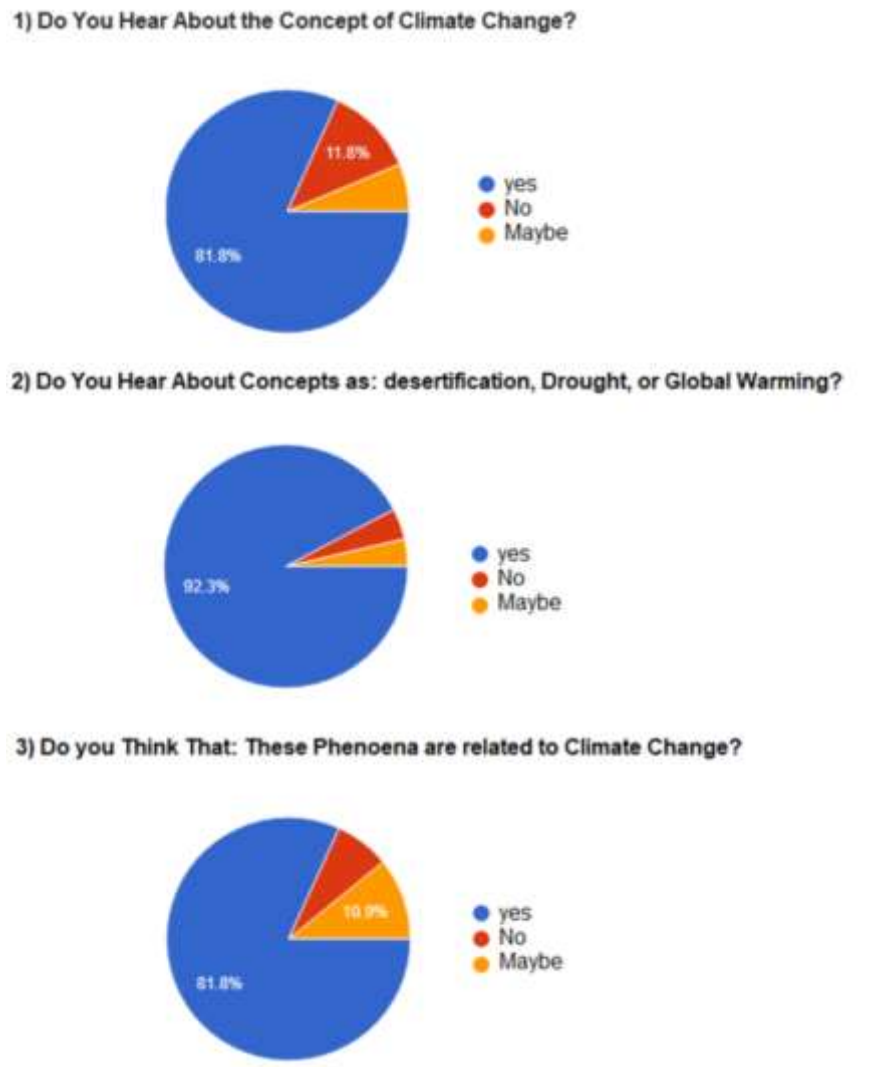

Figure 6: Students Knowledge of Climate Change.

The survey results revealed a high level of familiarity among students regarding the concept of climate change and associated phenomena. Figure 6 shows that more than 81.8% of the participants had prior knowledge of climate change, and more than 90% understood terms like drought, desertification, and global warming.

Furthermore, approximately 82% of students could link these phenomena to climate change. Students reported that climate change and related ideas were covered in different academic subjects, with a focus on social studies (particularly geography) and science. Approximately 78% of the surveyed students indicated a recognition of the significance of studying climate change, global warming, and related subjects in terms of their perception and awareness. Moreover, a significant percentage (57.3%) of student respondents indicated that the survey was beneficial. Additionally, 34.5% of students found the survey to be both informative and engaging (Figure 7).

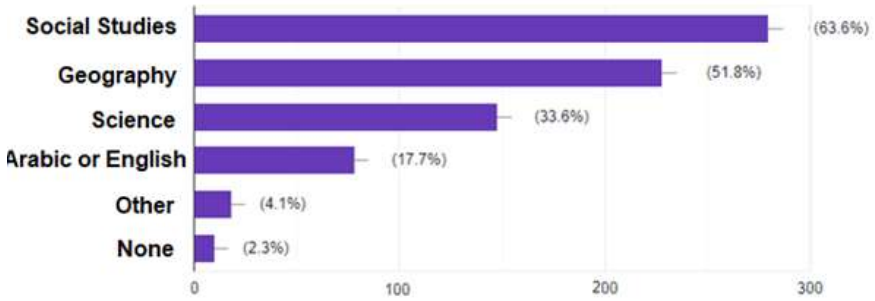

Figure 7: Student Prospects about Studying Climate Change

A substantial majority (83.6%) of students expressed the belief that studying climate change concepts was essential for mitigating environmental degradation, protecting humanity, and reducing climate-related mortality (56.8%) and global warming (40%). The survey results revealed that around 67% of students were interested in gaining further knowledge about climate change (Figure 8).

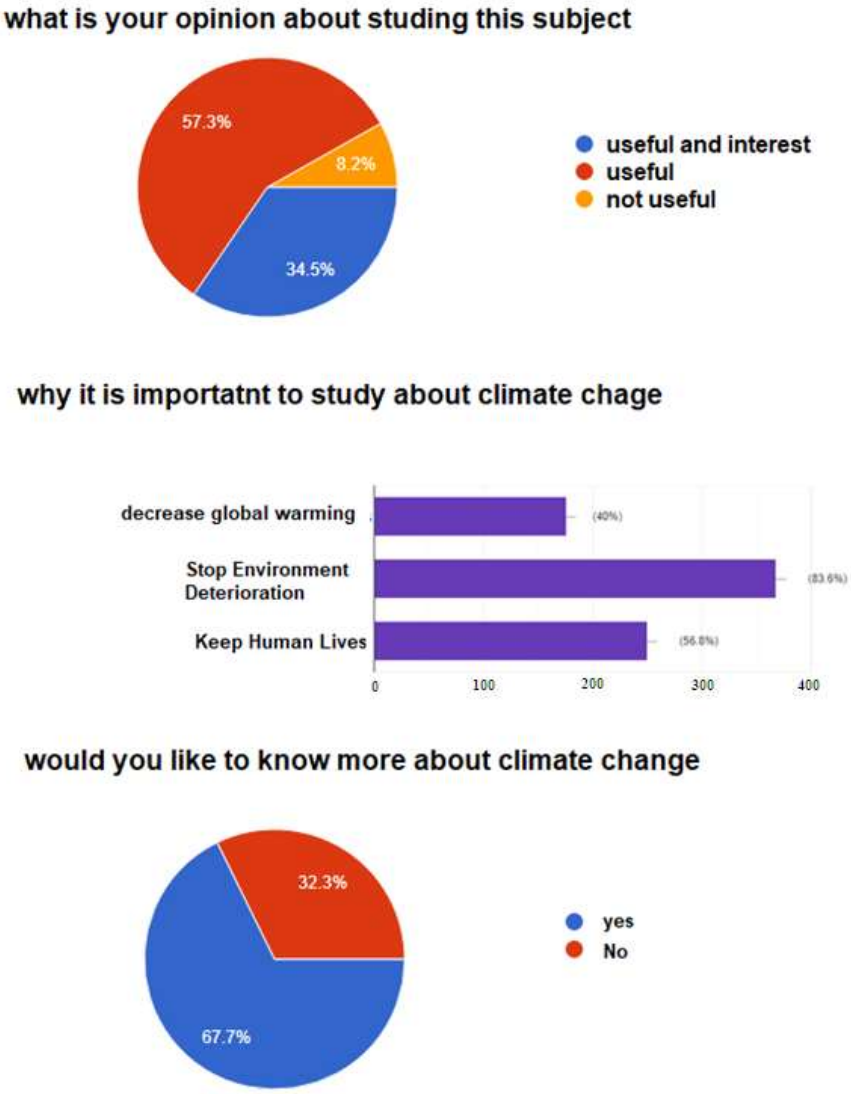

Figure 8: Student Prospects about Studying Climate Change.

The majority of students (88.6%) reported that they had primarily learned about climate change concepts from school textbooks. However,

they expressed a strong desire to use a broader range of resources to study climate change in the future. The most commonly used tools were videos and other visual aids (66.4%), followed by laboratory studies (42.3%), Internet websites (56.4%), and library activities (24.1%) (Figure 9a). Students also also believed that information regarding climate change could be acquired not only through school syllabi but alsO through television, radio, and online campaigns.

The surveyed teachers were selected from a diverse array of schools representing various types, and the respondents included educators from all school levels. Of the teachers surveyed, 44.1% were primary school teachers, 27.1% were preparatory school teachers, and 28.8% were secondary (high) school educators (Figure 9b).

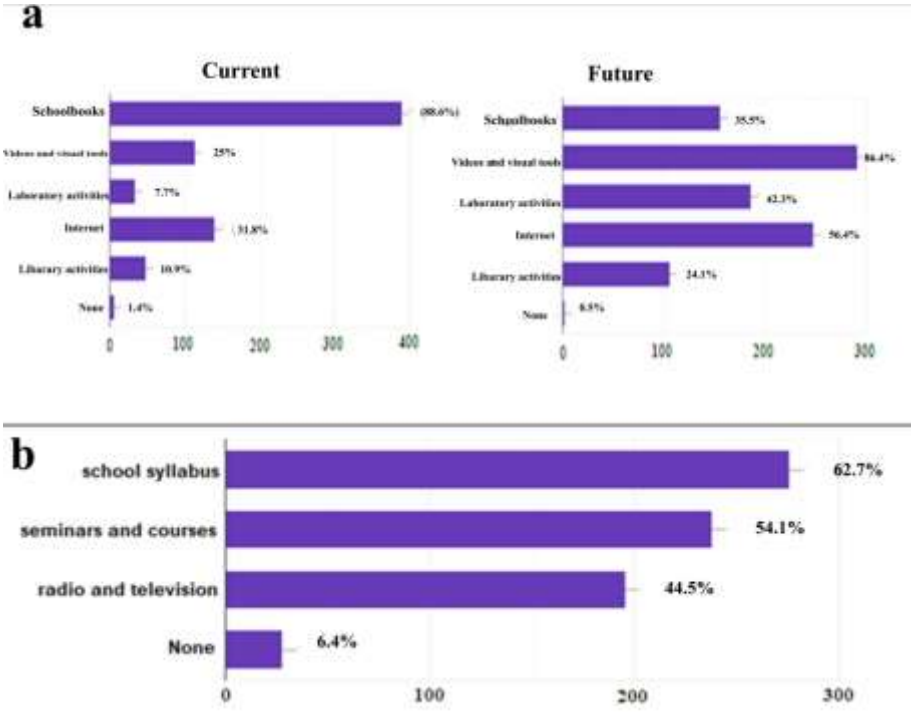

Figure 9a &b: **a** Means of Studying Climate Change; **b**: Sources of Climate Change Knowledge.

Despite the variation in subjects taught within our sample, approximately 89.8% of the teachers demonstrated familiarity with the concept of climate change, while 94.9% exhibited awareness of several related concepts, such as drought, desertification, and global warming. Out of the surveyed individuals, 71.2% of teachers specifically attributed these occurrences to climate change (Figure 10a).

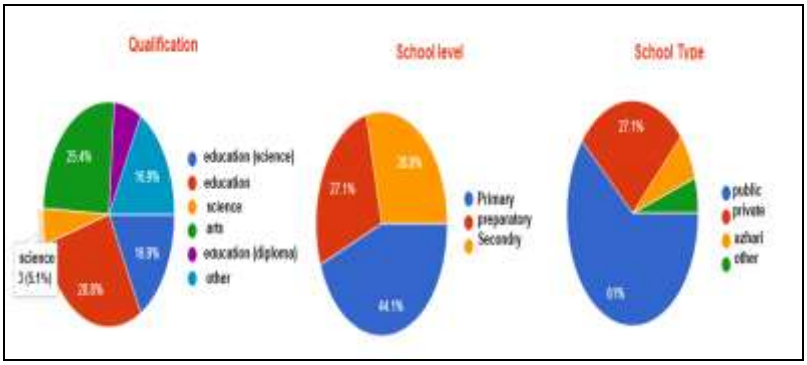

Figure 10a: Teachers Qualifications, Teaching School level, and school type

Intriguingly, 70% of teachers indicated they include instruction on drought, desertification, global warming, and/or climate change in their curriculum. Similarly, 81.4% of the teachers expressed a conviction regarding the significance of teaching this particular subject (Figure 10b).

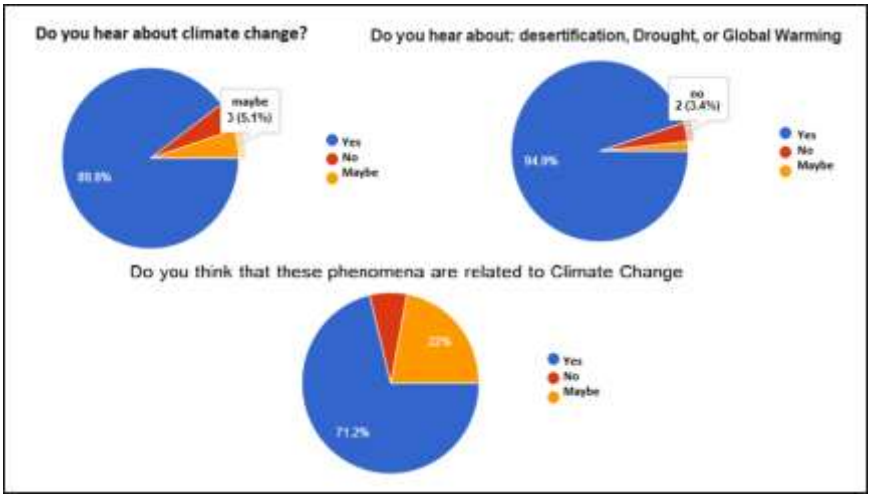

Figure 10b: Teachers Knowledge about Climate Change.

This finding is important because this apparent pervasiveness of climate change within various school subjects should help the younger generation acquire the knowledge necessary to fight or revere global warming, reduce related morbidity and mortality, and save the environment. This knowledge can also help convince future generations to effectively regulate the utilization of natural resources when they hold positions of authority. Approximately 64% of educators expressed their agreement with the inclusion of climate change subjects in the curriculum, demonstrating their recognition of the importance of imparting this information to their students (Figures 11 and 12).

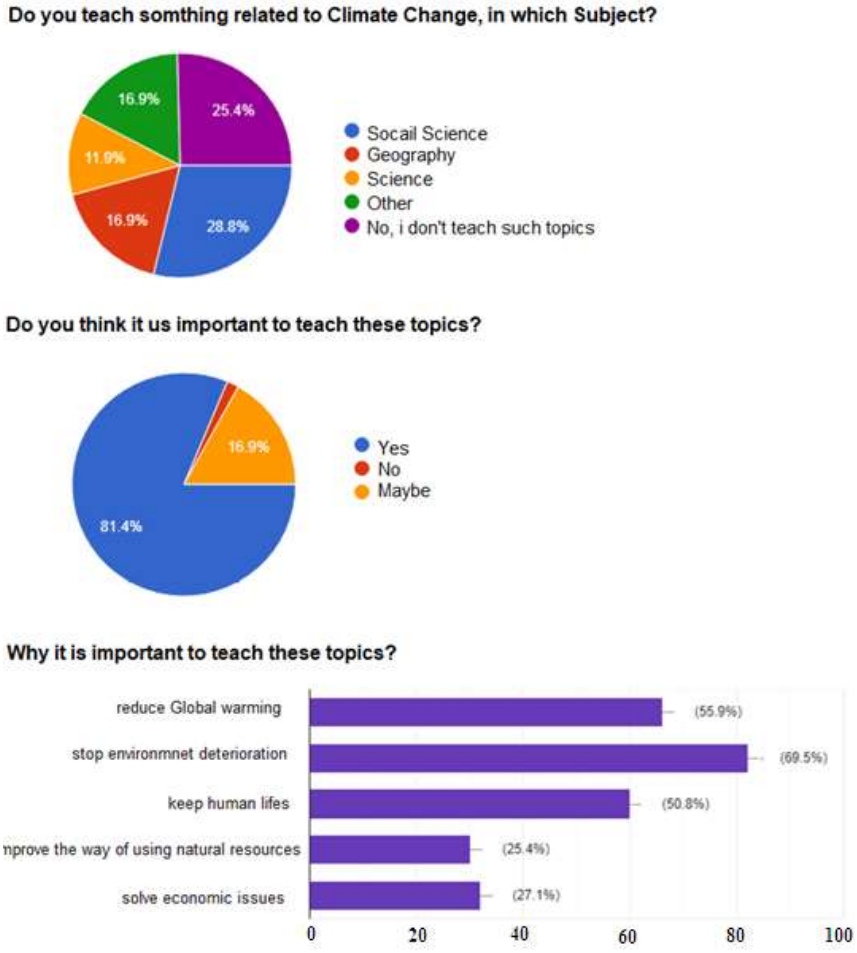

Figure 11: Importance of Teaching about Climate Change.

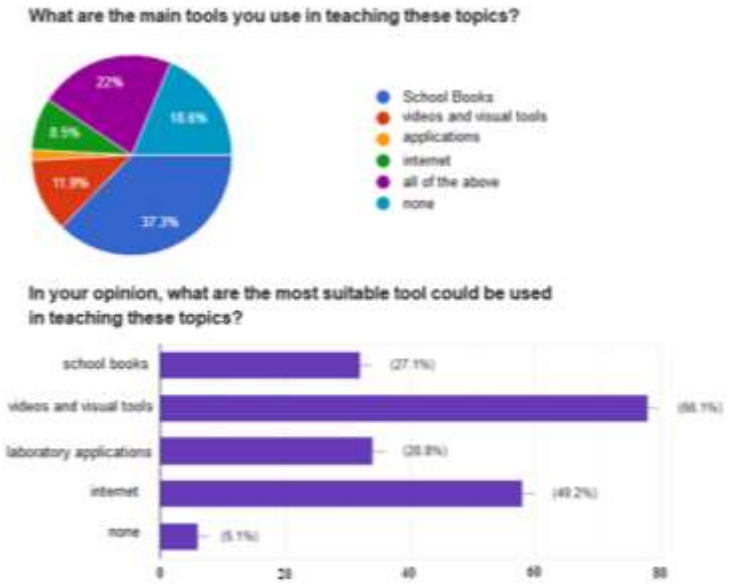

Figure 12: Tools of Teaching about Climate Change.

The survey indicated that teachers currently utilize a range of tools and methodologies for teaching climate change science. Teachers have found that the most effective ways to teach climate change are through the utilization of videos and visual aids.

In addition to the surveys, interviews were conducted with teachers from a limited number of schools (ten). Although the number of interviews conducted was limited, the authors of the study are confident that these interviews served to validate the findings of the online questionnaire and provide supplementary data. The interviewees expressed their intention to gain a deeper understanding of climate change and to attempt to gain more knowledge about the subject. Some respondents reported organizing climate-change-focused activities for their students, including volunteering, during the 2022 United Nations Climate Change Conference (COP 27) held in Sharm El Sheik, Egypt. Students provided suggestions regarding the content that could be incorporated into future syllabi.

Teacher Interviews

Out of the larger pool of teachers in both public and private schools that were initially selected, 80, primarily science and social studies teachers, were eventually successfully interviewed. Questions focused on the teaching methodologies utilized by these teachers at both the primary and preparatory stages. Additionally, the interviews explored how teachers approached geography, biology, and chemistry in the secondary stage, these subjects being relevant to climate change issues. The selection of school subjects to be discussed during the interviews was determined through consultation with several teachers. The participants were asked which subjects they perceived as encompassing themes pertaining to climate change, such as adaptation, floods, desertification, and other related concepts.

1- The primary stage

Fourth grade elementary (science): The elementary curriculum covers two main aspects of climate change. The first topic is adaptation, in which students study the impact of increasing temperatures on the extinction of polar bear species that are unable to adjust to the melting of ice. The second topic is pollution, specifically focusing on general air pollution and pollution caused by carbon dioxide. Students investigate the impact of pollution on global warming and the subsequent increase in temperatures.

Fifth grade elementary (science): In the elementary curriculum, students learn about climate change under the theme of environmental balance and how the imbalance resulting from global warming adversely affects animals.

2- The preparatory stage:

First grade preparatory (geography): In the first year of preparatory stage geography, students learn about climate change within the context of *natural and environmental hazards*. One aspect covered in this context is the issue of desertification, including topics such as overgrazing and its relationship to global warming. This represents a portion of the broader content addressed in the curriculum.

Second grade preparatory (science): The consequences of global warming are discussed. Students are instructed that climate change results in the thawing of ice, the occurrence of floods, the formation of

torrents, and the process of desertification. Furthermore, the issue of climate change is examined under the topic of the 'atmosphere.' The material provides an overview of the earth's atmosphere, followed by an examination of global warming and alterations to the ozone layer as illustrations of the effects of climate change.

Second grade preparatory (social studies): In social studies, the topic of climate change is explored by examining the concept of desertification, which is recognized as a significant barrier to agricultural expansion.

3- The secondary stage

First-grade secondary school (geography): The concept of climate change and its impact on humans, agriculture, and tourism are student study subjects. The subject of global warming is thoroughly examined in the context of the climatic regions of Egypt.

Third-grade secondary school (geography): Climate change is included in the curriculum as part of the subject of "environmental balance." The curriculum also encompasses an examination of overgrazing and its contribution to instigating wars and border conflicts, which is explored using relevant examples from Western Africa.

II. Conclusions and recommendations

The previously mentioned findings indicate that climate change education is present to some extent in different Egyptian schools. However, the absence of a specific unit focused on climate change in any subjects being taught is concerning. According to the findings, the term' climate change' or any related concepts are not used as distinct titles or subtitles in any of the school curricula. Instead, interconnected subjects are incorporated into broader chapters across various disciplines, primarily in the fields of science and geography. In addition, the English language curriculum now includes instruction on climate change terminology, which places the responsibility on teachers who may not have expertise in science or geography. Egyptian schools' regulations and testing procedures compel teachers

to focus primarily on delivering concepts within official textbooks, which students are usually required to memorize. The surveyed students expressed a preference for unorthodox methods, such as seminars and hands-on practical learning. Teachers surveyed reported that they primarily rely on the Egyptian Knowledge Bank (EKB) as their main source of information. The EKB is a valuable resource that can enhance the instruction of different subjects by providing a large amount of information. Teachers utilize photos and videos from the EKB to elucidate climate change-related concepts, particularly when practical learning activities or field visits are not feasible.

The results also indicated that climate change is examined within broader categories such as environmental balance, pollution, adaptation, or atmospheric unity in the primary, middle, and secondary stages. The concept of global warming is explored in different school curricula and serves as an introduction to the topic of climate change.

In Egypt, secondary school students choose between literature or science track diplomas. Those who graduate from the literature track are still exposed to concepts of climate change, global warming, and desertification. In addition, we found no differences between private schools and public in terms of the content of their curricula on climate change.

Based on the above, some recommendations are worth making:

- Egyptian syllabi can be modified and tailored to include more comprehensive units on climate change. These units can be authored by experts in the field of climate change.
- The added units should be incorporated into the geography syllabus. Geography teachers can be allowed to use unorthodox and creative methods of delivering concepts related to climate change.
- Universities can participate by organizing workshops or simplified seminars for both students and teachers in schools.

- University academics could collaborate with the Egyptian Ministry of Education to organize their involvement through a project or an initiative.
- Research projects focused on sustainability carried out in Egyptian educational institutions, specifically those conducted in partnership with the European Union, can be examined to enhance climate change education by utilizing their findings.
- Developing context-specific indicators: Climate change education can be tailored to the local context, and the specific vulnerabilities and priorities of Egyptian communities should be considered. Monitoring indicators should reflect this context.
- Utilizing technology for data collection and analysis: Technology-based tools can facilitate data collection, storage, and analysis, making monitoring more efficient and cost-effective.
- Promote knowledge-sharing and capacity building: Regular workshops, training sessions, and knowledge-sharing platforms can enhance the capacity of educators and stakeholders to conduct adequate monitoring and evaluation.
- Advocating for increased funding: It is essential to obtain sufficient funds for monitoring and evaluation activities in order to guarantee the long-term viability and efficiency of climate change education programs in Egypt.

Climate change education has become of significant importance with the current environmental degradation the world is facing. Egypt will face specific challenges associated with water scarcity, in addition to the overall impacts of global warming that affect the entire planet.

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