Faculty of Natural and Applied Sciences Journal of Mathematics and Science Education
Print ISSN: 2814-0885 e-ISSN: 2814-0931
www.fnasjournals.com
Volume 5; Issue 2; March 2024; Page No. 87-96.

Senior Secondary School Chemistry Students' Knowledge of Climate Change in the Niger Delta Region of Nigeria

[1]Zudonu, O.C., [2]Wagbara, S.O., [3]Ikwut, E.F., & [1]Iroro, P.E.
[1]Federal College of Education (Technical) Omoku, Nigeria.
[2]Ignatius Ajuru University of Education Rumuolumeni, Port Harcourt, Nigeria
[3]Department of Science Education, Rivers State University, Port Harcourt, Nigeria

***Corresponding author email:** wagbara@iaue.edu.ng

Abstract
This work investigated the Knowledge of Chemistry Students on Climate Change in Senior Secondary Schools in the Niger Delta area of Nigeria. The study adopted a descriptive survey design. The sample of the study consists of five hundred and twenty (520) participants (223 males and 297 females) who were randomly selected from 50 senior secondary schools in the region. The instrument used for this study was titled Knowledge of Chemistry Students in Climate Change Structured Questionnaire in the Niger Delta area (KCSCCSQND). The items were structured on a 5-point Likert scale. The instrument consists of 30 items that address the three research questions. The instrument was face-validated and the reliability coefficient using the test-retest method was 0.81. Descriptive statistic of percentages was used to answer the research questions. It was established that chemistry students in the Niger Delta hold a good knowledge of climate change and the untoward effect of weather variation in the Niger Delta region. Some of the chemistry students in the Delta area remained neutral to ways and methods of mitigating temperature alteration and its effect in the Delta zone due to their incomplete knowledge of the art of weather change. Hence, recommendations were made to the Government and relevant stakeholders that there should be establishment of vital programmes to increase the awareness of climate change and effective methods to curtail its effect in the country and Niger Delta in particular.

Keywords: Climate Change, Temperature, Chemistry Students' Attitude, Weather Patterns.

Introduction

Climate change is the gradual alteration of weather conditions over an extended period, resulting in significant and lasting variations to the earth's weather structure (Russell, 2007). Climate change is the changing weather in an area, like how hot or cold it gets, how much rain falls, or how windy it is, either in one place or all around the world (Zudonu and Ekpa, 2012). It describes the long-time shifts of the average weather conditions, and this predominantly talks about the untoward variations that happen or occur over time on the average temperature of Earth. Climate change, which is already understood, as the gradual alteration of earth's climate patterns or arrangement over a long period is a basic culprit in the degradation of the environment (Ede & Edokpa, 2015). It is mainly occasioned by human activities, such as the actions of international oil and gas corporations, burning remnant fuels such as coal, oil, and gas and deforestation, which emit gases that greenhouse gases into the air (Ite et al., 2013). These gases, such as carbon (IV) oxide, capture heat from the sun, causing the earth to get warmer. It is called the "greenhouse effect". Because of this, the Earth's usual temperature is going up, causing things like ice melting, oceans getting higher, and more life-threatening weather (like strange precursors of huge or mild rainfall, hurricanes, and heat waves), and shifts in ecosystems. According to Kruse (2019), climate change affects all spheres of life, including agriculture, water resources, culture, socioeconomic, health, and biodiversity (the variety of living organisms, plants, animals, and microorganisms not precluded, as well as the ecosystems in which they exist). To mitigate climate change, we need to cut down on gases that trap heat, switch to clean energy like solar and wind power, save and fix natural places, and adjust to the changes happening now. to reduce greenhouse gas emissions, transition to renewable energy sources, protect and restore natural habitats, and adapt to the changes already occurring (Smit, 2001; Zudonu, 2015). Also, by

Cite this article as:
Zudonu, O.C., Wagbara, S.O., Ikwut, E.F., & Iroro, P.E. (2024). Senior secondary school chemistry students' knowledge of climate change in the Niger Delta region of Nigeria. *FNAS Journal of Mathematics and Science Education, 5(2),* 87-96.

taking collective action, we can fix this monster by consciously striving towards attaining a sustainable tomorrow and minimising the undesirable influences of weather change on planet Earth.

The penalties of weather transformation are far-reaching and impact countless facets of our planet. Some of the utmost noticeable influences are the upsurge in worldwide temperatures, occasioning warmer and more extreme climate measures like heavy rainfall, heat waves, droughts, and hurricanes. These chains of events can cause or lead to devastating consequences like heavy floods, crop failure, destruction of houses, scarcity of good drinking water, scarcity of water, strange diseases, increased death rates, and increased risk of other natural disasters (Zudonu et al., 2014). Another substantial consequence of climate change is that the ice at the North and South poles and on mountains is melting. When it gets hotter, the huge sheets of ice in Antarctica and Greenland are rapidly dissolving, leading to increasing levels of the sea. These pose monumental for places near the coast and areas that are very close to sea level. Climate change affects the whole world and has big effects on nature and people everywhere. The Niger Delta area in Nigeria is at high risk from climate change because of where it is and because the government relies a lot on its natural resources. the Niger Delta area has lots of different plants and animals, and it has got lots of valuable stuff in the ground and water. But climate change is putting all that at risk.

Figure 1: States of the Niger Delta (Ite et al., 2013)

The Niger Delta is on the coast of southern Nigeria and is about the size of 110,445.98 square kilometres (Km^2), and it is also known as one of the most polluted places on the planet. (Mbachu, 2020). The Delta ecosystem is dissimilar from each other, supporting both aquatic and terrestrial habitats, and providing food, traditional plants, and medicine to its inhabitants. Its different ecological zones include the lowland rainforest neighbourhood, mangrove swamp region, freshwater zone, then coastal inland zone (Chijioke et al., 2018). But still, the ecosystem is threatened by air pollution, depletion and degradation notwithstanding the oil and gas reserves that sustain the country's economy (Eduk, 2017).

As future or potential leaders and citizens, it is critical and crucial for secondary school students to develop a positive attitude towards environmental issues and understand the place of chemistry in tackling climate change challenges. McNeill and Vaughn (2010) stated that precise knowledge of chemistry is needed to produce a favourable attitude as it concerns weather variation. Many chemistry students study the chemistry of climate change as a broad area of their studies. It provides knowledge in such topics as chemical bonding, gases, electromagnetic spectrum, acids, and bases, and change of state, which is in line with Education for Sustainable Development (ESD) (Burmeister et al., 2012). The study emphasizes the importance of integrating sustainable development principles into education systems to foster environmental awareness, social responsibility, and economic viability. However, research has shown that the knowledge of the chemistry student about climate change is fragmented because of the intricate models and integrated content knowledge of Chemistry, Physics, Biology, Earth, and Atmospheric Science needed to understand better the concept of climate change (Kerr & Walz, 2007). Furthermore, research also shows that secondary school chemistry students often misplace the greenhouse effect with ozone layer depletion and associate global warming with depletion

Cite this article as:
Zudonu, O.C., Wagbara, S.O., Ikwut, E.F., & Iroro, P.E. (2024). Senior secondary school chemistry students' knowledge of climate change in the Niger Delta region of Nigeria. *FNAS Journal of Mathematics and Science Education, 5(2),* 87-96.

of the ozone layer, believing that the depletion of the ozone layer is caused by greenhouse gases (Russell, 2007); Pruncau et al., 2003; Zudonu, 2014). Also, students show a poor understanding of the impact of climate change on human health (Kerr & Walz, 2007). Some chemistry students believe that the impact of climate change will only cause them skin cancer while some believe that the cause of climate change is air pollution (Pruncau et al., 2003; Shepardson et al., 2009). This poor knowledge and misconception held by the chemistry students need to be addressed for a better attitude towards climate change. However, there is limited research on the impact of climate change on students' attitudes towards environmental issues and their motivation to learn chemistry (Russell, 2007). Understanding students' attitudes and perceptions can help educators develop effective strategies to promote environmental consciousness and foster a sense of responsibility towards the environment.

Constructivist Learning Theory

Constructivist learning theory is the educational theory upon which this study is grounded. Constructivism is a learning theory that emphasizes the active participation of learners in acquiring knowledge rather than passively receiving it from contact with the teacher. In other words, we build new knowledge on top of what we already know and have experienced. This indicates that each person understands things in their way because everyone has different ideas and experiences. So, the new things we learn depend on what we already know and have been through. Furthermore, the new knowledge a person gains should make sense based on what they already know and have experienced, even if it does not perfectly match the actual world. It is more important for new information to align with their past experiences and understanding. Building knowledge involves creating new ideas and checking if they make sense with what we already know. When the new knowledge fits well with our past experiences and understanding it becomes meaningful learning. This kind of learning is useful because we can apply it in different situations. It is different from rote learning, which is just memorizing facts without really understanding them (Bodner, 2001). The implication of using this constructivist learning theory in this present study is that chemistry students in the Niger Delta already have their ideas about chemistry and climate change. These ideas might be incomplete, wrong, or not quite accurate. The goal of this study is to find out how much these students know about climate change. The study could look at what the students understand and believe, and then see if their knowledge is correct or needs improvement.

Climate Change

Air pollution: Air pollution is one of the major drivers of climate change in the Niger Delta area (Zudonu, 2015). Climate is an integral or essential part of the environment. It includes things like temperature, rain, wind, and humidity over a long time in a specific place. When the climate changes, it affects the entire ecosystem. For example, changes in temperature and rainfall can alter plant growth, animal behaviours, and water availability. These changes can then impact other parts of the ecosystem, like the food chain and habitats. So, any shift in the climate can lead to significant changes in the whole environment (Ede & Edokpa, 2015). It is important to note that the indigenous people of the Delta area rely entirely on their land and water to live. However, oil and gas activities in the area have polluted the air, land, and water (Eduk, 2017). The high levels of carbon dioxide and methane released into the atmosphere during their activities alter the atmosphere of the region and hence, temperature change leads to warming and climate change (Eduk, 2017; Russell, 2007). Climate change is further contributed to by the incomplete combustion of fossil fuel and biomass emitting more greenhouse gases. This incomplete combustion produces Black Carbon and affects the balance of the atmosphere thus, contributing to global warming and climate change (Zudonu, 2015; Weli et al., 2018).

Gas Flaring: Gas flaring has affected the Delta environment negatively, resulting in high concentrations of greenhouse gases in the region (ANEEJ, 2004). It was reported by Iyayi (2004) that the emission of carbon dioxide in the Niger Delta is the highest in the world. The non-stop gas flaring in the region has pushed much of the carbon dioxide into the atmosphere, causing an upsurge in atmospheric temperature. This escalation of atmospheric temperature eventually leads to heavy rainfall in the Niger Delta as there is a corresponding increase in the evaporation of water bodies found in the Niger Delta.

Rainfall and Flooding: As stated above, there is now an increased intensity of rainfall which is governed by the escalation of atmospheric temperature and evaporation of water bodies. This increased intensity of rainfall has flooded the plains of the Niger Delta, leading to the loss of farmlands and crops, washing away roads and houses, as well as washing away topsoil, thus reducing the fertility of the soil in the Niger Delta. That is, the means of livelihood of the people have been impacted negatively and paralyzed.

Cite this article as:
Zudonu, O.C., Wagbara, S.O., Ikwut, E.F., & Iroro, P.E. (2024). Senior secondary school chemistry students' knowledge of climate change in the Niger Delta region of Nigeria. *FNAS Journal of Mathematics and Science Education, 5(2),* 87-96.

Climate Change and the Chemistry Student

Knowledge and Awareness: Chemistry students in the Niger Delta area learn a lot about climate change. They study important things like greenhouse gases, the carbon cycle, and how human actions affect the Earth's climate. Greenhouse gases, like carbon dioxide, trap heat in the atmosphere, which makes the Earth warmer. The carbon cycle explains how carbon moves through the air, plants, animals, and soil. When people burn fossil fuels like coal and oil, they add more carbon dioxide to the air, which disrupts this cycle. These chemistry students understand that human activities, such as driving cars, running factories, and cutting down forests, release a lot of greenhouse gases. This makes the Earth's climate change, leading to problems like higher temperatures, more extreme weather, and rising sea levels. Because of their education, these students know why climate change happens and what its effects are. This knowledge helps them see why it is important to take action to protect our planet.

By understanding the science behind climate change, these students can explain it to others and support efforts to reduce greenhouse gas emissions. They might get involved in projects to use cleaner energy, save energy, and promote sustainable practices. Their education gives them the tools to make a difference in fighting climate change.

Environmental Consciousness: Chemistry students, with their scientific background, often develop a heightened environmental consciousness. They see the possible dangers and long-term impacts of climate change on nature, people's health, and the economy. This awareness can drive them to adopt sustainable practices and advocate for environmentally friendly solutions.

Research and Innovation: Chemistry students could contribute to research and innovation in areas related to climate change. They can explore ways to develop cleaner energy sources, design more efficient catalysts, or create sustainable materials. Their knowledge of chemistry helps them find ways to cut down on greenhouse gases and lessen the damage caused by factories and other industrial activities. They understand how different chemicals react and can figure out how to make processes cleaner and more efficient. For example, they might work on developing new materials that produce less pollution or finding better ways to capture and store carbon (IV) oxide. They can also analyze data to see which methods work best for reducing emissions. By studying chemical reactions, they can suggest changes to make industries greener. Their skills allow them to come up with practical solutions that can help slow down climate change and protect the environment.

Laboratory Practices: Chemistry students can contribute to addressing climate change by adopting sustainable laboratory practices. They can promote the use of greener solvents, minimize waste generation, and implement energy-efficient protocols. By incorporating sustainable practices into their laboratory work, they can lead by example and inspire others to follow suit.

Education and Outreach: Chemistry students can actively engage in educating others about climate change. They can organize workshops, seminars, or awareness campaigns to share their knowledge and promote sustainable practices among their peers and the wider community. By disseminating information and fostering dialogue, they can inspire behavioural changes and encourage collective action.

Statement of the Problem

Indeed, there is an extreme paucity of literature on climate change and chemistry students' knowledge in secondary schools in the Niger Delta area of Nigeria; the very rare ones available are not very thorough and therefore lack details (Zudonu & Ekpa, 2012). The study investigated the knowledge of chemistry students on climate change in the Niger Delta region. Zudonu and Ekpa (2012) opined that the effects of climate change are cataclysmic and occasion tremendous destruction and devastation in the Niger Delta Zone in Nigeria. Consequently, many questions could be raised, questions such as, is climate change anthropogenic or has its origin in the influence of human activity on nature? Are the activities of multinational oil companies responsible for the Niger Delta region's environmental woes? What exactly should be done to remedy these untoward effects of the menace?

Purpose of the Study

This work investigated the Senior Secondary School chemistry students' knowledge of Climate Change in the Niger Delta area of Nigeria. The study sought to:

1. determine chemistry students' knowledge of climate change in the Niger Delta area.
2. ascertain chemistry students' knowledge of the effects of climate change on the Niger Delta region.
3. determine chemistry students' knowledge of ways of mitigating climate change in the Niger Delta.

.

Research Questions

To guide the study the following research questions were formulated.

1. What knowledge do chemistry students possess about climate change in the Niger Delta region?
2. What knowledge do chemistry students have about the effect of climate change on the Niger Delta area?
3. What knowledge do chemistry students possess regarding ways of mitigating climate change in the Niger Delta region?

Research Methods

The study used a descriptive survey design. It was conducted in the Niger Delta region of Nigeria. The population of the study comprised all the oil-bearing communities in the Niger Delta. The study Sample for the study consists of five hundred and twenty (520) subjects (223 males and 297 females) which were randomly selected from the region. The instrument used for this study was the Knowledge of Chemistry Students on Climate Change Structured Questionnaire in the Niger Delta region (KCSCCSQND). The questions were structured in a five-point Likert scale. Where Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), and Strongly Disagree (SD), ranging from 1-5 respectively. The instrument consists of 30 items that address the research questions. The Knowledge of Chemistry Students on Climate Change Structured Questionnaire in the Niger Delta region (KCSCCSQND) was face validated by two experts in environmental chemistry and geography. The study used the test-retest method. Copies of the instrument were administered to the participants and retrieved after completion. An hour later, a modified version of the instrument with the same items in a different order was given to the same participants. The reliability score, determined by Pearson's correlation, was 0.81, which is considered reliable for the study. Percentages were used to answer the research questions.

Results

Research Question 1: What knowledge do chemistry students possess about climate change in the Niger Delta region?

Table 1: showing responses in the percentage of chemistry students' knowledge about climate change in the Niger Delta.

S/N		SA%	A%	N%	D%	SD%
1.	Climate change may be primarily caused by human activities, such as burning fossil fuels and deforestation.	93 17.9	210 40.4	60 11.5	85 16.3	72 13.9
2.	The greenhouse effect could be a natural process that helps regulate the Earth's temperature.	59 11.4	177 34.0	166 31.9	30 5.8	88 16.9
3.	Increasing levels of carbon (IV) oxide in the atmosphere could contribute to global warming.	204 39.2	161 31.0	41 7.9	55 10.6	59 11.3
4.	Climate change can cause more frequent and severe natural disasters, like hurricanes and droughts.	87 16.7	186 35.8	33 6.3	132 25.4	82 15.8
5.	Renewable energy sources, like solar and wind power, can help reduce greenhouse gas emissions.	111 21.4	231 44.4	39 7.5	89 17.1	50 9.6
6.	Climate change only affects the environment and has no impact on human health.	102 19.6	109 21.0	50 9.6	141 27.1	118 22.7
7.	The Niger Delta region is especially at risk from climate change because it is on the coast and has oil extraction activities.	287 55.2	127 24.4	3 0.6	53 10.2	50 9.6
8.	Climate change can cause the loss of biodiversity and the extinction of species.	88 16.9	152 29.2	46 8.9	98 18.8	136 26.2
9.	Individuals need to adopt sustainable practices, such as recycling and conserving energy, to mitigate climate change.	176 33.9	126 24.2	35 6.7	106 20.4	77 14.8
10.	Education and awareness about climate change are essential for addressing this global issue.	268 51.5	134 25.8	9 1.7	50 9.6	59 11.4

The results in Table 1 reveal that 40.4% of the students agree that climate change may be caused by human activities, such as burning fossil fuels and deforestation. 34.0% agree that the greenhouse effect is a natural process that could

Cite this article as:
Zudonu, O.C., Wagbara, S.O., Ikwut, E.F., & Iroro, P.E. (2024). Senior secondary school chemistry students' knowledge of climate change in the Niger Delta region of Nigeria. *FNAS Journal of Mathematics and Science Education, 5(2),* 87-96.

help regulate the Earth's temperature whereas 31.9% were neutral. 39.2% strongly agree that increasing levels of carbon (IV) oxide in the atmosphere may have contributed to global warming. 35.8% agree that climate change could lead to more severe natural disasters, such as hurricanes and droughts. A great number 44.4% of the chemistry students agree that renewable energy sources, such as solar and wind power, can help reduce greenhouse gas emissions. 27.1% of the students disagree that climate change only affects the environment and has no impact on human health against 21.0% that agree. More than half of the students 55.2% strongly agree that the Niger Delta region is particularly vulnerable to the impacts of climate change due to its coastal location and oil extraction activities. He insisted that even those who are also far from the zone could as well suffer from it since wind power can spread it. Meanwhile, 29.2% agree that climate change can lead to the loss of biodiversity and extinction of species compared to 26.2% that strongly disagrees. 33.9% of students strongly agree alongside 24.2% that agreed in contrast to 20.4% that disagree that it is important for individuals to adopt sustainable practices, such as recycling and conserving energy, to mitigate climate change. 51.5% of the chemistry students strongly agree that education and awareness about climate change are essential for addressing this global issue in the Niger Delta region.

Research Question 2: What is the knowledge of chemistry students about the effects of climate change on the Niger Delta area?

Table 2: showing responses in the percentage of chemistry students' knowledge of the effects of climate change on the Niger Delta area.

S/N		SA%	A%	N%	D%	SD%
11.	Climate change can lead to increased flooding in the Niger Delta region.	124 23.8	250 48.1	29 5.6	69 13.3	48 9.2
12.	Rising sea levels due to climate change can result in the loss of coastal land in the Niger Delta region.	89 17.1	143 27.5	105 20.2	85 16.4	98 18.8
13.	Climate change can negatively impact agriculture and food production in the Niger Delta region.	231 44.4	90 17.3	28 5.4	76 15.6	61 17.3
14.	Rising temperatures from climate change can cause more frequent heatwaves in the Niger Delta region.	163 31.4	200 38.5	20 3.8	76 14.6	61 11.7
15.	Climate change can result in the loss of biodiversity and ecosystem disruptions in the Niger Delta region.	80 15.4	130 25.0	90 17.3	130 25.0	90 17.3
16.	The Niger Delta region may experience more frequent and intense storms and hurricanes due to climate change.	63 12.1	100 19.2	55 10.6	120 23.1	182 35.0
17.	Climate change can lead to the depletion of freshwater resources in the Niger Delta region.	96 18.5	144 27.6	50 9.6	123 23.7	107 20.6
18.	Rising temperatures and changing rainfall patterns can negatively impact the fishing industry in the Niger Delta region.	117 22.5	203 39.1	63 12.1	60 11.5	77 14.8
19.	Climate change can increase the prevalence of vector-borne diseases, such as malaria, in the Niger Delta region.	113 21.7	215 41.3	67 12.9	58 11.2	67 12.9
20.	The Niger Delta region may experience increased erosion and coastal erosion due to climate change.	122 23.5	189 36.3	71 13.7	93 17.9	45 8.6

The results from Table 2 reveal that 48.1% agree that climate change can lead to increased flooding in the Niger Delta region. 27.5% agree contrary to 20.2% of the students that was neutral that rising sea levels due to climate change can result in the loss of coastal land in the Niger Delta region. 44.4% strongly agreed that climate change can negatively impact agriculture and food production in the Niger Delta region. 38.5% agree together with 31.4% of the students who strongly agree that increased temperatures due to climate change can lead to repeated heatwaves in the Niger Delta region. It is surprising to know that 25.0% both agreed and disagreed that climate change can cause the loss of biodiversity and ecosystem disruptions in the Niger Delta area. Meanwhile, 35.0% of the students strongly disagree that the Niger Delta region may experience more frequent and strong storms and hurricanes due to climate change. 27.6% agree that climate change can lead to the depletion of freshwater resources in the Niger Delta region while

Cite this article as:
Zudonu, O.C., Wagbara, S.O., Ikwut, E.F., & Iroro, P.E. (2024). Senior secondary school chemistry students' knowledge of climate change in the Niger Delta region of Nigeria. *FNAS Journal of Mathematics and Science Education, 5(2),* 87-96.

23.7% and 20.6% disagree and strongly disagree respectively. 39.1% agree that rising temperatures and changing rainfall patterns can negatively impact the fishing industry in the Niger Delta region. It was also agreed by 41.3% of the students that climate change can increase the prevalence of vector-borne diseases, such as malaria, in the Niger Delta region. 36.3% agree along with 23.5% who strongly agree that the Niger Delta region may experience increased erosion and coastal erosion due to climate change.

Research Question 3: What knowledge do chemistry students possess regarding ways of mitigating climate change in the Niger Delta region?

Table 3: Showing responses in percentage of chemistry students' knowledge of ways of mitigating climate change in the Delta region of Nigeria.

S/N		SA%	A%	N%	D%	SD%
21.	Switching from fossil fuels to renewable energy like solar and wind power can help reduce climate change in the Niger Delta region.	126 24.2	253 48.7	30 5.8	52 10.0	59 11.3
22.	Implementing sustainable agricultural practices, such as organic farming and agroforestry, may help reduce climate change mitigation in the Delta area.	96 18.5	250 48.1	70 13.5	31 5.9	73 14.0
23.	Promoting afforestation and reforestation efforts in the Niger Delta region can help absorb carbon dioxide and mitigate climate change.	103 19.8	244 46.7	64 12.3	54 10.4	55 10.6
24.	Encouraging the use of energy-efficient technologies and appliances can reduce greenhouse gas emissions in the Niger Delta region.	82 15.8	114 21.9	163 31.3	78 15.0	83 16.0
25.	Implementing policies and regulations that promote maintainable and workable transport, such as improving public transport systems and encouraging cycling, can help lessen climate change in the Niger Delta area.	120 23.1	200 38.5	72 13.8	85 16.3	43 8.3
26.	Educating communities of the Niger Delta area about waste management and recycling practices can contribute to climate change mitigation.	220 42.3	163 31.3	50 9.6	42 8.1	45 8.7
27.	Encouraging the use of energy-efficient building designs and materials can reduce energy consumption and mitigate climate change in the Niger Delta region.	66 12.7	105 20.2	183 35.2	100 19.2	66 12.7
28.	Implementing sustainable water management practices, such as rainwater harvesting and water conservation, can contribute to climate change mitigation in the Niger Delta region.	64 12.3	186 35.8	152 29.2	71 13.7	47 9.0
29.	Promoting awareness and behaviour change regarding food waste reduction and sustainable consumption can help mitigate climate variation in the Delta area.	84 16.2	126 24.2	175 33.7	55 10.6	80 15.3
30.	Collaborating with local communities, organizations, and government agencies to develop and implement climate change adaptation and mitigation strategies is crucial for the Niger Delta region.	108 20.8	216 41.5	34 6.5	94 18.1	68 13.1

The results from Table 3 show that 48.7% of the students agree that transitioning from fossil fuel-based energy sources to renewable energy, such as solar and wind power, can help mitigate climate change in the Niger Delta region. Also, 48.1% agree that implementing sustainable agricultural practices, such as organic farming and agroforestry, can contribute to climate change mitigation in the Niger Delta region. Similarly, 46.9% agree that promoting afforestation and reforestation efforts in the Niger Delta region can help absorb carbon dioxide and mitigate climate change. But it

Cite this article as:
Zudonu, O.C., Wagbara, S.O., Ikwut, E.F., & Iroro, P.E. (2024). Senior secondary school chemistry students' knowledge of climate change in the Niger Delta region of Nigeria. *FNAS Journal of Mathematics and Science Education, 5(2),* 87-96.

is remarkable to know that 31.3% were neutral about how encouraging the use of energy-efficient technologies and appliances can reduce greenhouse gas emissions in the Niger Delta region. 38.5% agree together with 23.1% who strongly agree that implementing policies and regulations that promote sustainable transportation, such as improving public transportation systems and encouraging cycling, can help mitigate climate change in the Niger Delta region. Likewise, 42.3% strongly agree alongside 31.3% that agreed that educating communities in the Niger Delta region about waste management and recycling practices can contribute to climate change mitigation. On the other hand, 35.2% were also neutral about how encouraging the use of energy-efficient building designs and materials can reduce energy consumption and mitigate climate change in the Niger Delta region. More so, 35.8% agree against 29.2% that were neutral about how implementing sustainable water management practices, such as rainwater harvesting and water conservation, can contribute to climate change mitigation in the Niger Delta region. 33.7% of students were also neutral on how to promote awareness and behavioural change regarding food waste reduction and sustainable consumption can help mitigate climate change in the Delta region. 41.5% of chemistry students agreed that collaborating with local communities, organizations, and government agencies to develop and implement climate change adaptation and mitigation strategies is crucial for the Niger Delta region.

Discussion

This study sought to determine the knowledge of chemistry students on climate change in the Niger Delta region of Nigeria. Data in Table 1 reveals that 40.4% of the students agree that climate change may be caused by human activities, such as burning fossil fuels and deforestation. This is consonance with the work of Zudonu and Ekpa (2012) who opined that human activities are the chief to the increasing climate change. 34.0% agree that the greenhouse effect is a natural process that could help regulate the Earth's temperature whereas 31.9% were neutral. 39.2% strongly agree that increasing levels of carbon (IV) oxide in the atmosphere may have contributed to global warming. This agrees with the study of Chijioke et al. (2018) who asserted that rising levels of carbon (IV) oxide is one of the main causes of global warming. 35.8% agree that climate change could lead to more severe natural disasters, such as hurricanes and droughts. A great number 44.4% of the chemistry students agree that renewable energy sources, such as solar and wind power, can help reduce greenhouse gas emissions. This is in line with the findings of Zudonu (2015) who opined that renewable energy like solar and wind power could reduce greenhouse emissions. 27.1% of the students disagree that climate change only affects the environment and has no impact on human health against 21.0% that agree. More than half of the students 55.2% strongly agree that the Niger Delta region is particularly vulnerable to the impacts of climate change due to its coastal location and oil extraction activities. This disagrees with the study of Eduk (2017), who argued that location may not necessarily be the factor for the impacts of climate change. He insisted that even those who are also far from the zone could as well suffer from it since wind power can spread it. Meanwhile, 29.2% agree that climate change can lead to the loss of biodiversity and extinction of species compared to 26.2% that strongly disagrees. 33.9% of students strongly agree alongside 24.2% that agreed in contrast to 20.4% that disagree that it is important for individuals to adopt sustainable practices, such as recycling and conserving energy, to mitigate climate change. 51.5% of the chemistry students strongly agree that education and awareness about climate change are essential for addressing this global issue in the Niger Delta region.

Furthermore, data in Table 2 shows that 48.1% agree that climate change can lead to increased flooding in the Niger Delta region. 27.5% agree contrary to 20.2% of the students that was neutral that rising sea levels due to climate change can result in the loss of coastal land in the Niger Delta region. 44.4% strongly agreed that climate change can negatively impact agriculture and food production in the Niger Delta region. 38.5% agree together with 31.4% of the students who strongly agree that increased temperatures due to climate change can lead to repeated heatwaves in the Niger Delta region. It is surprising to know that 25.0% both agreed and disagreed that climate change can cause the loss of biodiversity and ecosystem disruptions in the Niger Delta area. Meanwhile, 35.0% of the students strongly disagree that the Niger Delta region may experience more frequent and strong storms and hurricanes due to climate change. 27.6% agree that climate change can lead to the depletion of freshwater resources in the Niger Delta region while 23.7% and 20.6% disagree and strongly disagree respectively. 39.1% agree that rising temperatures and changing rainfall patterns can negatively impact the fishing industry in the Niger Delta region. It was also agreed by 41.3% of the students that climate change can increase the prevalence of vector-borne diseases, such as malaria, in the Niger Delta region. 36.3% agree along with 23.5% who strongly agree that the Niger Delta region may experience increased erosion and coastal erosion due to climate change.

Cite this article as:
Zudonu, O.C., Wagbara, S.O., Ikwut, E.F., & Iroro, P.E. (2024). Senior secondary school chemistry students' knowledge of climate change in the Niger Delta region of Nigeria. *FNAS Journal of Mathematics and Science Education, 5(2),* 87-96.

Going forward, results in Table 3 indicate that 48.7% of the students agree that transitioning from fossil fuel-based energy sources to renewable energy, such as solar and wind power, can help mitigate climate change in the Niger Delta region (Zudonu, 2015). This agrees with the study of Zudonu and Ekpa (2012). Also, 48.1% agree that implementing sustainable agricultural practices, such as organic farming and agroforestry, can contribute to climate change mitigation in the Niger Delta region (Iyayi, 2004). Similarly, 46.9% agree that promoting afforestation and reforestation efforts in the Niger Delta region can help absorb carbon dioxide and mitigate climate change. But it is remarkable to know that 31.3% were neutral about how encouraging the use of energy-efficient technologies and appliances can reduce greenhouse gas emissions in the Niger Delta region. 38.5% agree together with 23.1% who strongly agree that implementing policies and regulations that promote sustainable transportation, such as improving public transportation systems and encouraging cycling, can help mitigate climate change in the Niger Delta region. Likewise, 42.3% strongly agree alongside 31.3% that agreed that educating communities in the Niger Delta region about waste management and recycling practices can contribute to climate change mitigation. On the other hand, 35.2% were also neutral about how encouraging the use of energy-efficient building designs and materials can reduce energy consumption and mitigate climate change in the Niger Delta region. More so, 35.8% agree against 29.2% that were neutral about how implementing sustainable water management practices, such as rainwater harvesting and water conservation, can contribute to climate change mitigation in the Niger Delta region (Chijioke et al., 2018). 33.7% of students were also neutral on how to promote awareness and behavioural change regarding food waste reduction and sustainable consumption can help mitigate climate change in the Delta region. 41.5% of chemistry students agreed that collaborating with local communities, organizations, and government agencies to develop and implement climate change adaptation and mitigation strategies is crucial for the Niger Delta region. The study aligns with the work of Zudonu and Ekpa (2012), and Keohane and Raustiala (2008).

Conclusion

From the results of this study, it was recognized that chemistry students in the Niger Delta have a good knowledge of climate change. Also, the students are aware of the negative impact of climate change in the Niger Delta region. Additionally, several chemistry students in the area remained neutral to ways and methods of mitigating climate change and its effect on the Niger Delta because of their incomplete knowledge of the science of climate transformation, hence, they remained neutral.

Recommendations

The following recommendations are put forward.

1. Stakeholders in the Niger Delta need to come forward and unite to curb the untoward effect of climate change in the region.
2. Government needs to come up with effective and satisfactory methods to address the environmental injustices in the Niger Delta.
3. Government and relevant stakeholders should establish programmes to increase awareness of climate change and its effect on the country and the Niger Delta in particular.
4. Government and relevant stakeholders should put more funds into the education of chemistry students in the Niger Delta as they could contribute meaningfully to the mitigation of climate change in the Niger Delta and the country at large.

References

ANEEJ (2004). *Oil of Poverty in the Niger Delta*. A publication of the African Network for Environment and Economic Justice.

Bodner, G.M. (2001). Constructivism: A theory of knowledge. *Journal of chemical education*, 63(10), 873–878.

Burmeister, M.; Rauch, F., & Eilks, I. (2012). Education for Sustainable Development (ESD) and secondary chemistry education. *Chem. Educ. Res*. Pract. 2012, 13, 59−68.

Chijioke, B., Itoro, B. E., and Ufomba. H. (2018). The impact of oil exploration and environmental degradation in the Niger Delta Region of Nigeria: A study of oil producing communities in Akwa Ibom State. *Global Journal of Human-Social Political Science* 18, 55–70.

Ede, P., & Edokpa, D. (2015). Regional air quality of the Nigeria's Niger Delta. *Open Journal of Air Pollution* 4: 7–15.

Cite this article as:

Zudonu, O.C., Wagbara, S.O., Ikwut, E.F., & Iroro, P.E. (2024). Senior secondary school chemistry students' knowledge of climate change in the Niger Delta region of Nigeria. *FNAS Journal of Mathematics and Science Education, 5(2),* 87-96.

Eduk, R. A. (2017). Urban air pollution evaluation and mitigation: A case study of Uyo City, Niger Delta Nigeria. *International Journal of Science Inventions Today* 6: 36-48.

Ite, A., Udo, I., Margaret, I., & Sunday, P. (2013). Petroleum exploration and production: past and present environmental issues in Nigeria's Niger Delta. *American Journal of Environmental Protection*, 1, 78-90.

Iyayi, F. (2004). *An integrated approach to development in the Niger Delta*. A paper prepared for the Centre for Democracy and Development (CDD)

Keohane, R.,& Raustiala, K. (2008). *Towards Post-Kyoto Climate Change Architecture: "A Political Analysis"*. Discussion Paper 2008-01, Cambridge, Mass: Harvard Project on International Climate Agreements, July 2008.

Kerr, S. C., & Walz, K. A. (2007). "Holes" in student understanding: Addressing prevalent misconceptions regarding atmospheric environmental chemistry. *J. Chem. Educ*. 2007, 84 (10), 1693−1696.

Kruse, M. (2019). Ecosystem Health Indicators. *In Encyclopedia of Ecology*, 2nd ed. Edited by Brian Fath. Oxford: Elsevier, pp. 407–14.

Mbachu, D. (2020). The Toxic Legacy of 60 Years of Abundant Oil. Available online: https://www.bloomberg.com/features/2020-niger-delta-oil-pollution/ (accessed on 11 October 2021).

McNeill, K.L.,& Vaughn, M.H., 2010. Urban high school students' critical science agency: conceptual understandings and environmental actions around climate change. *Research in Science Education*, pp.1-27.

Pruneau, D, Gravel, H, Courque, W., & Langis, J. (2003). Experimentation with a socio-constructivist process for climate change education. *Environ. Educ. Res*. 2003, 9 (4), 429−46.

Russell, R. (2007). The greenhouse effect and greenhouse gases University Corporation for atmosphere research windows to the universe. Http://www.windows.ucar.edu/tour/link=/earth/climate/greenhouseeffectgases.htmI&edu. [Assessed in December 2009].

Shepardson, D. P., Niyogi, D., Choi, S., & Charusombat, U. (2009). Seventh-grade students' conceptions of global warming and climate change. *Environ. Educ. Res*. 2009, 15 (5), 549-70.

Smit, E. (2001). *Adaptation Types and Forms: Chapter 18: Adaptation to Climate Change in the Context of Sustainable Development and Equity*, Section 18:2.3.

Weli, V. E., Jimmy A., & Bassey J. E. (2018). The incidence of soot and surface boundary layer meteorology in port Harcourt metropolis, Nigeria. *Journal of Climatology and Weather Forecasting 6*,2.

Zudonu, O.C.,& Ekpa, M.M.M. (2012) Environmental problems in the Niger Delta a focus on acid rain and its effects. *Approaches in International Journal of Research Development*.

Zudonu, O.C., Ezegbirika, P.,& Nnaobi, A.F. (2014). Outstanding introductory chemistry for tertiary institution. #32 Ikiri Road, Omoku: Jef Printing & Publishing Co.

Zudonu, O. C. (2015). Acid rain in environmental pollution: The Perception of the people of Edagberi/Betterland Communities in the Niger Delta region of Nigeria. *Civil and Environmental Research*, *7*(2), 2015.