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Chemical System, Atmospheric and Aquatic Remediation

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Abstract

This study comprises the role of Chemistry in Environmental Education for sustainable growth. Chemistry in Environmental Education plays a crucial role in understanding and solving contemporary environmental problems and by combining scientific knowledge with awareness and behavioral change strategies. The researcher concludes that Integrating Chemistry with Environmental Education provides a powerful approach to addressing environmental issues. By implementing these recommendations, educational systems can equip students with the knowledge, skills, and attitudes needed to promote sustainable development and environmental protection. However, the researcher made the following suggestions: Curriculum planners should incorporate environmental topics such as pollution, waste management, climate change, regular workshops and training programmes should be organized to equip teachers with the knowledge and skills needed to effectively integrate environmental needs.

Keywords- Fundamental, Chemical System , Aquatic, Environmental etc.

Introduction

Chemistry provides the foundational understanding of matter, chemical reactions, and processes, while environmental education focuses on developing attitudes, skills, and behaviors that promote environmental sustainability. Together, they foster a holistic approach to solving environmental problems (Danczak et al., 2020). At the core of this intersection is the application of chemical principles to understand environmental issues such as pollution, climate change, and resource depletion. For instance, concepts like Acid Rain, Greenhouse Effect, and Biogeochemical Cycles are rooted in chemistry but are essential topics in environmental education. Through these concepts, students learn how human activities influence the natural environment and how chemical processes can either harm or help ecological balance (Castro et al., 2019).

Furthermore, the integration promotes the development of environmentally responsible citizens. By understanding chemical pollutants and their effects, students become more conscious of issues such as water contamination, air pollution, and soil degradation. This knowledge encourages sustainable practices such as

waste reduction, recycling, and the use of eco-friendly materials. For example, the study of Green Chemistry emphasizes designing chemical products and processes that minimize hazardous substances, thereby aligning scientific advancement with environmental protection (Chen & Liu, 2020). In the educational context, combining chemistry with environmental education enhances teaching and learning by making scientific concepts more relevant and practical. Teachers can adopt experiential learning strategies such as laboratory experiments, fieldwork, and environmental monitoring activities. These approaches help students connect theoretical knowledge with real-world environmental challenges, thereby improving critical thinking and problem-solving skills (Chen & Liu, 2020).

Additionally, this intersection supports global sustainability efforts by aligning with educational goals that emphasize sustainable development. It prepares students for careers in environmental science, engineering, waste management, and related fields, contributing to national development and global environmental conservation (Clark et al., 2020). The intersection of chemistry and environmental education is essential for fostering scientific literacy and environmental stewardship. By integrating chemical knowledge with environmental awareness, education systems can empower learners to make informed decisions and actively participate in solving environmental problems, ultimately promoting a sustainable future.

The intersection of Chemistry and Environmental Education plays a crucial role in understanding and solving contemporary environmental problems. By combining scientific knowledge with awareness and behavioral change strategies, this interdisciplinary approach equips individuals with the skills needed to protect and sustain the environment (Miranda et al., 2018). Chemistry provides a scientific understanding of environmental problems. Many environmental issues such as air pollution, water contamination, soil degradation, and climate change are rooted in chemical processes. Through concepts like Chemical Reactions, students learn how pollutants are formed, transformed, and degraded in the environment. Environmental education complements this by helping learners understand the real-world implications of these chemical processes and encouraging responsible behavior.

Intersection enhances problem-solving and critical thinking skills. Students are encouraged to analyze environmental challenges and propose scientifically sound solutions. For example, understanding Water Purification methods such as filtration, distillation, and chlorination enables learners to address water pollution issues in their communities. Environmental education ensures that

such knowledge is applied ethically and sustainably (Junior & Fernandez, 2016). Furthermore, the integration fosters sustainable lifestyle practices. Chemistry helps individuals understand the impact of everyday activities, such as the use of plastics, fossil fuels, and household chemicals, on the environment. Environmental education then guides individuals toward adopting eco-friendly habits, such as waste segregation, energy conservation, and sustainable consumption (Junior & Fernandez, 2016). The intersection supports policy formulation and community engagement.

Chemically informed citizens are better positioned to participate in environmental decision-making and advocate for policies that reduce pollution and promote sustainability. Environmental education empowers communities to take collective action based on scientific evidence. This interdisciplinary approach contributes to achieving global sustainability targets, particularly those related to environmental protection, health, and sustainable development. By integrating chemistry knowledge with environmental awareness, learners become equipped to tackle environmental issues effectively. While chemistry provides the scientific foundation for understanding environmental processes, environmental education ensures that this knowledge translates into responsible actions and sustainable solutions (Hong & Talib, 2018). Together, they promote informed decision-making, environmental stewardship, and a healthier planet.

The intersection of Chemistry and Environmental Education plays a vital role in understanding and addressing environmental problems. The basic factors that define this intersection include:

1. Scientific Knowledge and Chemical Literacy:-

Understanding chemical principles such as reactions, compounds, and cycles (e.g., carbon and nitrogen cycles) helps explain environmental issues like pollution and climate change. Environmental education promotes chemical literacy, enabling individuals to make informed decisions about environmental sustainability (Ewais & Troyer, 2019).

2. Awareness of Environmental Pollution:

Chemistry helps identify the sources, composition, and effects of pollutants in air, water, and soil and environmental education raises awareness about issues such as acid rain, ozone depletion, and water contamination.

2. Water Pollution:-

Water bodies are contaminated by industrial waste, agricultural runoff (fertilizers and pesticides), oil spills, and domestic sewage. Water pollution is a major environmental problem that affects human health, aquatic life, and sustainable development. Both Chemistry and Environmental Education play complementary roles in understanding, preventing, and controlling water pollution. Chemistry and Environmental Education play crucial roles in addressing water pollution by combining scientific knowledge with public awareness and responsible behavior. Their integration is essential for achieving sustainable environmental management and ensuring access to clean and safe water (Ramadhan et al., 2019).

- a) **Role of Chemistry:** Chemistry is used to analyze water quality, detect contaminants, and develop purification methods such as filtration, chlorination, and desalination. It also helps in designing eco-friendly chemicals that reduce water contamination.
- b) **Role of Environmental Education:** It encourages proper waste disposal, conservation of water resources, and public participation in protecting water bodies.

3. Soil Degradation and Pollution:-

Soil pollution results from excessive use of fertilizers, pesticides, industrial waste, and improper disposal of solid waste. Soil degradation and pollution are major environmental challenges, especially in regions affected by industrial activities, poor agricultural practices, and waste mismanagement. Integrating Chemistry and Environmental Education provides both scientific understanding and behavioral change needed to address these problems effectively. The combination of Chemistry and Environmental Education provides both scientific solutions and awareness needed to tackle soil degradation and pollution.

- a) **Role of Chemistry:** Chemistry helps in understanding soil composition, the effects of chemicals on soil fertility, and the development of organic fertilizers and bioremediation techniques to restore contaminated soils.
- b) **Role of Environmental Education:** It educates farmers and communities on sustainable agricultural practices, such as crop rotation and reduced chemical usage.

4. Climate Change and Global Warming:-

This is caused by the accumulation of greenhouse gases such as carbon dioxide and methane in the atmosphere. Climate change and global warming are major environmental challenges driven largely by human activities such as fossil fuel combustion, deforestation, and industrial emissions. Both Chemistry and Environmental Education play crucial and complementary roles in understanding, mitigating, and adapting to these challenges. Chemistry provides the tools and technologies needed to reduce environmental impact, while Environmental Education equips individuals with the knowledge and attitudes necessary for sustainable living (Santos et al., 2021). Their combined efforts are essential for mitigating climate change and ensuring a healthier planet for future generations.

a) **Role of Chemistry:** Chemistry explains the greenhouse effect, monitors gas concentrations, and supports the development of alternative energy sources like solar, hydrogen, and biofuels.

b) **Role of Environmental Education:** It promotes climate-conscious behaviors such as energy conservation, tree planting, and reduced carbon footprint.

5. **Waste Management Issues:** Improper disposal of solid waste, plastics, and hazardous materials leads to environmental pollution. Waste management is a major environmental challenge, especially in rapidly growing urban and rural communities. The integration of Chemistry and Environmental Education provides practical and sustainable solutions for managing waste effectively by combining scientific knowledge with awareness and behavioral change. The combination of Chemistry and Environmental Education provides a comprehensive approach to addressing waste management issues. While chemistry offers scientific solutions for waste treatment and recycling, environmental education promotes awareness and responsible behavior. Together, they contribute significantly to sustainable waste management, environmental protection, and improved public health (Santos & Royer, 2020).

Integrating green chemistry principles into curricula teaches students to design, reduce, or eliminate hazardous substances, empowering them to tackle real-world environmental challenges, improve scientific literacy, and drive innovation (Soeharto et al., 2019)

Yet, in India, the teaching of chemistry remains largely exam-oriented and disconnected from sustainability issues. Students often perceive the subject as abstract and difficult, with little application to their daily lives. Meanwhile, environmental degradation, deforestation, and climate risks continue to intensify in Cross River State. This disconnect underscores the need to reimagine chemistry education as a vehicle for climate literacy and sustainable development (Teksoz et al., 2020). Chemistry is uniquely positioned to contribute to climate literacy. Concepts such as combustion, photosynthesis, acid rain, and ozone depletion are directly linked to climate change. Chemistry also underpins renewable energy technologies, waste management, and sustainable materials, all of which are central to the SDGs.

Globally, research shows that contextualized and inquiry-based chemistry teaching improves both learning outcomes and environmental awareness. For example, integrating green chemistry principles into curricula encourages students to consider the environmental impact of chemical processes and to explore sustainable alternatives (Wajdi et al., 2022). In Nigeria, however, chemistry education remains largely theoretical. Teachers often focus on preparing students for national examinations such as the West African Examinations Council (WAEC) assessments. Climate-related topics, when included, are treated superficially without linking them to local issues such as solutions. Integrating green chemistry principles into curricula teaches students to design, reduce, or eliminate hazardous substances, empowering them to tackle real-world environmental challenges, improve scientific literacy, and drive innovation (Soeharto et al. 2019).

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Rheological, thermal, and frictional characteristics is essential to the extrusion process. While it makes sense in theory, it is rarely carried out in practice to modify the extruder screw's form and extrusion parameters to suit the characteristics of various polymers. Here, we have analyzed the temperature dynamics of the extrusion process with the use of process monitoring equipment. With the use of infrared thermometers, real-time energy monitoring, and a novel thermocouple grid sensor, researchers have seen melt temperature fields within flowing polymer melts directly at the entrance of an extruder die. Three distinct extruder screw shapes have been tested using a commercial grade of polyethylene in a range of extrusion operating circumstances. We discovered that energy usage and melt temperature uniformity were significantly impacted by the extruder's screw shape, screw rotation speed, and set temperature.

The suggested study makes the argument that knowledge of the existing safety culture in organizations like shipping companies and on-board ships is necessary to maintain and grow safety culture as well as safety in a maritime business [10]. Questionnaires designed with that objective are frequently used to assess safety culture. This study suggests a method for handling questionnaire data in order to analyze and explain relationships between safety culture components. A crucial step in the process is the use of variable cluster analysis, where cluster solutions are displayed as dendrograms. They were found to be an excellent tool for explaining the safety culture concept and helping to make sense of the numerous links found in quantitative data. The results of applying the statistical technique to safety culture data from six Swedish ships involved in international trade are presented. The safety and safety culture improvement procedures may benefit from the useful feedback that the safety culture outcomes visualization offers, as well as conversations about safety at different organizational levels. and environmental education courses,

and environmental education courses, programs, and assessment (Bilgin, 2019). The essence of the current reform in science/chemical education, worldwide, is a paradigm shift from algorithmic/imparting knowledge-type teaching to higher-order cognitive skills (HOCS) learning. In the context of Education in Environmental Chemistry (EEC), the ultimate target is the STES-literate graduate, capable of evaluative thinking, decision making, problem solving, and taking a responsible action accordingly (Barke et al., 2018). The issue is how to translate this goal into effective, implementable courses, teaching strategies and assessment methodologies, which are consonant with this goal of „HOCS learning“.

1. Environmental literacy requires the integration of environmental sciences into core chemical courses as well as the development and implementation of HOCS-promoting teaching strategies and assessment methodologies in chemical education.
2. The development of students' HOCS for transfer, followed by assessment of „HOCS performance“; is the task ahead for meaningful EEC. These require a change in emphasis in the way environmental chemistry is taught, – from a narrowly-focused applied analytical/ecotoxicological, or environmental engineering chemistry, to an interdisciplinary/multidisciplinary approach (Bilgin, 2019). The essence of these challenges involves the dealing with uncontrolled complex global systems and the practicing of science, technology, research and education from social responsibility and open-ended culture perspectives. The main contemporary relevant paradigms shift have been identified and presented in the Table below (Bedin et al., 2020).

Conclusion-

Integrating Chemistry with Environmental Education provides a powerful approach to addressing environmental issues. By implementing these suggestions, educational systems can equip students with the knowledge, skills, and attitudes needed to promote sustainable development and environmental protection. the following recommendations are proposed:

1. Integrate Environmental Concepts into Chemistry Curriculum: Curriculum planners should incorporate environmental topics such as pollution, waste management, climate change, and green chemistry into chemistry courses and lessons should emphasize real-life environmental problems and their chemical basis to make learning more relevant and practical.
2. Promote Practical and Inquiry-Based Learning: Teachers should adopt laboratory experiments and field-based activities that demonstrate environmental chemistry concepts and inquiry-based learning should be encouraged to help students investigate environmental problems and propose solutions.
3. Encourage the Use of Green Chemistry Principles: Schools and institutions should promote the application of green chemistry principles to reduce hazardous substances and environmental pollution and students should be taught environmentally friendly chemical practices, including waste minimization and safe disposal of chemicals.
4. Strengthen Teacher Training and Capacity Building: Regular workshops and training programmes should be organized to equip teachers with the knowledge and skills needed to effectively integrate environmental education into chemistry teaching and teachers should be exposed to modern teaching strategies and environmental issues relevant to their local context.
5. Foster Environmental Awareness and Responsibility: Schools should organize seminars, campaigns, and environmental clubs to raise awareness about environmental challenges and students should be encouraged to adopt environmentally responsible behaviors such as recycling, conservation, and pollution prevention.

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