

CHAPTER EIGHTEEN

Leveraging Earth Science Education in Environmental Sustainability in Africa

OMORINOYE Ajoke Omolayo, BAMIGBOYE Olufemi Sijuade & ALEBIOSU Mercy Titilayo

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Abstract

Environmental sustainability involves integrating sustainable practices and principles into environmental management. The knowledge of earth sciences is useful in the management of climate change, natural resources, including water, mineral and fossil fuels. The application of various aspects of earth sciences is pivotal in ecosystem and biodiversity conservation, soil health, sustainable agriculture and mitigation of natural disasters. In recent times, interdisciplinary approaches have been greatly utilised in understanding the exploration and exploitation of natural resources and their effect on human life. The aim of this study was to understand natural systems and make informed decisions that contribute to the health of humanity.

Keywords: Environmental sustainability, Earth sciences, Soil health, Mitigation.

Introduction

Africa is facing significant environmental sustainability challenges, including climate change (IPCC, 2020), deforestation (FAO, 2020), desertification (UNCCD, 2018), and pollution (UNEP, 2018). These challenges have severe impacts on the continent's ecosystems, economies, and human well-being (UNECA, 2019). Earth science education is critical in addressing these challenges by providing individuals with the knowledge, skills, and competencies needed to understand and manage the Earth's systems and resources sustainably (Huntoon & Lane, 2017). Despite the critical role of earth science education in promoting environmental sustainability, Africa continues to face significant environmental challenges. The lack of effective earth science education and awareness among African populations exacerbates these challenges, leading to inadequate management of natural resources,

increased vulnerability to environmental disasters, and decreased resilience to climate change (UNECA, 2019). Furthermore, the current state of earth science education in Africa is often characterised by inadequate infrastructure, insufficient funding, and a lack of qualified teachers, which hinders the development of a scientifically literate and environmentally conscious population (Huntoon and Lane, 2017). Therefore, there is a pressing need to harness earth science education in Africa to promote environmental sustainability, build resilience, and support sustainable development (Figure 1).

Harnessing earth science education in environmental sustainability in Africa is crucial for addressing the continent's pressing environmental challenges. This paper explored the potential of earth science education in promoting environmental sustainability in Africa, building on existing research that highlights the importance of earth science education in fostering sustainable development (Pedersen et al., 2018). By examining the current state of earth science education in Africa and identifying best practices for implementation, this paper aimed to contribute to the growing body of literature on earth science education and environmental sustainability (Kortz and van der Hoeven Kraft, 2016). The specific objectives of the study included assessing the current state of earth science education in Africa and its impact on environmental sustainability, building on existing research (Huntoon and Lane, 2017; Pedersen et al., 2018). Secondly, it aimed at identifying the key challenges and opportunities for harnessing earth science education in promoting environmental sustainability in Africa, drawing on the experiences of educators, policymakers, and practitioners (Kortz and van der Hoeven Kraft, 2016). Lastly, the study aimed at developing a framework for integrating earth science education into environmental sustainability initiatives in Africa, incorporating best practices and strategies from existing literature (UNESCO, 2019). The findings of this study would have implications for policy, practice, and future research in earth science education and environmental sustainability in Africa.



Figure 1: The Sustainable Development Goals (SDGs)

Overview of Earth Science Education in Africa

Earth science education in Africa is critical for promoting environmental sustainability, managing natural resources, and addressing the challenges of climate change (Huntoon and Lane, 2017). However, the current state of earth science education in Africa is characterised by several challenges, including limited access to quality education that is being faced by many African countries, particularly in rural and disadvantaged areas (UNESCO, 2019). Similarly, there is an inadequate infrastructure and resources including outdated textbooks, lack of laboratory equipment, and limited access to technology (Kigotho, 2017) where efforts were made to make the education available. This is complimented by shortage of qualified earth science teachers in many African countries, which can impact the quality of education and student outcomes (Bajah, 2018). Furthermore, the earth science curriculum in Africa often needs to be revised to address the specific environmental challenges and needs of the continent (Pedersen et al., 2018).

Despite these challenges, there are opportunities for improving earth science education in Africa. Such opportunities include integration of technology, such as digital resources and online learning platforms that can enhance access to quality earth science education in Africa (Kafyulilo, 2014). Such opportunities can also lead to the establishment of community-based learning

approaches that will help students to develop practical skills and apply earth science concepts to real-world problems (Machinga, 2018). In addition, partnerships and collaborations between African institutions and international organisations can provide opportunities for capacity building, resource sharing, and knowledge exchange (UNESCO, 2019). It is also worthy of note that earth science education can be designed to emphasise sustainability and environmental stewardship, promoting a culture of environmental responsibility among African students (Huntoon & Lane, 2017). By addressing the challenges and leveraging the opportunities, earth science education in Africa can play a critical role in promoting environmental sustainability and supporting the development of a more resilient and sustainable future.

Importance of Earth Science Education

Earth science education is crucial for promoting environmental sustainability in Africa. Some of the reasons why earth science education is important include, but are not limited to, understanding environmental systems, especially the complex relationships between human and natural systems, enabling the making of informed decisions about environmental management (Huntoon & Lane, 2017). Secondly, earth science education provides students with the knowledge and skills needed to address environmental challenges such as climate change, deforestation, and pollution (IPCC, 2020; FAO, 2020). Furthermore, earth science education can promote sustainable development by teaching students about the importance of sustainable resource management, environmental conservation, and social responsibility (UNESCO, 2019). In addition, earth science education help students to develop critical thinking skills, enabling them to analyse complex environmental issues and develop effective solutions (Kortz and van der Hoeven Kraft, 2016). Other importance of earth science education is in fostering environmental literacy among students, enabling them to understand the impact of human activities on the environment and make informed decisions about environmental issues (Pedersen et al., 2018). It provides students with a deep understanding of earth systems and environmental processes. Indeed, earth science education can play a critical role in promoting environmental sustainability in Africa (Figure 2).

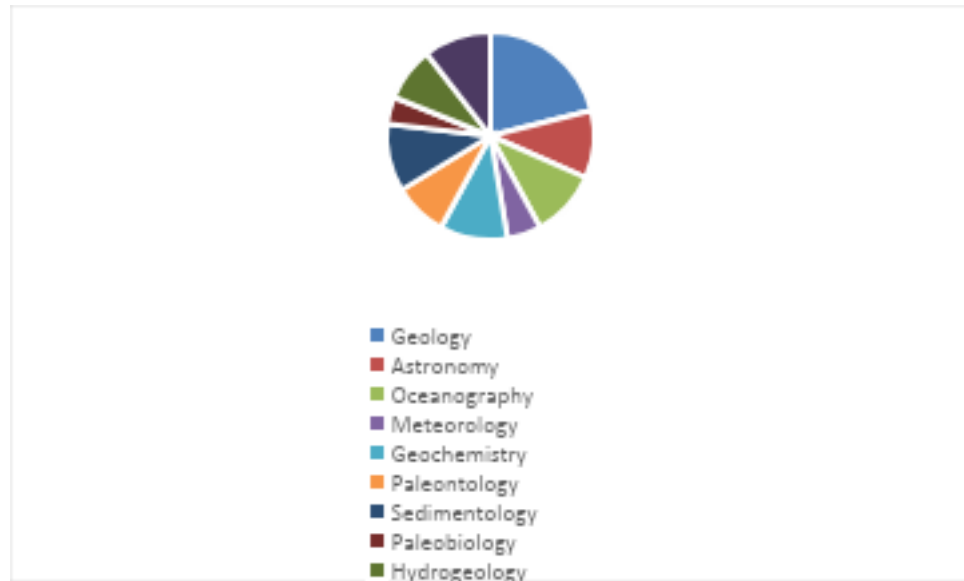


Figure 2: Some Branches of Earth Science

Environmental Sustainability Challenges in Africa

Africa faces numerous environmental sustainability challenges that impact the continent's ecosystems, economies, and human well-being. Some of the key challenges include: climate change which is a significant threat to Africa's environmental sustainability, with rising temperatures, changing precipitation patterns, and increased frequency of extreme weather events (IPCC, 2020). Deforestation and land degradation are another major environmental concern in Africa, with widespread clearance of forests for agriculture, urbanization, and other purposes (FAO, 2020). Rich arrays of biodiversity are threatened or endangered due to habitat loss, pollution, and other human activities (IUCN, 2020). Many African countries are also faced with water scarcity challenges, with limited access to clean water for drinking, sanitation, and agriculture (UN Water, 2020). Other challenge is pollution, which is a significant environmental challenge in Africa, with air and water pollution affecting human health and the environment (UNEP, 2018). These environmental sustainability challenges have significant impact on Africa's ecosystems, economies, and human well-being, and require urgent attention and action.

Impact of Environmental Sustainability Challenges

The impact of environmental sustainability challenges facing Africa have significantly impacted the continent through environmental degradation. This leads to loss of ecosystem services, including clean air and water, soil formation, and climate regulation (MEA, 2005). Environmental sustainability challenges can impact food security, particularly in areas where agriculture is a major source of livelihood (FAO, 2020). Human health impact from pollution and degradation, including increased risk of disease and mortality, is another growing area of concern from the poorly managed environment (WHO, 2018). It is also worth mentioning that environmental sustainability challenges can have significant economic impacts that include loss of productivity, increased costs, and decreased economic opportunities (UNECA, 2019).

Impact of Human Activities on the Environment

Human activities have a significant impact on the environment, affecting ecosystems, biodiversity, and the planet's natural resources. Some of the key impacts of human activities on the environment include the burning of fossil fuels and deforestation, which have led to an increase in greenhouse gas emissions, contributing to climate change (IPCC, 2020). Human activities, such as agriculture, urbanisation, and logging, have led to widespread deforestation and land degradation, resulting in loss of biodiversity and ecosystem disruption (FAO, 2020). Activities, such as industrial processes, transportation, and waste disposal, have led to pollution of the air, water, and soil, affecting human health and the environment (UNEP, 2018). Other activities, such as over-extraction of groundwater and pollution of water sources, have led to water scarcity, affecting human consumption, agriculture, and ecosystems (UN Water, 2020). Human activities, such as habitat destruction, overfishing, and pollution, have led to loss of biodiversity, affecting ecosystem function and resilience (IUCN, 2020).

Consequences of Human Impact on the Environment

Many human activities have led to environmental degradation, affecting ecosystem function and resilience (MEA, 2005). Environmental pollution and degradation can have significant human health impacts, including increased risk of disease and mortality (WHO, 2018). Environmental degradation can also have significant economic impact, including loss of productivity,

increased costs, and decreased economic opportunities (UNECA, 2019). Similarly, environmental degradation can also have significant social impact, including displacement of communities, loss of livelihoods, and social inequality (UNDP, 2020).

Mitigating the Impact of Human Activities on the Environment

To mitigate the impact of human activities on the environment, it is essential to adopt sustainable practices and reduce environmental degradation. Some strategies for mitigating the impact of human activities on the environment involve adopting sustainable resource management practices that can help reduce environmental degradation and promote ecosystem resilience (UNEP, 2018). Transitioning to renewable energy sources can help reduce greenhouse gas emissions and mitigate climate change (IRENA, 2020) while conserving and restoring natural habitats can help promote biodiversity and ecosystem resilience (IUCN, 2020).

Role of Earth Science Education in Addressing Environmental Sustainability Challenges

Earth science education plays a critical role in addressing environmental sustainability challenges by providing individuals with the knowledge, skills, and competencies needed to understand and manage the Earth's systems and resources sustainably. Some of the ways earth science education can contribute to addressing environmental sustainability challenges include promotion of environmental literacy among students, enabling them to understand the impact of human activities on the environment and make informed decisions about environmental issues (Pedersen et al., 2018). Earth science education also helps students in developing critical thinking skills, enabling them to analyse complex environmental issues and develop effective solutions (Kortz and van der Hoeven Kraft, 2016). It fosters sustainable development by teaching students about the importance of sustainable resource management, environmental conservation, and social responsibility (UNESCO, 2019). The art of earth science education is crucial for students understanding of the causes and consequences of climate change, and development of strategies for mitigating and adapting to its impacts (IPCC, 2020).

It can promote sustainable resource management by teaching students about the importance of conserving and managing natural resources sustainably (UNEP, 2018).

Strategies for Integrating Earth Science Education into Environmental Sustainability Initiatives

Integrating earth science education into environmental sustainability initiatives can help promote sustainable development and environmental conservation. Some strategies for integrating earth science education into environmental sustainability initiatives may involve integrating earth science education with other disciplines, such as biology, chemistry, and social sciences, which can provide a holistic understanding of environmental sustainability issues (UNESCO, 2019). Using project-based learning approaches can help students develop practical skills and apply earth science concepts to real-world environmental sustainability challenges (Kortz & van der Hoeven Kraft, 2016). Community-based learning approaches can help students develop a deeper understanding of environmental sustainability issues and promote community engagement and participation (Machinga, 2018). Incorporating local contexts and case studies into earth science education can help students understand the relevance of earth science concepts to environmental sustainability issues in their own communities (Pedersen et al., 2018). Using technology, such as digital resources and online learning platforms, can enhance access to earth science education and promote environmental sustainability (Kafyulilo, 2014).

Benefits of Integrating Earth Science Education into Environmental Sustainability Initiatives

The benefit of integrating earth science education into environmental sustainability initiatives embraces integrating earth science education into environmental sustainability. Such initiatives can promote sustainable development and environmental conservation (UNESCO, 2019). Earth science education can help students develop environmental literacy, enabling them to understand the impact of human activities on the environment (Huntoon and Lane, 2017). Furthermore, integrating earth science education into environmental sustainability initiatives can foster critical thinking and problem-solving skills among students (Kortz and van der Hoeven Kraft, 2016).

Challenges and Opportunities

While integrating earth science education into environmental sustainability initiatives offers many benefits. There are also challenges and opportunities to consider. Some of these include limited resources, including funding and infrastructure (Kigotho, 2017). Interdisciplinary collaboration between earth science educators and environmental sustainability practitioners can provide opportunities for developing innovative and effective solutions (UNESCO, 2019).

Inadequate infrastructure, including classrooms, laboratories, and technology can hinder the implementation of earth science education programmes (UNEP, 2018) while a lack of trained teachers and educators can pose challenges to implementing earth science education programmes, particularly in rural and underserved areas (UNESCO, 2019). Cultural and linguistic barriers can equally affect the effectiveness of earth science education programmes, particularly in diverse and multilingual contexts (UNESCO, 2019). Other factor is the passive threat of the indigenous as a result of limited community engagement and participation because of their skills. This is capable of hindering the effectiveness of earth science education programmes and limiting their impact on environmental sustainability (Machinga, 2018).

Best Practices for Implementation

Implementing earth science education for environmental sustainability in Africa requires careful planning, collaboration, and stakeholder engagement. The best practices for the implementation of earth science education in environmental sustainability in Africa will involve engagement with local communities, governments, and other stakeholders to ensure that earth science education programmes are relevant, effective, and sustainable (UNESCO, 2019). The use of interdisciplinary approaches that integrate earth science education with other disciplines, such as biology, chemistry, and social sciences, to provide a holistic understanding of environmental sustainability issues (Pedersen et al., 2018), would be crucial. Practical training and hands-on experience for students to develop skills and apply earth science concepts to real-world environmental sustainability challenges should be a must for them (Kortz & van der Hoeven Kraft, 2016). Capacity-building programmes for teachers, educators, and community leaders to enhance their knowledge and skills in earth science education and environmental sustainability should

be formulated (SAEON, 2020). A continuous monitoring and evaluation framework to assess the effectiveness of earth science education programmes and identify areas for improvement (UNEP, 2018) is of utmost importance for the successful implementation.

Alignment of Earth Science Education with SDGs

Earth science education can contribute significantly to achieving the Sustainable Development Goals (SDGs), particularly those related to environmental sustainability and climate action. Earth science education can help students understand the causes and consequences of climate change, and develop strategies for mitigating and adapting to its impact (IPCC, 2020). Secondly, earth education can also support the achievement of SDG 14, which deals with life below water. Earth science education can promote understanding of ocean systems, marine ecosystems, and the impact of human activities on the ocean environment (UNESCO, 2019). Thirdly, it can also significantly enhance SDG 15, which deals with life on land. Earth science education can help students understand the importance of terrestrial ecosystems, biodiversity, and sustainable land management practices (UNEP, 2018).

Addressing the Challenges

To address the challenges earlier highlighted, it is essential to build partnerships with governments, civil society, and the private sector to leverage resources and expertise (AFR100, 2020). It is equally important to develop contextualised curricula that take into account local cultures, languages, and environmental sustainability issues (Pedersen et al., 2018). Government and corporate bodies would have to invest in infrastructure, including classrooms, laboratories, and technology, to support the implementation of earth science education programmes (UNEP, 2018). The teachers should be provided with training and capacity-building programmes to enhance the knowledge and skills of educators in earth science education and environmental sustainability (SAEON, 2020).

Educational Strategies

An interdisciplinary approach is a pivotal strategy in educational sustainability, connecting all aspects of earth science with life sciences, social sciences, economics, ethics, and policy. Place-based learning that involves

teaching through local environmental issues will help in managing communities with peculiar challenges. Engaging students in real-world sustainability challenges through project-based learning should be encouraged. Use of technology and modeling tools, such as GIS, remote sensing, and simulations to understand mitigation and sustainability, is crucial.

Roles of Students

The role of students in environmental sustainability is important considering their ability to combine education, action and innovation. Students are brought to enhance understanding the interconnections in Earth's systems, critical thinking, problem-solving skill, collaboration and communication, ethical reasoning and civic responsibility (Figure 3). Students play important role as learners, change- agents and future stewards of the earth. By being well educated, equipped, responsible and proactive, they can drive meaningful and impactful change and help build a more sustainable world.



Figure 3: Some students and a tutor studying the environment in part of Northcentral Nigeria

Opportunities for Collaboration and Partnership

Collaboration and partnership are essential for harnessing earth science education to promote environmental sustainability in Africa. Some opportunities for collaboration and partnership include:

Government-Private Sector Partnerships that involved partnering with governments and the private sector to provide access to resources, expertise, and funding for earth science education initiatives (AFR100, 2020). Collaborating with international organisations and institutions can provide access to global best practices, expertise, and resources for earth science education (UNESCO, 2019). Engaging with local communities and stakeholders can help ensure that earth science education initiatives are relevant, effective, and sustainable (Machinga, 2018). Partnering with other disciplines, such as biology, chemistry, and social sciences, can provide a holistic understanding of environmental sustainability issues (Pedersen et al., 2018). Others include utilising digital platforms and technologies that provide opportunities for collaboration, knowledge sharing, and capacity building in earth science education (Kafyulilo, 2014).

Benefits of Collaboration and Partnership

The benefits of collaboration and partnership in earth science education for environmental sustainability helps in providing access to increased resources, including funding, expertise, and infrastructure (AFR100, 2020). Collaboration and partnership can improve the effectiveness of earth science education initiatives by leveraging global best practices and expertise (UNESCO, 2019). It enhances the sustainability of earth science education initiatives by promoting community engagement and ownership (Machinga, 2018).

Benefits of Collaboration and Partnership

The benefits of collaboration and partnership in earth science education for environmental sustainability will provide access to increased resources, including funding, expertise, and infrastructure (AFR100, 2020). It also Improve earth science education initiatives by leveraging global best practices and expertise (UNESCO, 2019) and enhance the sustainability of earth science education initiatives by promoting community engagement and ownership (Machinga, 2018).

Conclusion

Implementing earth science education for environmental sustainability in Africa requires careful planning, collaboration, and stakeholder engagement. By addressing the challenges and leveraging opportunities, promotion of sustainable development and environmental conservation in Africa can be achieved. Schools and universities should emphasise integrating sustainability into earth and environmental science programmes. The role of teachers, lecturers and researchers are important for continuous learning. Adherence to government policies, implementation government laws and community partnerships for sustainability projects like international programs can foster and improve environmental sustainability. Collaboration and partnership are essential for harnessing earth science education to promote environmental sustainability in Africa. By leveraging resources, expertise, and funding, effective earth science education initiatives that promote sustainable development and environmental conservation can be developed.

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