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Promoting Climate-Smart Education for Economic Sustainability

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Abstract

Climate change has emerged as a significant global challenge, with particularly devastating consequences for developing countries with rapidly emerging industries. Sustainable development is critical in these areas. As a result, Climate-Smart Education is critical for integrating climate change knowledge and sustainable practices to ensure the long-term viability of industries. As a result, this study examines strategies for advancing Climate-Smart Education to improve economic sustainability, with a focus on developing countries. To accomplish this, a commentary approach was used to review existing literature, policies, and current practices, and suggested actionable strategies. The findings suggest that strategies such as public-private partnerships, digital advisory services, and incorporating climate-smart principles into formal education can help to close knowledge gaps and boost resilience. Adapting initiatives to the socioeconomic realities of rural and peri-urban areas, along with coordinated policy efforts, is critical. However, challenges such as limited resources, inadequate teacher training, and cultural resistance, particularly in developing countries, may impede the successful implementation of climate change education. It was suggested that policymakers ensure the implementation of climate-smart principles in key sectors such as education, industry, agriculture, and the environment. This can promote a unified and coordinated approach to climate resilience and sustainability.

Keywords: Climate Change, Climate-Smart Education, Education, Sustainability, Developing Countries

Introduction

International debates on global warming and climate change issues show that education has a key role to play in responding to the climate crisis. Policy interventions to support climate-smart education in industrial curricula and training can include government support for the provision of high-level support, including cross-sectoral coordination and blending (Reid, 2019). Many developing countries are therefore not immune to the climate change crisis and its negative impact on the economy. Addressing climate change issues, particularly in South Africa has been critical in the agenda of Education for Sustainable Development (ESD) which aims to provide education that could be the channel for advancing sustainable development (Cordero et al., 2008). Climate action is the priority of the latest ESD for 2030 to step up the mainstreaming of sustainable development (UNESCO, 2020). Climate Change Education (CCE) is fundamentally part of ESD. In addition, economic and environmental sustainability is part of the 2030 Sustainable Development Goal agenda. Hence, this paper sought to discuss how to promote Climate-Smart Education. Mhlongo (2024) posits that the current national education policies in South Africa do not provide clear direction about what climate-smart education means for schools. Usman et al. (2022) support that climate change is an environmental phenomenon with the potential to exacerbate existing disaster risks and cause extensive human, financial and environmental losses. For South Africa to improve social welfare, sustainable economic growth and development are required. It has been argued that environmental deterioration is a difficult issue in the process of economic growth (Burke et al., 2016).

Cho (2019) argues that globally, climate change and its impacts would threaten the bottom line of businesses in various ways. The intensity of extreme weather in other countries could damage factories, supply chain operations and other infrastructure. The scholar further states that drought could result in water becoming expensive which would affect the cost of raw

materials and production. Climate volatility may force companies to deal with uncertainty in the price of resources for production, energy transport and insurance. Furthermore, some products could lose their market due to weather uncertainty. It is against this background that this paper sought to determine ways of promoting climate-smart education for the economic sustainability of industries in South Africa.

Research questions

i. How can climate-smart education programmes promote economic sustainability?
ii. What strategies can be adopted to promote climate-smart education in developing countries?

Methods

In this study, the commentary approach was used to address the research questions. The commentary approach is an analytical and reflective research method that provides insight into the phenomenon (Braun et al., 2023). This approach looks at existing literature and policies to assess current practices and propose actionable strategies for incorporating climate-smart principles into industries like agriculture, mining, and manufacturing. The commentary method identifies gaps and challenges in aligning educational programs with industry needs by critically examining the available evidence. It provides a forum for discussing barriers and opportunities, as well as practical recommendations for improving policy frameworks, fostering partnerships, and strengthening institutional capacities. The commentary addressed topical issues thematically, supported by relevant literature. The details of the commentary are as follows.

Climate-smart education programmes

Climate-smart education is an approach that equips students with the necessary knowledge, skills, attitudes, and values to effectively address the challenges of climate change (Hügel &

Davies, 2024). It integrates climate change awareness, mitigation efforts, and adaptation strategies into educational curricula, teaching practices, programs, and policy frameworks. Climate-smart education programs are essential for preparing students in developing countries to face the challenges of climate change. Harper (2023) introduces a seven-dimensional framework for incorporating climate resilience into education systems. This approach focuses on revising curricula to address climate adaptation and mitigation, training teachers to deliver climate-focused content, and fostering collaboration between schools and local communities. The programs aim to develop informed citizens capable of making long-term decisions while also promoting environmental responsibility. Incorporating localized climate adaptation strategies into learning is a critical component of climate-smart education. Access to relevant climate information increases the practical utility of education (Alidu et al., 2022; Davies et al., 2024). Smallholder farmers in Ghana, for example, have benefited from climate-smart adaptation practices integrated into programs. This assists students in applying theoretical knowledge to real-world scenarios (Mpuangnan et al., 2023). Similarly, place-based approaches integrate geography, local knowledge, and climate change education, empowering communities to become more resilient to climate-related challenges.

Additionally, Hebsale Mallappa and Pathak (2023) believe that climate-smart education programs are inspired by the successes of climate-smart agricultural practices. Ariom et al. (2022) demonstrate that farmers in Gujarat, India, and throughout Africa have used innovative techniques to manage climate impacts. As a result, education systems can adapt these lessons to teach students about sustainable resource management and climate adaptation strategies. This interdisciplinary approach can deepen understanding and prepare learners to participate in sustainability initiatives in their communities. According to Barooah et al. (2023), climate-smart education programs prioritize inclusivity, especially through gender-sensitive approaches. In this vein, Phiri et al. (2021) emphasize the significance of addressing gender

disparities in climate adaptation initiatives. In education, this entails developing curricula and initiatives to empower women and girls, who frequently face disproportionate challenges as a result of climate change. By including all demographic groups in climate education, these programs promote equity and enhance collective resilience.

Promoting economic sustainability through climate-smart education programmes

Climate-smart education programs play an important role in promoting economic sustainability in local communities by providing individuals with the knowledge and skills necessary to adopt sustainable practices. Branca et al. (2021) argue that climate-smart agriculture (CSA) can boost productivity and economic stability by increasing crop yields and lowering greenhouse gas emissions. Educating communities about these practices allows them to make more informed decisions that improve both environmental and economic outcomes. However, the high initial costs of implementing CSA practices may limit adoption in resource-constrained communities, emphasizing the importance of financial support in addition to educational efforts.

Public-private partnerships can help to increase the reach and impact of climate-smart education in local communities. Senyolo, Long, and Omta (2021) highlight the success of initiatives such as the Water Efficient Maize for Africa (WEMA) program, which demonstrates the potential for collaboration to scale CSA adoption. Incorporating such examples into local education programs can demonstrate how collaboration can break down resource barriers and promote economic resilience. However, Chitakira and Ngcobo (2021) argue that peri-urban and rural communities require tailored approaches to address their unique socioeconomic contexts, emphasizing the need for context-specific education programs.

Community-driven and locally tailored approaches are critical to ensuring that climate-smart education meets the needs of South African communities. Angom and Viswanathan (2023) emphasize the importance of locally relevant education models, such as those focused on water

conservation or sustainable farming techniques, in establishing long-term livelihoods. Education programs should prioritize community engagement to ensure that they are in line with local realities. However, as Molieleng, Fourie, and Nwafor (2021) point out, many smallholder farmers lack access to critical infrastructure, limiting their ability to implement CSA practices. Climate-smart education must therefore incorporate advocacy for systemic change to assist these communities.

Beyond agriculture, climate-smart education can address other critical industries, such as mining, which is both economically and environmentally important in South Africa. Nair (2024) focuses on the work of the Khuthala Environmental Care Group in Mpumalanga, which has implemented innovative practices to promote sustainable mining. Incorporating such examples into education programs can encourage local communities to investigate climate-smart innovations in a variety of fields. However, it is critical that these programs offer practical solutions for communities reliant on traditional livelihoods, fostering an equitable transition to sustainability.

Policy interventions on climate-smart education

Policy interventions are critical in advancing climate-smart education in developing countries, with the goal of providing communities with the knowledge and skills they need to engage in sustainable practices. Acharyya (2022) emphasizes the importance of incorporating climate-smart agriculture (CSA) strategies into education systems, pointing out that coherent policies can improve the dissemination of CSA knowledge and technologies. Policies aimed at strengthening institutional frameworks and creating enabling environments are critical for expanding these interventions. However, gaps in implementation and a lack of locally tailored approaches frequently undermine the effectiveness of these policies, necessitating more targeted and adaptable strategies.

Through institutional support, policy initiatives have demonstrated promise in advancing climate-smart practices in certain regions. According to Patra and Babu (2023), policy frameworks in Nagaland, India, have successfully aided in the adoption of CSA by coordinating institutional procedures with regional agricultural requirements. This integration demonstrates how education policies can help close the gap between community-level implementation and climate-smart initiatives. However, Defe and Matsa (2021) contend that a large number of policies in developing nations are limited in their applicability and impact because they do not take into consideration the distinct socioeconomic and cultural contexts of rural communities. To guarantee wider adoption, effective policies should address these local dynamics.

To improve climate-smart education initiatives, community-based methods of policy formulation and execution are essential. According to Hanley et al. (2021), food security and livelihoods have benefited from policies that emphasize community engagement and participatory techniques, like those employed in Myanmar's climate-smart villages. By ensuring that policies speak to the needs of the target communities, these strategies promote longer-term sustainability and increased acceptance. Acosta et al. (2021) warn that these interventions frequently ignore gender-specific issues, especially those pertaining to women's decision-making and resource access. Therefore, in order to address disparities and advance inclusive education, policies must embrace an intersectional perspective.

Another important element in promoting climate-smart education is policy coherence. According to Chevallier (2023), disjointed policies make it more difficult for CSA programs in Africa to scale and be effective. To align objectives and maximize impact, there needs to be more coordination between sectors, such as education, agriculture, and the environment. This viewpoint is supported by Rodríguez-Barillas et al. (2024), who point out that Costa Rica's CSA policy mix has been plagued by overlapping initiatives and inconsistencies, which have

reduced efficacy and caused confusion. Developing nations should concentrate on developing cohesive policy frameworks that prevent duplication and expedite efforts at climate-smart education.

Allocating resources and providing financial incentives are also essential for promoting climate-smart education. According to van Asseldonk et al. (2023), smallholder farmers can be persuaded to embrace CSA practices by means of policy incentives like subsidies and training initiatives. To encourage widespread learning and application, these incentives can be incorporated into educational programs. Erekalo and Yadda (2023) caution that, especially in environments with limited resources, insufficient funding and resource limitations continue to be major obstacles. Policies that place a high priority on funding training initiatives and educational infrastructure are necessary to address these issues.

Factors Affecting Implementation of climate-smart education in developing countries

A number of important factors, most notably limited resources and poor infrastructure, make it difficult to implement climate-smart education in developing nations. The integration of climate-smart practices is hampered by limited access to digital resources, particularly in rural areas, as Hebsale Mallappa and Pathak (2023) point out. Similarly, Victory et al. (2022) contend that Nigeria's lack of resources has slowed efforts to integrate climate education, especially in areas that are impoverished. These infrastructure deficiencies severely limit students' access to high-quality climate change education as well as teachers' capacity to instruct.

The absence of capacity building and training for teachers is another urgent problem. A lot of teachers lack the knowledge and abilities needed to effectively teach climate-smart education. Asante et al. (2024) emphasize how crucial it is to give teachers technical training in order to improve their capacity to present lessons that are both interesting and pertinent. However,

Senyolo et al. (2021) contend that by offering focused resources and capacity-building initiatives, public-private partnerships could close this gap. However, these collaborations frequently encounter coordination issues and bureaucratic roadblocks, which restrict their efficacy and scalability. Another major barrier to climate-smart education is social and cultural factors. Some communities' traditional values and customs may be at odds with contemporary climate policies, which could lead to opposition to educational programs. According to Okoronkwo et al. (2024), incorporating local knowledge into climate-smart education could aid in bridging this gap; however, careful preparation is necessary to prevent alienation or misrepresentation. According to Shekmohammed et al. (2023), farmers' field schools and other participatory approaches are effective examples of fusing traditional knowledge with modern methods to increase community acceptance.

The difficulties in putting climate-smart education into practice are made worse by problems with governance and policy. In order to successfully incorporate climate education into their educational systems, many developing nations lack cogent policies or frameworks. According to Chevallier (2023), two major obstacles to scaling climate-smart interventions throughout Africa are policy fragmentation and a lack of institutional capacity. In order to close these gaps, Karume et al. (2022) call for greater international cooperation and policy alignment; however, political will and conflicting national priorities frequently impede progress. Insufficient knowledge of climate change among students, teachers, and legislators compromises the efficacy of climate-smart education initiatives. Low engagement and support for such initiatives are frequently the result of this knowledge gap. According to Ali (2021), community participation is decreased in Togo when people are unaware of the advantages of climate-smart practices. Nonetheless, community-based initiatives and awareness campaigns have demonstrated the ability to promote increased comprehension and participation. It will take a

coordinated strategy that combines capacity-building programs, policy reform, and active community engagement to overcome these obstacles.

Strategies for promoting climate-smart education

Targeted strategies that incorporate context-specific needs—like addressing the effects of climate change on agriculture and livelihoods—are necessary to promote climate-smart education in developing nations. In order to reduce climate-related risks, Hebsale Mallappa and Pathak (2023) stress the significance of implementing climate-smart agriculture (CSA) technologies. This approach is pertinent to South Africa's rural communities that rely on subsistence farming. The Farmer Field School (FFS) approach, which employs community-based training to encourage the adoption of CSA practices, is also highlighted by Shekmohammed et al. (2023). By adopting this strategy in South Africa, farmers will be better equipped to incorporate climate-smart practices and increase their resilience to environmental shocks. Digital advisory services are a potent instrument for advancing climate-smart education, especially when it comes to expanding knowledge availability. Asante et al. (2024) show how these services help farmers adopt CSA in Ghana by giving them customized advice. This is an example that South Africa can use to spread climate-smart practices in both urban and rural areas by utilizing mobile platforms. However, as Victory et al. (2022) point out, issues with digital literacy and infrastructure gaps continue to exist. Investing in digital education and increasing internet access in underserved areas is necessary to remove these obstacles and guarantee equitable access to resources.

Another successful tactic for promoting climate-smart education in developing nations is public-private partnerships or PPPs. According to Senyolo et al. (2021), PPPs are essential for increasing the adoption of CSA, as demonstrated by the Water Efficient Maize for Africa (WEMA) program. These collaborations can offer funding, educational opportunities, and technical assistance to advance CSA practices. However, Okoronkwo et al. (2024) warn that

striking a balance between business interests and community needs is essential to the success of such collaborations. Policymakers in South Africa must make sure that PPPs avoid exploitative practices and give sustainability and inclusivity a top priority. For long-term change, formal education systems must integrate CSA strategies. In order to prepare students to be change agents, Abdulai (2023) emphasizes the importance of universities in climate-smart education and the incorporation of CSA into curricula. This strategy can be implemented by South African universities, guaranteeing that agricultural, environmental, and technical education programs incorporate climate-smart concepts. Additionally, South African farmers who lack formal education but require practical knowledge to implement climate-smart strategies can benefit from the targeted workshops and extension services that Isiwu and Adejoh (2023) advocate for smallholder farmers.

Lastly, the success of climate-smart education in developing nations depends on encouraging policy coherence and coordinated action. Chevallier (2023) calls for integrated frameworks that align educational, agricultural, and environmental goals, emphasizing that fragmented policies impede the adoption of CSA throughout Africa. To guarantee the scalability and sustainability of climate-smart education initiatives in South Africa, cooperation between government agencies, academic institutions, and non-governmental organizations is necessary. South Africa needs to concentrate on developing all-encompassing strategies that address both short-term and long-term issues, taking inspiration from other African countries like the Democratic Republic of the Congo (Karume et al., 2022).

Recommendation

Policymakers ought to make sure that climate-smart concepts are incorporated into important fields like industry, education, agriculture, and the environment.

Public-private sector cooperation should be encouraged by policymakers in order to pool resources, knowledge, and technological advancements for the expansion of climate-smart education.

Future studies should concentrate on adjusting Climate-Smart Education programs to meet local needs, especially in peri-urban and rural areas.

To develop a comprehensive strategy for integrating climate-smart principles across different sectors, research should embrace interdisciplinary approaches that integrate economics, education, climate science, and industry practices.

Conclusion

This research investigates methods for advancing Climate-Smart Education to improve industry economic sustainability, with an emphasis on South Africa. The purpose of climate-smart education programs is to equip local communities with the values, knowledge, and abilities needed to effectively address climate change issues. Adaptation, mitigation, and climate awareness are all part of these programs. However, issues like a lack of funding, inadequate training for teachers, and cultural resistance still exist, especially in developing nations, and they could have an impact on how it is implemented in South Africa. As a result, methods like digital advisory services, public-private partnerships, and incorporating climate-smart concepts into formal education can fill in knowledge gaps and reduce vulnerability. Initiatives must be tailored to the socioeconomic conditions of rural and peri-urban regions, and policy efforts must be coordinated. Additionally, collaborative frameworks that align educational, agricultural, and environmental objectives can facilitate scalability and ensure the enduring success of climate-smart education programs.

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