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EDITORIAL NOTE

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From Policy to Practice: Governance, Education, and Social Transformation in Africa:

Welcome to the October 2026 issue of the Journal of Contemporary Society and Education (JCSE). The sixteen articles assembled in this volume reflect the journal's commitment to rigorous, interdisciplinary scholarship on the pressing social, political, and educational challenges confronting contemporary Africa. Together, they illuminate a central tension of our time: the persistent gap between policy ambition and lived reality.

Several contributions in this issue grapple directly with the question of governance and service delivery. Motadi examines the opportunities and barriers shaping digital transformation in South African government departments, while Moloto and Pillay explore technology's influence on governance at the local municipal level. Akindele, Sanni, and Lamidi assess citizen satisfaction with public transportation in Lagos State, offering an important reminder that the legitimacy of the state rests on the quality of everyday services. Jutta and Alao interrogate the democratisation of the administrative state through South Africa's Government of National Unity, and Okudolo examines decentralisation and the effectiveness of local political leaders in Nigeria. Kambiri's analysis of governance challenges in managing internal displacement further underscores the consequences of normative commitment without implementation capacity. Agbor's critical perspectives on the operational independence of Elections Cameroon and the Constitutional Council round out this focus on democratic institutions.

Education remains a cornerstone of social progress, and this issue devotes considerable attention to it. Mtshali and Meyiwa assess the role of climate change education in maritime studies, while Modiba asks whether rural secondary schools are adequately managing learners with special educational needs associated with HIV/AIDS. Babalola interrogates the legal and policy complexities of foreign partnerships in Nigerian higher education, and Shabangu examines how school management teams respond to violence in rural South African schools. Nephawe and Mudimeli offer a distinctive contribution on the indispensability of English as a lingua franca in interpreting selected Pauline epistles.

The issue also foregrounds questions of gender, culture, and well-being. Nesane and Amaechi explore *Mamalo* as a resource for gender equality and women's empowerment in Limpopo, while Gudani, Khosa, and Nomatshila examine adolescents' perceptions of

child support grant management through a family systems lens. Matheere offers an exploration of the life journey of traditional healers in rural Limpopo, and Nkuna and colleagues provide an analytical study of compounding and naming in Siswati personal names. These articles remind us that social transformation is experienced at the level of culture, family, and community.

Collectively, these contributions demonstrate the vitality and breadth of contemporary social science research in Africa. They challenge scholars and policymakers alike to move beyond policy pronouncements toward meaningful implementation. We thank our authors and reviewers for their dedication and trust that this issue will stimulate further inquiry and debate.

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NAVIGATING THE GREEN TRANSITION: ASSESSING THE ROLE OF CLIMATE CHANGE EDUCATION IN MARITIME STUDIES ON FOSTERING ENVIRONMENTAL SUSTAINABILITY

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Abstract:

The global maritime community is moving toward net-zero carbon emissions, and education is vital for building environmental awareness and advancing green agendas. Although climate change literacy has improved globally, a gap remains between students' understanding of environmental science and their ability to participate in a green economy. It is also unclear whether secondary school curricula adequately equip learners with practical green skills. This study investigates the presence of "green" subjects within the secondary school curriculum and evaluates how well Climate Change Education (CCE) frameworks in Grades 11 and 12 align with the functional requirements of a sustainable green economy. Using deductive content analysis, Grade 11 and 12 lesson plans and relevant government policies are systematically reviewed to identify gaps in preparedness for sustainable workplaces. National education standards are then compared with the International Labour Organization's Skills for the Green framework. Preliminary findings suggest that learners demonstrate an acceptable level of environmental awareness but struggle to translate sustainability principles into clear green-economy opportunities and benefits. The curriculum appears more focused on theoretical climate awareness than on socio-economic outcomes embedded in green skills. The study highlights the need for an educational shift that links STEM learning to real-world green economic participation. It concludes that policymakers should move beyond science-centric models toward an

integrated approach that connects environmental stewardship with economic inclusion and employability.

Keywords: *Climate Change Education, Green Economy, Sustainable Economy, Green Skills, Just Transition.*

1. Introduction

1.1. Background to the Study

Climate change refers to a persistent, long-term shift in global temperatures and weather patterns. While these shifts occur naturally, the primary driver of climate change is the human-induced release of greenhouse gases (GHGs) into the atmosphere, also known as anthropogenic emissions (Oladunni et al., 2022). GHG emissions originate from a diverse range of anthropogenic sources, with the energy and industrial sectors acting as primary contributors. Notably, maritime transport accounts for nearly 3% of the global carbon dioxide emissions (Bilgili & Ölçer, 2024). The Maritime industry is essential for international trade and travel; however, its reliance on Heavy Fuel Oil (HFO) results in substantial greenhouse gas emissions. These emissions are a primary driver of global climate change. The resulting environmental climatic shifts manifest as a series of interconnected crises: intensified precipitation, oceanic warming, receding glaciers, and biodiversity loss, all of which threaten global infrastructure and economic instability. The maritime industry is undertaking a significant transformation to net zero carbon emissions which is anticipated to be reached by 2050. This

change is necessitated by the Greenhouse Gas (GHG) 2023 Strategy formulated by the International Maritime Organization (IMO). The organization is responsible for safe, secure and efficient shipping, and the prevention of pollution from ships (MEPC, 2023). The primary aim of the IMO 2023 GHG Strategy is to achieve maritime decarbonization and mitigate the effects of climate change through the reduction of GHG emissions from ships (Zhang et al., 2024; Bilgili & Ölçer, 2024). Traditional fuels, also known as legacy fuels, are the primary driver of shipping industry environmental footprint. The burning of these legacy fuels releases GHG emissions into the atmosphere. Ships contribute only 2.9% of anthropogenic GHG emission to the atmosphere. Although this contribution appears marginal, its elimination may yield a substantial impact over the long term. The strategy advocates for alternative energy sources and future fuels with low or zero carbon life cycles. The future fuels include green ammonia, e-methanol, hydrogen, biofuels, and Liquid Natural Gas (LNG). In addition to shifting fuels, ships must employ advanced energy-efficiency technologies such as air lubrication system to reduce hull friction, and wind-assisted propulsion. Under the IMO 2023 GHG

Strategy, waste management plays a vital role in decarbonization by converting waste streams into usable energy.

It is important that ships channel their efforts towards a sustainable environment through the adoption and implementation of the 2023 GHG Strategy. The achievement of the of IMO 2023 GHG Strategy net zero carbon emissions goes beyond environmental stabilization. The reduction of GHG emissions decreases the level of pollution in the atmosphere and effectively stops the rise in global temperatures, reduces severe weather patterns such as floods and droughts. Beyond climate stability, the reduction of emissions acts as a catalyst for public

health and economic rejuvenation. Decarbonization and Net zero significantly improves air quality and prevents premature deaths caused by respiratory and cardiovascular diseases (Moutet et al., 2025; Shindell et al., 2024). It also boosts the economy by creating “green jobs” (Jaeger et al., 2021). Net zero removes reliance on volatile foreign fossil fuel markets, replacing them with local, cleaner energies (Bouckaert et al., 2021). The author outlines the advantages of achieving net-zero emissions in the following diagram, the benefits resulting from this transition are further detailed in the figure below.

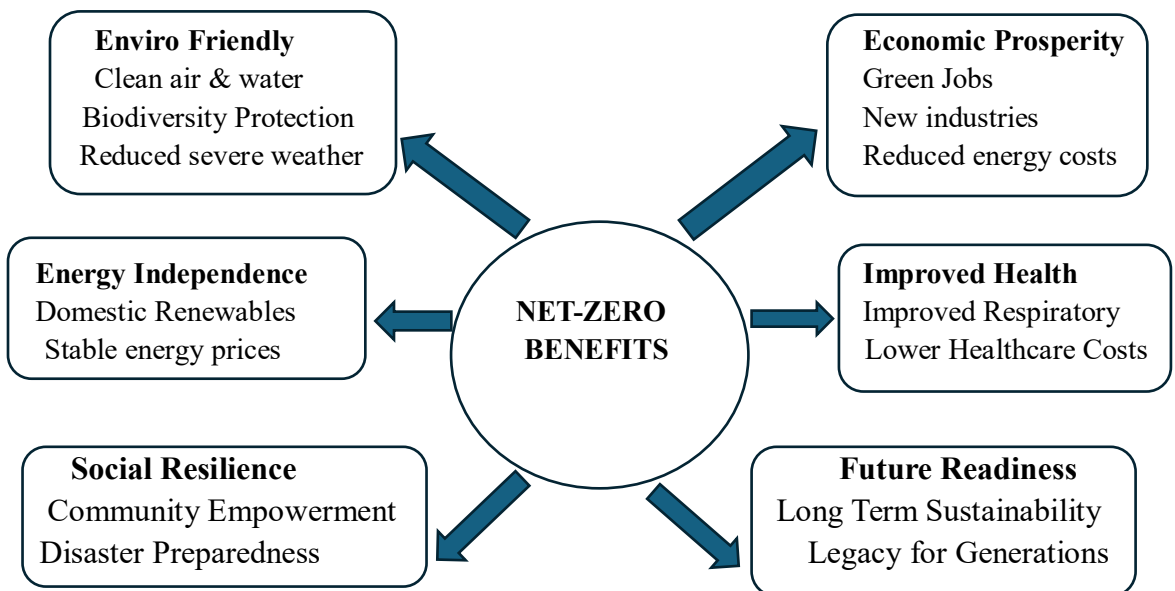


Figure 1: The Benefits of Carbon Emissions Elimination

Source: Author constructed

While significant strides have been made in Eco ship technology, the widening “Green Skills” gap remains a cause for concern for the shipping industry. The “Green Transition” within the maritime sector transcends the mere adoption of technological advancements and alternative fuels such as green ammonia, green hydrogen, or green methanol; rather, it necessitates a fundamental paradigm shift in the industry’s organizational culture. The strategy without human involvement and commitment is merely a document on the shelf. All maritime stakeholders, including schools, must contribute towards the strategy’s successful implementation. Seafarers must possess a deep understanding of climate change to ensure the long-term sustainability of maritime economic growth. CCE is a primary strategy for fostering awareness and teaching mitigation measures. By facilitating knowledge transfer, CCE advocates for the adoption of cleaner energy and emphasizes the transition from traditional fossil fuels to green alternatives. To support this shift, schools must integrate decarbonization and “green skills” into their curricula. The adoption of CCE in schools will provide MTIs with well-prepared students who are better equipped for advanced studies. MTIs are uniquely positioned to connect secondary school graduates with the opportunities in the green economy. The identification of the current gaps in the secondary curriculum can better equip

students with the practical green skills required for a sustainable environment and workforce. CCE within the schooling environment should serve as the foundation for raising awareness and preparing students for the essential demands of green economy. It prepares aspiring seafarers with the specialized knowledge and technical skills required to implement climate change mitigation and adaption measures, effectively reducing the risk of environmental disasters (Stevenson et al., 2017). There must be link between Pedagogical Theory and the Industrial Application (“Green Transition” in Shipping). It remains to be seen to what extent the national secondary CCE curriculum equips students with the essential “Green Skills” required for a sustainable environment. While many learners complete schooling with a theoretical understanding of climate change, the curricula often proves inadequate to provide practical, solution-oriented training that translates into green career pathways. The curricula deficiency creates a bottleneck for a sustainable economy.

Bridging the gap between secondary school and the labour market requires a fundamental shift in educational focus, moving from a pure theoretical knowledge to the integration of practical, industry-relevant skills such as ‘green skills’. This transition is necessitated by the need to close the gap between the school curriculum and the evolving

demand of the industry. Secondary schools establish a conceptual foundation, focusing on theoretical awareness. MTIs then bridge the gap into the labour market by emphasizing practical applications. Consequently, a secondary school graduate may understand the greenhouse effect but lack the technical proficiency to manage the

physical systems used to fix it. At the industry level, the focus shift towards strategic implementation, where the primary goal is managing the full scope of net-zero operation. In table 1, the author summarizes how each component of the Skills Supply Chain contributes to the achievement of the net-zero goals.

Table 1: Bridging the Gap between Secondary School and Labour Market

Career Level	Focus Area	Skills
Secondary School	Foundation & Awareness	Understanding basic STEM principles & Greenhouse Effect
MTIs	Specialized Technical Skills	Operating a Carbon-Capture System
Labour Market	Strategic Implementation	Directing Net Zero Operations on zero-emission ships

Source: Author constructed

1.2. Problem Statement

The maritime industry is undergoing a rapid transition towards a green economy, driven by rigorous international laws and regulations (MPEC, 2023). However, despite stringent IMO 2023 and 2050 targets, the integration of Climate Change Education (CCE) within maritime studies has not kept pace with the industry's technical shift, resulting in a significant knowledge gap (Barasa et al., 2025; Kitada et al., 2020). This disparity is further widened by rapid technological innovations in alternative fuels, energy-efficient hull designs, and carbon capture technologies. Current university maritime curricula often remain anchored

in traditional frameworks that prioritize technical design and operations while neglecting the socio-ecological dimensions of climate change (Simanjuntak et al., 2025).

Consequently, a resistance to pedagogical change persists. This deficiency produces graduates who possess technical proficiency but lack the environmental literacy needed to navigate changing regulatory prospects or to serve as effective advocates for sustainable maritime practices. Consequently, there is an urgent need to evaluate the status of CCE within maritime studies. However, it essential that this assessment begins at

the secondary school level, as these serve as the primary feeders for tertiary maritime education. By addressing climate change literacy during these foundational years, educators can ensure that students entering MTIs possess the prerequisite environmental awareness necessary to grasp advanced sustainable shipping concepts. Neglecting the secondary level risks a delay, where universities must spend valuable time teaching basic environmental principles rather than advanced green transition competencies. This paper thus evaluates the extent to which Secondary Schools curricula incorporate climate change mitigation, decarbonization, and green shipping practices. It does this by focusing on the intersection of CCE and maritime studies, particularly on how the integration of environmental sustainability into the curriculum fosters 'green skills' essential for future seafarers' professional advancement. Traditionally, maritime education focused on compliance with International Convention for the Pollution Prevention from Ships (MARPOL) regulations, and not so much on Stewardship. CCE plays a transformative role by instilling an ethical understanding of the marine environment as a finite resource that requires rigorous protection and sustainable management.

2. Literature Review

2.1. Climate Change Education Framework in Maritime Studies

Matsepe & Maluleke (2013) noted the lack of integration of Climate Change Education into the Curriculum and Assessment Policy Statement (CAPS).

Climate Change Education (CCE) prepares students to actively address the climate crisis through mitigation strategies, adaptation techniques, and disaster preparedness (Stevenson et al., 2017). CCE is a multidisciplinary framework that transcends traditional navigation and technical aspects of shipping. The framework encompasses ocean, maritime regulatory, and green technology literacy, incorporating specific competency components under each pillar. The primary aim is to equip the workforce for sustainable practices. The CCE framework must focus on 3 broad maritime pillars, namely Ocean Science Literacy, Maritime Regulatory Literacy, and Green Technology Literacy. The first pillar is the foundation of the CCE framework, focusing on understanding the ocean's role within the climate system and the impact of maritime activities on the ecosystem. The second pillar establishes the international legal framework necessary to promote the safety, security, and sustainability of all activities within maritime jurisdictions. Finally, the third pillar addresses the transition to low-carbon fleet, focusing on

the hardware and software innovations required to decarbonize maritime operations. The author outlines the 3

pillars of the CCE framework in the diagram below.

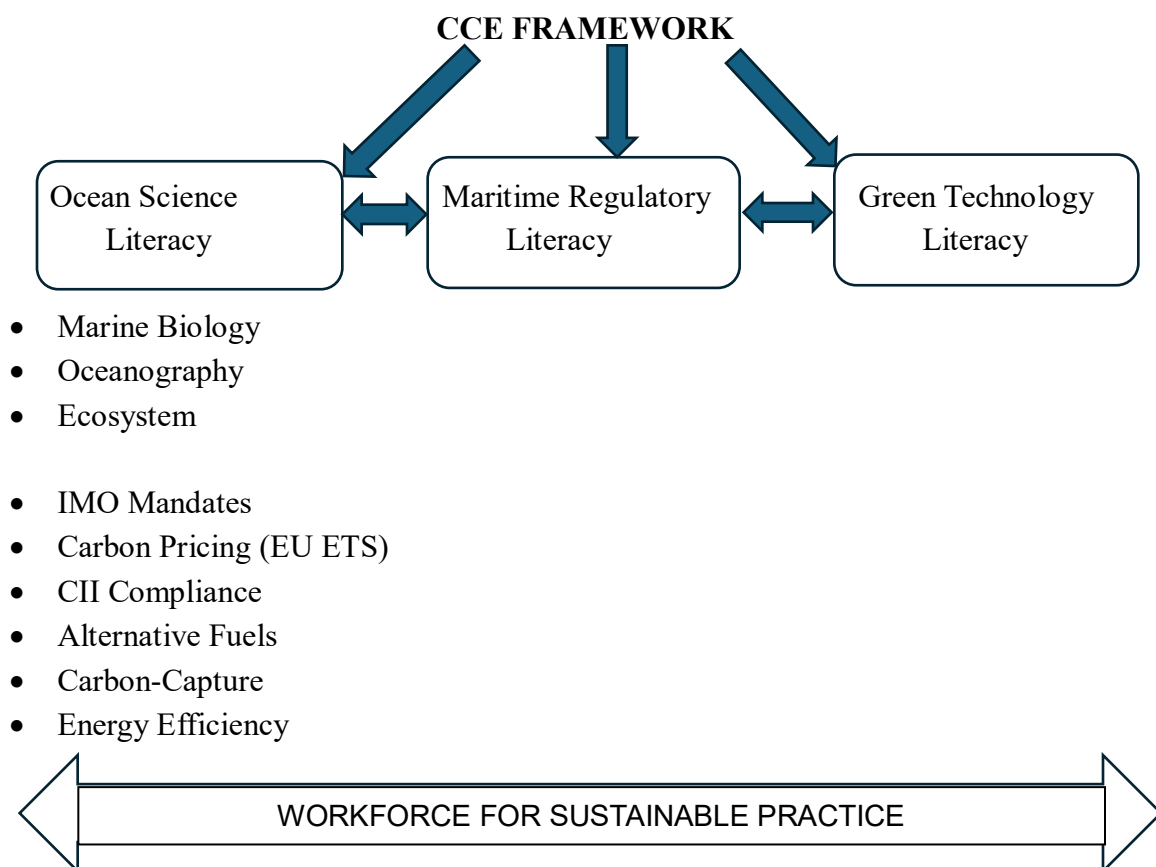


Figure 2: Climate Change Education Framework

To adapt to climate change and be economically sustainable, education must embrace multidisciplinary, interdisciplinary, and transdisciplinary approaches to teaching, learning, and curriculum development (Matsepe &

Maluleke, 2013). The three pillars of CCE should be seamlessly embedded into STEM (Science, Technology, Engineering, and Mathematics) curricula. This integration is essential, as STEM proficiency remains a primary driver of

future employability and long-term career success for learners. CCE establishes real-world context, meanwhile, STEM contributes the practical framework, utilizing science to interpret atmospheric shifts, technology to track environmental data, engineering to innovate carbon-capture or renewable energy systems, and mathematics to project future climate scenarios. STEM education establishes a vital foundation in critical thinking for an increasingly automated world, preparing the workforce for the rapidly evolving industries and career paths for the future (Pols, 2019). The transition from secondary school STEM (Science, Technology, Engineering, and Mathematics) subjects to maritime education at Maritime Training Institutions (MTIs) is both direct and foundational. Maritime education is essentially applied STEM within a high-stakes, dynamic environment. Secondary school mathematics provides the analytical tools required in Navigation-Calculations & Passage Planning to enable seafarers to safely navigate a vessel from port to port. The physics taught in secondary school is tested daily at sea to ensure a ship stays afloat and upright. The fundamental concept of buoyancy (**Archimedes' Principle**), which dictates that a floating vessel displaces a weight of water equal to its own mass, is the core principle behind ship stability. Secondary school physics and engineering fundamentals, such as Ohm's law and thermodynamics, scale up

at an MTI into the management of massive marine diesel engines, auxiliary machinery, refrigeration plant, and complex electrical distribution boards. CCE and STEM are deeply linked through an interdisciplinary approach that turns complex scientific data into practical, real-world solutions. Integrating CCE into the STEM curricula is essential for fostering critical thinking and data literacy. This allows learners to become future innovators capable of designing renewable energy systems, developing carbon-capture technologies, and engineering resilient port infrastructure. The growing recognition of STEM education is largely due to its integrated methodology, which fosters essential skills such as critical thinking, complex problem-solving, and creative innovation (Buriro et al., 2023). An integrated CCE and STEM curriculum, referred to hereafter as Green STEM, should prioritize 'green' disciplines or subjects, specifically environmental science, sustainable development, and ecological preservation, to provide learners with a purpose-driven education. Integrating sustainability into STEM education offers a unique opportunity to develop environmentally conscious leaders equipped to solve complex global challenges (Buriro et al., 2023). Despite its benefits, the implementation of Green STEM in South Africa faces significant hurdles, as many schools lack the essential infrastructure, such as chemistry laboratories, computer centres, and

simulation facilities, required for technical training. In table 2, the author

details how STEM subjects contribute to a sustainable environment.

Table 2: STEM Contributions to Environmental Sustainability

Discipline	Role in Climate Change Education
Science	Understanding greenhouse effect, carbon cycles, and ecological impact
Technology	Using remote sensing, climate modelling software
Engineering	Creating low-carbon ships
Mathematics	Calculating carbon footprints

Source: Author constructed

It is essential to note that STEM proficiency is a formal prerequisite for maritime seagoing careers, particularly within the disciplines of Nautical Studies and Marine Engineering. STEM subjects provide the foundation for maritime professionals to develop the ‘green skills’ requisite for effective environmental protection. To ensure the protection of marine environment, maritime professionals must utilize advanced monitoring technologies and implement rigorous controls for waste disposal and carbon emissions. In table 3, the author

outlines the Grade 11 and 12 Green STEM subjects as defined by the 2024/2025 lesson plans that serve as mandatory prerequisites for entry into maritime seagoing careers. The table also outlines the green focus areas the author recommends embedding into Grade 11 and 12 STEM curricula, categorized by subject. An analysis of lesson plans will be conducted to determine the extent to which STEM subjects incorporate Green Focus Areas and to assess their contribution to environmental sustainability.

Table 3: South African Grade 11 and 12 Green STEM Subjects

Discipline	Subjects	Green Focus Area
Science	Physics, Chemistry, Life Science	Climate change, renewable energy & alternative fuels, energy efficiency,

		environmental impact
Technology	Information Technology	Climate change, environmental monitoring system, climate data analysis software
Engineering	Mechanical, Electrical	Climate change, renewable energy (solar/wind), carbon footprint, carbon capture, water & waste management
Mathematics	Pure Mathematics	Climate change, calculating carbon footprint

Source: Author constructed

2.2. South African Government Policies on Climate Change

The South African government has the responsibility to strengthen the consistency and coordination of policies and tools designed to improve learning outcomes (Gustafsson & Nonkenge, 2025). Such policies serve as tools to

unlock the funding needed to facilitate teaching and learning for both educators and students at all levels and disciplines. Consequently, government policies must provide a framework for embedding climate change into the curriculum to foster environmental literacy and address the multifaceted impact of the climate

crisis. Government policies must ensure that climate is an integral part of education system that seeks to raise awareness and impart knowledge about the impacts of climate change. The CCE initiative is designed to cultivate literacy and improve the decision-making capabilities of community members, hence, it must be supported by government policies. The author examines the government policies to determine the extent of state efforts to support CCE within the schooling environment. The following government policies are examined:

- Department of Basic Education Strategic Plan 2025 – 2030
- Department of Transport, Revised Strategic Plan 2020 - 2025
- Climate Change Act no 22 of 2024
- National Climate Change Response, White Paper

2.3. Introduction to the Maritime Green Transition

Under the 1997 Kyoto Protocol, the United Nations Framework Convention

on Climate Change (UNFCCC) officially delegated the responsibility for limiting and reducing greenhouse gas (GHG) emissions from international shipping to the International Maritime Organization (UPDATE, 2018; Bullock et al., 2024). In 2015, at the 21st Conference of the Parties (COP21), representatives from 196 adopted the Paris Agreement to reduce GHG emissions and mitigate the rise in global average temperatures (Chircop, 2019; Joung et al, 2020; Bilgili & Ölçer, 2024). This landmark accord necessitated the involvement of the IMO to establish stringent standards in the shipping sector. Consequently, the IMO adopted the Initial GHG Strategy in 2018, which aimed to reduce the emissions by at least 50% by 2050. This strategy was subsequently revised in 2023 to reach net-zero GHG emissions by 2050. The attainment of the decarbonization strategy relies heavily on 3 measures, namely (1) alternative fuels, (2) technological, and (3) operational (Halim et al., 2018). Halim et al. (2018) indicate the 3 measures and their individual subcomponents in Table 4.

Table 4: Overview of principal measures to reduce ship's carbon emissions

Measure	Subcomponent
Alternative fuels	Ammonia, hydrogen, biofuels, solar energy
Technological	Carbon capture, friction reduction, light material
Operational	Low speeds, weather routing, cold ironing

2.4. Theoretical Framework for Sustainable Education

South Africa's transition towards a greener economy has been significantly impeded by systematic historical

inequalities. In many emerging economies, immediate developmental priorities such as poverty alleviation and energy security frequently take precedence over long-term climate mitigation goals. While South Africa is expected to decarbonize, it must do so from a foundation of extreme systemic inequality. This transition is hindered by the legacy of apartheid and coal-centric industrial model that remains the bedrock of the economy. Because shifting away from this structure threatens the core of the industrial base, the government remains hesitant to aggressively pursue decarbonization or reform education policies, as the entire economic system is deeply locked into coal.

Higher education has a vital role to play in transitioning from fossil fuels to green fuels. While global renewable energy adoption is accelerating, higher education systems often exhibit institutional inertia, as entrenched academic structures and curricula continue to favour traditional carbon-intensive sectors over emerging green technologies (Vakulchuk & Overland, 2024). Higher education institutions remain disproportionately focused on the fossil fuel industry, resulting in a surplus of graduates compared to those entering the renewable energy sector (Vakulchuk & Overland, 2024). A critical shortage of specialized human capital, specifically within the scientific, engineering, and technical sectors, remains a primary obstacle

(Strietska-Ilina et al., 2011). Furthermore, the nation's entrenched reliance on coal-based energy production exacerbates this delay. This carbon-intensive dependency effectively undermines the implementation of educational policies aimed at fostering environmental sustainability and green industrialization (van Doesburgh & Winkler, 2025; Vakulchuk & Overland, 2024). The development of a highly skilled technical workforce necessitates robust international and cross-sector collaboration. The alignment of the national pedagogical framework with international labour market demand is dependent upon the cultivation of strategic global partnerships (McGrath & Powell, 2016). These collaborations serve as channels for knowledge transfer and benchmarking of curricula against global sustainability indicators. Furthermore, given the escalating challenges posed by climate change, it is imperative that developing countries internalize and adapts UN educational frameworks to build systemic environmental resilience and ensure long-term socio-economic stability.

The United Nations Education, Scientific and Cultural Organization (UNESCO) provides a comprehensive global framework for integrating sustainability within educational system. The organization identifies education as a fundamental enabler for the achievement of the Sustainable Development Goals

(SDGs), with particular emphasis on SDG 13, which addresses urgent climate change action. The UNESCO framework is organized around five “Priority Action Areas” designed to support member states in the strategic expansion of Education for Sustainable Development (ESD). These pillars facilitate the systematic integration of sustainability principles into national education policies and institutional practices (UNESCO, 2015).

- Advancing policy
- Transforming Learning and Training Environments
- Building capacities of educators and Trainers
- Empowering and Mobilizing Youth
- Accelerating Sustainable Solutions at the Local Level

While these pillars are interlinked, this paper contributes to the realization of the second pillar, which is: “Transforming Learning and Training Environments”.

3. Research methodology

In keeping up with the overall objective of this paper, which is the interrogation of the intersection of CCE and maritime studies, particularly on the integration of environmental sustainability into the curriculum, the researchers have used deductive content analysis to determine the extent to which it incorporates environmental topics, including **renewables and non-renewables, alternative green fuels, waste management, ocean acidification, atmospheric pollution, carbon cycle, and climate change**. The documents under analysis were for 13 STEM subjects (each presenting four terms’ lesson plans) and two Curriculum and Assessment Policy Statements (CAPS) for Maritime Economics and Nautical Sciences subjects, tallying up to an overall of 54 documents. These were downloaded from the department of basic education website, and they are for grades 10 to 12. The table below summarizes the secondary data used.

Table 5: STEM Subjects under analysis

Subject	Grade/Level	Year	Term	Tally
Mechanical Technology (Welding and Metalwork)	11	2023/24	1-4	4
Mechanical Technology (Fitting and Machining)	11	2023/24	1-4	4
Mechanical Technology (Automotive)	10	2023/24	1-4	4
Geography (Inland)	11	2023/24	1-4	4
Life Sciences	11	2023/24	1-4	4

Physical Sciences	11	2023/24	1-4	4
Technical Sciences	12	2023/24	1-4	4
Mechanical Technology (Welding and Metalwork)	12	2023/24	1-4	4
Mechanical Technology (Fitting and Machining)	12	2023/24	1-4	4
Mechanical Technology (Automotive)	12	2023/24	1-4	4
Geography (Inland)	12	2023/24	1-4	4
Life Sciences	12	2023/24	1-4	4
Physical Sciences	12	2023/24	1-4	4
CAPS Documents				2

Source: Department of Basic Education website

The selection of these senior secondary levels is justified by their role as a critical transition phase, where students are on the threshold of entering tertiary maritime education. These were the only documents that were readily available online at the time that the authors wrote the paper. This study focuses on one curriculum point in the 5-year review. The reason is that all lesson plans within the review cycle will fundamentally contain the same conceptual content. Changes are expected once in every 5 years. There is merit to looking at the evolutionary picture of the data, i.e.

comparing different curriculum review cycles over time in view of policy prescriptions, however, this warrants a larger study too big for one journal article (beyond the scope of this paper). The study deliberately excludes technical specifications and focuses on pedagogical delivery. Furthermore, students in Grades 1 through 10 are outside the scope of research. This exclusion is based on the premise that junior-level learners may lack the foundational technical knowledge required to process and internalize complex, industry-specific sustainability regulations.

4. Data presentation

Table 6: Inductive Themes observed from CAPS and lesson plans

Themes	Tally	Referenced Documents (and frequency)	Content
Renewables and non-renewables, sustainability	2	Grade 12 Geography (1); Grade 11 Geography (1)	Pre-requisite knowledge of mining resource use and sustainability; sustainable development and spatial planning
Alternative, green fuels, energy efficiency	4	Maritime Economics CAPS (1) Grade 11 Geography (2) Grade 12 Technical Sciences (1)	Non-conventional energy; energy management towards greener economies and sustainable lifestyles; discuss the use of alternate energies and their environmental impact
Waste management, Recycle, upcycle,	6	Maritime Economics CAPS (3) Nautical Science CAPS (3)	
Ocean acidification			
Atmospheric and environmental pollution	9	Nautical Science CAPS (2) Maritime Economics CAPS (3) Grade 12 Geography (4)	pollution domes and their economic, social and environmental impacts along with strategies to reduce them; impact of people on drainage basins and catchment areas like river pollution; environmental and air pollution from urban settlements; and air pollution from secondary and tertiary industrial sectors.

Climate change and global warming	0		
Carbon cycle, carbon capture, greenhouse gases, emissions	3	Grade 11 Life Sciences (3)	Plants' uptake of carbon dioxide from the atmosphere; Human impact on the environment: Causes and consequences

CAPS Documents

Seven themes pertaining to environmental awareness were identified within the CAPS statements for Nautical Studies and Maritime Economics. These themes encompass teaching learners about alternative energy sources and sustainable lifestyles; waste management (specifically nuclear, general, and ballast water disposal); and the causes of marine pollution, including its impacts and preventative mitigation measures. Moreover, the documents provide assessment guidelines aimed at fostering responsible attitudes and environmental awareness regarding the marine ecosystem. There is a notable overlap between the Maritime Economics and Nautical Science CAPS curricula regarding waste management and recycling protocols. However, the Nautical Science CAPS document notably omits content related to the transportation and disposal of nuclear waste. This omission likely reflects the infrequent arrival of nuclear-powered vessels at South African ports and perhaps the generally unfavourable light under which this energy source has been viewed. Consequently, nuclear energy and the management of nuclear waste do not feature prominently in the curriculum as part of the discussion on sustainable or alternative energy. Furthermore, while the CAPS statements for both Nautical Studies and Maritime

Economics foster an awareness of the environmental impacts of maritime trade, they notably lack fundamental coverage of global warming, carbon capture, climate change, and greenhouse gas emissions. The coverage of environmental topics within the curriculum is therefore relatively superficial.

Lesson Plans

Across the reviewed subjects, environmental awareness and climate change education are rarely addressed directly within the lesson plans. For example, while the Grade 11 Life Sciences curriculum includes themes related to carbon dioxide, the focus is limited to botanical processes, such as the uptake of CO₂ from the atmosphere during photosynthesis (1) driven by intensified anthropogenic and industrial processes. Additional themes explore the socio-environmental impacts of drought and desertification (1), the environmental impact of human activity on global food security, linking these to the increased frequency of droughts and floods driven by climate change (2), atmospheric concentrations of carbon dioxide and methane, which expand the carbon footprint and increase greenhouse gases, thereby driving climate change and global warming. While one might expect such environmentally focused content to fall

within the scope of Geography, this is surprisingly not the case.

In Grade 11 Geography, the concept of sustainability is applied primarily to spatial development, with significantly less emphasis on environmental sustainability (1). The curriculum explores non-conventional energy sources, such as wind energy, alongside their potential impacts on both the economy and the environment (1) in conjunction with energy management strategies aimed at fostering greener economies and sustainable lifestyles (1). Furthermore, the treatment of pollution within the high school Geography curriculum is primarily restricted to terrestrial sources and inland waterways. For example, the Grade 12 curriculum covers valley and urban climates, specifically defining the causes of pollution domes. These lessons further examine the resulting economic, social, and environmental impacts, alongside mitigation strategies (1); the anthropogenic impact on drainage basins and catchment areas, with a specific focus on river pollution (1); environmental degradation and atmospheric pollution stemming from rapid urbanization (1) alongside atmospheric emissions originating from secondary and tertiary industrial sectors (1).

This predominantly terrestrial focus within the current curriculum underscores the critical need to integrate climate change education into the maritime domain. This terrestrial focus is further exemplified by the Grade 12 Geography module on River Management. This framework could logically be extended to 'Oceans Management', a concept typically reserved for post-matric education, mirroring the

natural transition of river systems as they discharge into the sea.

In contrast, the 'hard sciences', including Physics, Chemistry, and Mechanical Technology, possess almost no integrated climate change education components. Broadly speaking, these subjects contain only climate-adjacent topics that lack the necessary depth and scope to help learners forge epistemic links. Consequently, students struggle to connect their foundational knowledge to practical, immediate contributions toward climate change adaptation and mitigation. For example, the Grade 12 Physical Sciences Annual Teaching Plan (ATP) covers organic molecules, specifically focusing on the 'combustion of alkanes in excess oxygen and their use as fuels'. The curriculum also covers 'electrochemical cells,' specifically focusing on galvanic and electrolytic systems. While these modules focus on traditional technologies, the curriculum fails to modernize or encapsulate emerging innovations such as 'alternative green fuels' or 'carbon capture' technologies. For instance, the Grade 12 Technical Sciences Annual Teaching Plan (ATP) for Term 3 (Week 7) explicitly requires students to 'discuss the use of alternative energies and their environmental impact'. While this represents a rare explicit alignment with the green transition within a technical subject, the curriculum focuses on discussion rather than practical application; students are not taught the technical competencies required to develop these alternative energy systems.

Table 5: Themes from South African Policy and Regulatory Framework documents

Policy Theme	DBE Strategic Plan 2025 - 2030	Climate Change Act 22 of 2024	Department of Transport Revised Strategic Plan (2020-2025)	National CC Response White Paper
Renewables and non-renewables, sustainability	0	A sustainable economy and society depend on healthy ecosystems. Enhancing these vital services is essential for an effective and efficient climate response (1)	(0)	The Renewable Energy Flagship Programme (1); Climate policies must prioritize the poor and vulnerable, upholding human dignity while pursuing environmental, sustainability (1)
Alternative, green fuels, energy efficient	0	Alternative measures to reduce greenhouse gas emissions (1)	Electric Vehicles (EVs) to eliminate tailpipe emissions and maximize energy efficiency (1); Energy Efficient Maritime Industry (1)	Climate-friendly choices depend on access to safe, reliable alternatives and the awareness to use them (1); Carbon taxes help promote energy efficiency and drive research, development, and

				technological innovation (1); Incentives include lower taxes on cleaner fuels and support for energy efficiency measures (1)
Waste Management, recycle, upcycle	0	Accurate monitoring of emissions and carbon sinks is required for all stationary, mobile, agricultural, and industrial processes (1)	0	The Waste Management Flagship Programme will assess the sector's GHG mitigation potential (1); exploring waste-to-energy opportunities (1)
Ocean acidification	0	0	0	Currently, the global climate is changing much more rapidly because of global warming, leading to ocean acidification (1); Marine ecosystems and species are at risk from ocean acidification (1)

Atmospheric and environmental pollution	0	Approved pollution prevention plans as contemplated in Section 29 of the National Environmental Management: Air Quality Act (1)	To prevent and combat pollution of the marine environment by ships (1); Inadequate oversight of port air emissions compromises marine pollution prevention capabilities (1)	Rising atmospheric concentrations of GHGs, primarily carbon dioxide, methane, and nitrous oxide (1)
Climate change and global warming	By building a climate-conscious education system, we prepare learners for a changing world while minimizing climate-driven disruptions (1)	The Act mandates a unified response (1); framing climate change as a core developmental priority (1); strengthens emissions regulation to curb global warming (1); building societal resilience against climate change impacts (1)	the effects of transport activities on climate change and environment, and engage on approaches to avoid or mitigate those effects (1); Increased greenhouse gas emissions raise atmospheric concentrations, accelerating global warming (1)	Climate change is a measurable reality driven by greenhouse gas (GHG) emissions (1); posing significant risks to national social, economic, and environmental stability (1); Evidence indicates that current global warming is primarily driven by human activities associated with industrialization (1)

Carbon cycle, carbon capture, greenhouse gases	0	To ensure a just transition toward a low-carbon economy and society, aligned with national circumstances (1)	Advances sustainable policies and investments to reduce carbon and other harmful emissions across all transport modes (1); In addition to combustion emissions, indirect emissions arise from the production, refining, and transportation of fuels (1)	The Carbon Capture and Sequestration Flagship Programme (1); greenhouse gas (GHG) emissions as the primary driver of anthropogenic climate change (1)
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The Department of Basic Education Strategic Plan 2025–2030 emphasizes quality education for 'meaningful participation in society' and a contribution to a 'prosperous, competitive, and innovative economy. However, it fails to address most of the required themes; it covers only one of the seven, focusing exclusively on climate change. While renewable energy, alternative fuels, energy efficiency, and carbon cycle management contribute to job creation and economic development, they remain among the themes unaddressed in the document. While the

document discusses the impacts of climate change, it fails to address mitigation strategies or innovative methods for curbing its effects.

The Climate Change Act, 2024 (Act No. 22 of 2024) calls for an 'effective climate change response' and a 'just transition' to a low-carbon and climate-resilient economy. It stipulates that public awareness must be strengthened regarding both the drivers and the consequences of climate change. Notably, the Act addresses six of the seven

identified themes, with ocean acidification being the sole exception.

The Department of Transport (DoT) Revised Strategic Plan 2024–2029 (2024), aims to develop transport in an 'integrated, sustainable, resilient, and low-carbon manner. While the plan addresses five of the seven identified themes, it remains silent on waste management, recycling, upcycling, and ocean acidification. While a low-carbon approach is cited as a primary aim of the plan, the document fails to address carbon capture or the broader carbon cycle.

The National Climate Change Response White Paper (2011), mandates that education 'promote and facilitate behavioural change' through a 'comprehensive labour market analysis' aimed at identifying critical resilience skills. Consistent with expectations, the document covers all themes previously identified by the author as central to the article. While the White Paper specifies job creation goals for green sectors, there remains a significant mismatch between the existing curriculum and these industry requirements.

5. Conclusion and Recommendations

In this paper, it became clear that there is a gap between learners' understanding and their ability to participate meaningfully in the green economy. It does not appear, based on CAPS and the lesson plans, that the curriculum adequately capacitates learners with green skills. There are virtually no

"green" subjects and the green element of the curriculum is essentially all, but one subject is very weakly represented. The findings of this study reinforce the observations made by Matsepe & Maluleke (2013) that CCE is not integrated into the CAPS framework.

This paper aimed to evaluate the extent to which Secondary Schools curricula incorporate climate change mitigation, decarbonization, and green shipping practices. The literature demonstrated that learners have sufficient awareness of climate change, but they cannot create links between this awareness and the formulation of mitigation strategies. The reason, chiefly, is that there is a more theoretical outlook to climate change than there is a practical aspect to address it.

Having investigated the lesson plans, CAPS and policy prescriptions and international conventions to which South Africa is party, it becomes clear that South African secondary education is trapped in a "Silo Effect." Environmental literacy is concentrated in theoretical STEM subjects (Geography, Life Sciences), while the "maker" subjects (Mechanical Technology) remain carbon heavy. This creates "stranded skills" in graduates who find their technical proficiency at odds with the maritime industry's net-zero trajectory. This implies that emerging graduates, pending the reform of high school curriculum, will often need re-training or even re-education to bridge the knowledge gap and skills shortage because of the net-

zero demands of the maritime sector. With all this considered, the authors thus make the following recommendations:

Recommendations

Without a deliberate infusion of green competencies into the CAPS framework, the transition to a sustainable economy remains a theoretical goal rather than a practical reality. To bridge this divide, curriculum designers must move beyond superficial mentions of environmentalism and prioritize the technical and cognitive skills required for green industrialization. Failure to do so risks leaving a generation of learners ill-equipped for the labour market of the future.

To align climate education with practical strategy, the Department of Education should replace rote learning with problem-based case studies, such as school-based carbon reduction plans. Partnering with maritime and logistics industries will enable "Green Career" modules that focus on the mechanics of carbon sequestration and the physics of alternative fuels

The current pedagogical disconnect between the Natural Sciences (Geography/Life Sciences) and Mechanical Technology produces graduates who grasp the theory of climate change but lack the practical engineering skills to mitigate it. To bridge this gap, 'Applied Green Technology' modules should be introduced, requiring students to integrate biological concepts, such as

carbon cycles, directly into mechanical design. Furthermore, the technical curriculum must be modernized to include mandatory units on Internal Combustion Engine (ICE) alternatives, specifically hydrogen and electric propulsion, to facilitate a transition away from carbon-intensive fuels

It is incumbent upon South Africa to cultivate a citizenry equipped with global competencies and technical proficiencies necessary for integration into the international labour market. Strategic global partnerships are essential for addressing South Africa's educational deficits, as they facilitate the transfer of technical skills and the systemic elevation of the national curriculum to meet international sustainability standards. South Africa must proactively mitigate the impacts of environmental shift by domesticating educational frameworks established by the United Nations (UN).

Future Studies

This study focused chiefly on secondary sources, analysing the CAPS framework, lesson plans on selected subjects and policy documents governing South Africa's basic education. The findings are thus limited to policy prescriptions, intentions by the CAPS framework and the objectives of curriculum delivery expressed in lesson plans. What the study could not explore was the learners' voices, classroom experience and perceptions on CCE. Therefore, future studies should aim to determine the

current level of awareness and attitudes of maritime students regarding the impact of traditional shipping fuels (HFO) versus

green energy alternatives. This, the authors aim to do in subsequent studies.

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