

Uncovering Climate Change Education-enabling Themes in the South African Grade 7 Natural and Social Sciences School Curricula

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Abstract

Environmental sustainability is perennially threatened by many challenges including drought, flooding, declining biodiversity, pollution, desertification, etcetera. Global warming, an offshoot of the greenhouse effect, is central to most of these environmental issues. Climate change education (CCE) has been touted as the main vehicle for the mitigation of climate change challenges. Accordingly, this study investigated whether the Grade 7 school curricula in South Africa provide for possible integration of CCE in pedagogy. The in-depth scoping review of the school subjects curricula taught in Grade 7 public schools classes suggests that, relative to other subjects, the Natural and Social Sciences provide greater opportunities for CCE. Accordingly, in this interpretive qualitative study, the researcher used content analysis to tease out some of the themes that could enable CCE from the Curriculum and Assessment Policy Statements (CAPS) which guide pedagogy in the two subjects. Aided by the abductive, deductive and inductive modes of extrapolation, the researcher found that there are several themes that could enable CCE in the Grade 7 Natural and Social Sciences subjects. However, the findings also suggest that there is, virtually, no guidance in the policy documents on how to infuse CCE in pedagogy. Furthermore, the literature points to the dearth of research in this area. Accordingly, the researcher recommends that the South African school curriculum be reviewed to accommodate the integration of CCE in pedagogy, and that scholars conduct more studies like this one, globally.

Keywords: Climate change, natural sciences, social sciences, curriculum, pedagogy

INTRODUCTION

The ravaging effects of climate change are fast becoming indelible perennial global and grand scale phenomena. Virtually, hardly a day goes by without news reports detailing catastrophes attributed to climate change in one or the other part of the world. Accordingly, environmental sustainability is threatened by a myriad of challenges such as drought, flooding, widespread vector-borne diseases, loss of biodiversity, pollution and etcetera (Anyanwu, Le Grange & Beets, 2015; Gough, 2024; Solomon et al., 2022; Reddy, 2011; Steg & Vlek, 2009; Yan & Fengfeng, 2008). These and other negative effects of climate change have notably spiralled in South Africa, especially in recent times. For example, the South African average annual temperature has increased to become twice the global average annual temperature of 0.7 °C, concomitantly, natural disasters such as storms and floods have become rife (Igamba, 2023). Undoubtedly, the clarion calls made by, *inter alia*, scholars, politicians, ordinary global citizens and influential international organisations like the United Nations (UN) organisation, that meaningful, impactful and on-going actions be undertaken to circumvent the scourge of climate change are not misplaced.

Notably, there is a sizeable consensus among various stakeholders in education and research as well as other significant role players in society that environment-inclined education must be adopted, refashioned and implemented as a “more proactive, provocative, and purposeful” (Nuangchalerm & El Islami, 2018)

vehicle to address environment sustainability challenges including climate change (Annisa, Kaniawati & Eliyawati, 2024; Eames et al., 2024; Le Grange, 2016; Monroe et al., 2017). For example, in its Sustainable Development Goals (SDGs)-driven 2030 Agenda, among its goals, the UN (2015) has SDG 4 which calls for global citizens to “ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” (p. 35). Significantly, of relevance to this study, SDG 13 urges humanity to “take urgent action to combat climate change and its impacts” (UN, 2015). In the main, researchers acknowledge the role of education in empowering the youth as future leaders who need help to gain awareness, knowledge, skills, attitudes, and values to enable them, to commence now, rather than in the future, to actively participate in pro-environment actions that seek to mitigate climate change (McKenzie, 2021; Monroe et al., 2017; Ojala, 2012). For this reason, various countries, globally, are taking up this challenge by implementing climate change education (CCE) (Boakye, 2015; Ben Zvi Assaraf, Dawson, Eilam, et al., 2024; Cutter-Mackenzie & Rousell, 2019; Eilam, 2023; Vesterinen, et al., 2016).

In the context of South Africa, where this study was conducted, the *National Curriculum Statement Grades R-12*, which is the public-school curriculum, accommodates; albeit exiguously, the possibility of climate change education in pedagogy across various grades and subjects. This is discernible from one of the aims of the national curriculum stated in

respective Curriculum and Assessment Policy Statements (CAPS) used to guide pedagogy in every school subject. These aims include, *inter alia*, “to produce learners that are able to use science and technology effectively and critically showing responsibility towards the environment and the health of others; and demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation” (Department of Basic Education, 2011a, p. 5). The preceding aims amplify the principles of the same curriculum which seek to ensure the realisations of “human rights, inclusivity, environmental and social justice: infusing the principles and practices of social and environmental justice and human rights” (DBE, 2011a, p. 5). However, even though the South African school curriculum underscores the importance of addressing environmental issues including climate change, the curriculum does not state which topics, subjects and grades (except in the Life Orientation Grade 11 CAPS document) should be used to enable the implementation of CCE.

Accordingly, to contribute towards addressing the shortcomings of the school curriculum as stated in the preceding paragraph, there is an urgent need to undertake studies that seek to guide teachers by teasing out, from various school subjects, the themes that could be used by teachers to enable CCE-inclined pedagogy. The literature reviewed for this study suggests that there is a paucity of research that seeks to contribute towards empowering teachers by outlining some of the topics, in

various subjects, that could aid the integration of CCE in pedagogy. For this reason, the purpose of this study is to contribute towards sealing this paucity in the research space, considering the urgency of empowering the global citizenry, especially the youth, regarding the challenges of climate change. This study seeks to answer the question: Which themes in the South African Grade 7 Natural Sciences (NS) and Social Sciences (SS) Curriculum and Assessment Policy Statements could be used to enable the integration of climate change in pedagogy?

Theoretical Framework

In this study, Bernstein’s (2003) concept of curriculum recontextualisation was deemed relevant as it empowers the researcher to determine the criteria for the adaptation of the curriculum content and its refashioning for implementation to fit a specific context. Hence, writing on the concept of curriculum recontextualisation, Nsubuga (2008) asserts that an expert in a specific curriculum can use their knowledge to decide on the criteria for adapting the curriculum content for implementation in another context. In essence, applied to the curriculum and pedagogical space, including in the infusion of CCE, recontextualisation entails adapting a concept or theme and applying it in a new space to fulfil specific curriculum intentions and obligations. Accordingly, in the context of this study, the researcher as ‘the knower’ in the space of environment and sustainability education (ESE), of which climate change is part, has the power to determine the topics from those set

down in the curriculum documents, the ones he deems pertinent to CCE. Likewise, the discussion of various environmental literacy frameworks by McBride et al. (2013) also assisted the researcher to determine the themes that have the potential to enable the infusion of climate change in pedagogy. McBride et al. (2013) highlight various concepts of relevance in the advancement of environment-inclined pedagogy, including CCE. Additionally, since the researcher conceives climate change as an aspect of ESE, Lucas's (1972) seminal work on the triadic approach to the environment-inclined pedagogy, i.e., education, *about*, *in* and *for* the environment was found also useful in enabling the attainment of the purpose of this study. This work by Lucas (1972) has been used for decades and to date scholars in ESE still use it as the basis to guide environment-inclined pedagogy (Kopelke, 2012; Reddy, 2021).

In a nutshell, the triadic approach entails education *about* the environment and the focus here is on sharing information *about* the nature of the environment, the challenges faced by the environment, possible solutions to environmental challenges and etcetera. Education *in* the environment focuses mainly on interacting directly with the environment and is undertaken outdoors to enable learners to experience, firsthand, the real holistic environment and some of the challenges inflicted by humans on the environment. The third aspect, i.e., education *for* the environment is action-oriented and empowers the learners to participate in pro-environment actions aimed at addressing environmental challenges.

Undoubtedly, the three pedagogical practices entailed in the triadic approach can be employed simultaneously for meaningful solution to environmental challenges.

METHOD

In this study, the researcher used an exploratory qualitative research approach with interpretivism as the undergirding paradigm. This strategy was deemed pertinent because the phenomenon under investigation is under-researched (Cresswell, 1994). Furthermore, this approach allows the researcher some room for flexibility and opportunity to “explore diverse dimensions of a phenomenon” (Khan, et al., 2023, p. 96) under investigation. Also, the interpretivist paradigm empowers the researcher as ‘the knower’ in the field of ESE the latitude to subjectively use personal and socially acquired experiences interspersed with the fusion of intuition and cognition (Swanwick, 1994) to cognise, make sense of and determine the potential application of themes for infusion in climate change-inclined education. In this text, owing to the intertwined interconnectedness of the steps used in data collection and data analysis in document content analysis (Zhang & Wildemuth, 2009). these aspects are discussed in the same subsection.

Data collection and analysis

The researcher commenced by conducting a scoping review of various CAPS documents with focus on Grade 7 subjects. The focus on Grade 7 was deemed relevant because this is the exit grade at primary school level in the South African schooling system. It needs to

be noted that the South African schooling system is divided into two bands, namely, the General Education and Training (GET) and the Further Education and Training (FET) bands. The former band is further divided into the following phases, Foundation Phase (Grade R to 3), and the Intermediate Phase (Grade 4 to 6) and the Senior Phase (Grade 7 to 9) while the latter band covers Grades 10 to 12. Most primary schools commence with Grade R and the exit phase is Grade 7. Therefore, the researcher was interested in finding out the extent to which the exit grade at primary school covers CCE. This is significant in the view of the researcher as it would indicate the extent to which primary school learners, at exit level, are exposed to CCE.

In the context of this study and owing to the broad and fluid meanings attached to the concept and processes involved (Hadie, 2024; Levac, Colquhoun & O'Brien, 2010; Wilson, 2014;), scoping entails a rapid, systematic and iterative scanning of curriculum documents to “map the breadth of evidence available on a particular” (Munn et al., 2022, p. 951) set of themes that could be used to enable CCE. It was essential for the researcher to conduct this review to determine whether there are any subjects that provide ‘sizeable’ and pertinent themes that could be used to expose primary school learners to climate change related knowledge.

In this study, the key criteria of exclusion and inclusion entailed in scoping review (Levac et al., 2010) were used to guide the researcher in the identification of the subjects that

contained more themes that could enable the infusion of CCE in Grade 7 pedagogy. This was done by going through the syllabi of all subjects taught in the Grade 7 public schools, namely: Home Language (English), First Additional Language (Afrikaans), Mathematics; Natural Sciences; Social Sciences; Technology; Economic Management Sciences; Life Orientation; Creative Arts. Based on the details contained in the CAPS documents guiding pedagogy in the respective subjects and the expert knowledge of the researcher and through the guidance of the framework selected for this study, all the themes that could not enable CCE implementation were excluded while those that could were selected. Ultimately, the researcher selected NS and SS as the subjects with more CCE-enabling themes.

The scoping review suggested that, relative to the other Grade 7 subjects, Social Sciences and Natural Sciences subjects, respectively, contained more themes that could be used as (a) vehicle(s) for the implementation of CCE. It is also worth mentioning that the Social Sciences subject covers the aspects of History Education and Geography Education, of which the latter contains more themes that could be used to implement CCE.

Upon the completion of the scoping review process, the research commenced with content analysis. In the process of data collection and analysis, the researcher began by reading the CAPS documents of the two subjects (DBE, 2011a; DBE, 2011b) consecutively, more than once, while highlighting the themes that could be used for

CCE. The initial reading, which was cursory, was followed by a meticulous and focused reading to help the researcher conduct a deeper content analysis of the respective subjects. The researcher focussed on all the themes, which are supposed to be covered in a single academic year over the four terms that constitute the academic year.

The process was aided by the theoretical frameworks stated earlier and the three methods of inference pertinent to document content analysis and other qualitative research methods, namely, the deductive, abductive and inductive reasoning. The three modes of inference were used in a complementary manner.

Deductive reasoning was useful in that it empowers the researcher to analyse “qualitative data in the context of existing theory” (Barrett & Younas, 2024, p. 6). In this case, deductive reasoning enabled the researcher to use the three theoretical frameworks selected for this study to make an analysis and apply inference to determine whether a specific theme could be used to implement CCE. Abduction was used because it “recognises the role of the researcher through embracing their prior experience... without undermining the integrity of the research” (Conaty, 2021, p. 2). Accordingly, this approach enabled the researcher to use personal experience, insight, creativity and reflection to determine the themes considered relevant in advancing CCE. In this case the current researcher’s knowledge and experience in the space of ESE and education, in general, were accommodated through this mode of reasoning. The inductive approach was used

because it enabled the researcher to identify relevant themes from the raw document data flexibly without hindrances that are typical of structured methods (Thomas, 2003) such as those used in positivism. For example, in the selection of the topic on “Volcanoes, earthquakes, and floods” (DBE, 2011a, p. 22) as one of the themes to enable CCE in Grade 7, the researcher used his extensive experience in Geography Education, the Environmental Literacy framework (McBride et al., 2013), intuition and inference to conclude that since active volcanoes emit pollutant gases which contribute to global warming, then this topic can be used to integrate CCE in the teaching of Social Sciences.

Therefore, as stated earlier, the researcher collected and analysed data by reading each document meticulously while reflecting and drawing inferences on whether a specific topic in each of the curriculum documents selected for this study could be used to teach CCE. Upon identifying the relevant topics, the researcher used the curriculum documents of the respective selected subjects to glean pertinent information while also using his experience to draw conclusion on how CCE could be implemented using the triadic approach of learning *about*, *in* and *for* the environment. The topics thus identified are indicated in Table 1 and 2, under the heading on results and discussion in this text.

Trustworthiness

To ensure validity and reliability of the process of selecting themes that could be used to enable CCE, the researcher relied on

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personal expert knowledge and adhered to the frameworks selected to guide the conceptualisation of pertinent ESE concepts in this study (Grant & Osanloo, 2014). Furthermore, a colleague with expert knowledge (Stahl & King, 2020) on both ESE and the process of coding and thematising in data collection and analysis was consulted to comment and critique the selection of themes for CCE in the subjects which form focus of this study.

RESULTS AND DISCUSSION

This section focuses on the presentation and discussion of empirical results. Two tables are used to expedite this process. The respective tables highlight some of the topics gleaned from CAPS documents analysed in this study and the researcher conceived as potential enablers of CCE. Table 1 presents some of the topics sourced from the Grade 7 Natural Sciences document while Table 2 focuses on selected topics that could be used in Social Sciences. In each table there is a second column which provides suggestions, informed by the inferences of the researcher and the information gleaned from the CAPS documents, on how the triadic approach, i.e., education *about, in* and *for* the environment, postulated by Lucas (1972) to ESE could be used to facilitate the implementation of CCE.

As indicated in tables 1 and 2, above, the findings of this study suggest that there are numerous topics that could be used to enable CCE in Grade 7 Natural Sciences and Social Sciences subjects in South African schools. In recent times, the interface between some of

these topics and climate change have received tangible attention both in the scholarly terrain and the media. For example, the connection between climate change and issues like “biodiversity” and “sources of energy”, which are covered in the Grade 7 Natural Sciences, and the topic on “population growth” covered in the Grade 7 Social Sciences finds extensive expression both in media and scholarly spaces. Additionally, albeit to a very limited extent, the curriculum documents do provide some pointers on the aspects that could form the focal point of pedagogy in certain topics.

For example, the Grade 7 Natural Sciences CAPS document provides for the coverage of issues related to “non-renewable sources of energy such as fossil fuels (coal, oil, natural gas) and nuclear fuels (such as uranium) ... and renewable sources of energy such as hydro power, wind, sunlight, biofuel (wood)” (DBE, 2011a, p. 26) when presenting the topic on “sources of energy”. Likewise, the Grade 7 Social Sciences CAPS document suggests that when addressing the topic on “Volcanoes, earthquakes, and floods”, teachers should, *inter alia*, focus on the “effects of earthquakes – including injury and loss of life, disease, displacement of people, damage to infrastructure, fires and tsunamis” (DBE, 2011b, p. 22). Nevertheless, the curriculum statements do not provide guidance on how CCE could be integrated in the teaching of these topics. Accordingly, this researcher provides some suggestions in the respective tables on how CCE could be integrated in some of the topics.

Table 1: Some of the topics that could enable climate change education in Grade 7: Natural Sciences

TOPIC	PEDAGOGICAL APPROACH
The biosphere	<p data-bbox="842 349 1353 454">(as guided by the triadic approach: pedagogy <i>about</i>, <i>in</i> and <i>for</i> the environment)</p> <p data-bbox="842 477 1353 723">The focus here is the planetary spaces “where life exists and includes the lithosphere (soil and rocks), hydrosphere (water), and atmosphere (gases)” (DBE, 2011a, p. 17.) Furthermore, attention is given to the needs (e.g., water, soil, energy and gases) of living things.</p> <p data-bbox="842 745 1353 1137">Here, teaching <i>about</i>, <i>in</i> and <i>for</i> the environment is possible with CCE as the focal point, e.g. focus can be on how human actions pertaining the generation of electricity contribute to the emission of greenhouse gases that cause global warming and climate change. Outdoor activities where the impact of acid rain could be observed and how electric power station pollute the atmosphere, culminating in global warming, can be undertaken.</p>
Biodiversity	<p data-bbox="842 1167 1353 1480">Pedagogy could focus on the various species on earth (and why there is a need to sustain biodiversity), and how human actions such as the emission of greenhouse gases lead to global warming, the rising temperature and pollution of water culminating in the death and even extinction of some organisms (plants and animals).</p> <p data-bbox="842 1503 1353 1682">Furthermore, teachers can also engage learners in discussions on and undertaking of actions to promote biodiversity. Local case studies could be effective in this respect.</p>
Properties of materials	<p data-bbox="842 1704 1353 1989">This topic focuses on, <i>inter alia</i>, the production of metals and plastics. Therefore, this topic could be used to enable CCE by focusing on the impact of the process of producing materials such as metals and plastic when fire generated through fossil fuels emits greenhouse gases to the environment.</p>

Sources of energy	<p>The focus here is on “non-renewable sources of energy such as fossil fuels (coal, oil, natural gas) and nuclear fuels (such as uranium) ... and renewable sources of energy such as hydro power, wind, sunlight, biofuel (wood)” (DBE, 2011a, p. 26)</p> <p>The focus can be on discussions on the process of energy generation and its impact on the environment, especially how it contributes to climate change. Furthermore, discussion on the impact of fossil fuels <i>vis-à-vis</i> the use of wind to generate energy on climate change is possible too. Field trips to power stations could be undertaken and learners could also be engaged in the discussions and potential participation in activism advocating for green energy.</p>
Heat transfer	<p>The section caters for discussion of heat transfer through “conduction, convection and radiation” (DBE, 2011a, p. 27).</p> <p>The teacher could discuss how heat, which warms our surroundings, is trapped by gases around us and how too much concentration of these gases in the air can lead to global warming and climate change</p>

Table 2: Some of the topics that could enable climate change education in Grade 7: Social Sciences

TOPIC	PEDAGOGICAL APPROACH (as guided by the triadic approach, i.e., pedagogy <i>about, in and for</i> the environment)
Volcanoes, earthquakes, and floods	<p>This topic focuses on aspects such as what a volcano entails and why it occurs (DBE, 2011b). Furthermore, it caters for discussions on the “effects of earthquakes – including injury and loss of life, disease, displacement of people, damage to infrastructure, fires and tsunamis” (DBE, 2011b, p. 22). The emission of gases when volcanoes occur and how these gases contribute to climate change could form the point of discussion in pedagogy. Also, case studies of real global events can also be the point of focus.</p>

Population growth and change (Focus: World)	This topic accommodates, <i>inter alia</i> , learning about disease (DBE, 2011b, p. 23). This could be used to discuss the impact of climate change on the spreading of diseases. Also, the issue on the clearing of land for housing and how this contributes to climate change can also form part of pedagogy.
World population growth	The topic accommodates pedagogy that focuses on the need for more food production as a corollary of population growth and limited land, which leads to the clearing of vegetation and climate change being an ultimate outcome emanating from an increase in carbon dioxide (CO ₂) due to a reduction in (green) vegetation.
Natural resources and conservation in South Africa	This theme focuses on and provides for pedagogical opportunities that relate to “natural resources on earth – including water, air, forests, soil, animal and marine life... use and abuse of selected examples” (DBE, 2011b, p. 24). This topic also zooms into water conservation with focus on “disappearing wetlands and why conservation is necessary” (DBE, 2011b, p. 24). CCE could focus on case studies pertaining to climate change induced disappearance of wetland and the need for action to avert this scourge.

Regarding the contemporaneity of some of the topics identified as potential enablers of CCE in this study, a few points are worth mentioning. This is essential to amplify the need to integrate these and other relevant topics in CCE-inclined pedagogy at school level. For example, there is some evidence to suggest that, over the years, volcanic eruptions have contributed to an increase in greenhouse gas emissions thereby

enabling global warming and climate change (Sadler & Grattan, 1999). Accordingly, Robock (2000, p.161) writes that “volcanism has long been implicated as a possible cause of weather and climate variations”. This point is accentuated by Aubry et al., (2022) who state that “volcanic eruptions shape Earth’s landscapes, have built up Earth’s atmosphere and are powerful drivers of environmental and climate change” (p.

2). Undoubtedly, within the context of the South African Grade 7 Social Sciences curriculum, the topic on “Volcanoes, earthquakes, and floods” can be used to enable CCE.

Likewise, empirical evidence suggests that population growth contributes to climate change (Dodson et al., 2020). For example, an increasing global population necessitates provision of basics such as accommodation, food, water, energy, economic development and numerous other requirements. Invariably, practices like the clearing of vegetation and an increase in industrialisation, to meet the demands of the growing population, contribute to an increase in global warming because industries emit greenhouse gases and the clearing of vegetation decreases natural users (i.e., plants) of carbon dioxide (Martine, 2009). Furthermore, an increase in population is linked to a reduction in biodiversity because the removal of vegetation for meeting accommodation needs leads to the reduction in certain species which use(d) the cleared vegetation as their habitat and niche. Additionally, population growth is associated with the spreading of diseases. Significantly, apart from population growth as a contributor to the spreading of diseases, scientists have found that climate change, which is partly a product of population growth, leads to an increase

in vector-borne diseases like malaria (Obame-Nkoghe, 2024; Ojwang, 2024). Undoubtedly, topics like biodiversity, population growth and change and all the others highlighted in Tables 1 and 2, respectively, could be used to enable CCE. Certainly, this study did not intend to exhaust the list of topics that could be used to enable CCE in the selected subjects. Therefore, there might be more themes that could enable CCE in the respective subjects selected for examination and analysis in this study.

Significantly, considering the expansive global empirical research which suggests the implementation of EE, of which CCE is part, is characterised by challenges (Jorgenson, Stephens & White, 2019; Phuong, Biesbroek & Wals, 2018; Tolppanen, S & Sirpa, 2022) it is conceivable that the infusion of CCE may not be easy to attain. Accordingly, the current researcher provides a few suggestions on what could be done by various stakeholders in education to offset some of the challenges of CCE implementation. These are entailed in tables 1 and 2 as already discussed and in the conclusion.

CONCLUSION

This study investigated whether there are any topics that could be used to enable CCE in the Grade 7 school subjects in South Africa. The findings

suggest that there are numerous topics in Natural Sciences and Social Sciences subjects that could be used to advance CCE, particularly, by using the *triadic approach*, i.e., education *about, in* and *for* the environment, espoused by Lucas (1972), that has been undisputed as a vehicle for advancing environment-inclined pedagogy over the years. However, the study also revealed that although there are scanty pointers in the South African *National Curriculum Statement Grades R-12* that could be used by teachers to enable CCE in the two subjects, it is worth noting that, generally, the curriculum documents do not provide guidance on how CCE should be integrated. Accordingly, it behoves the South African Ministry of Education to revise the curriculum to empower teachers on how the topics contained in respective curriculum statements could be used to enable CCE. Furthermore, owing to the paucity of research like the one entailed in this text, scholars, globally, especially in countries whose school curricula lack clear indicators on how CCE should be integrated in pedagogy, have a responsibility to conduct numerous studies such as the current one to contribute towards empowering curriculum developers and implementers with ideas on how CCE could be enabled and advanced in pedagogy.

REFERENCES

- Annisa D.P., Kaniawati, I & Eliyawati, E. 2024, STEM ESD-Based Learning with "Arduino Uno-Based Trash Can" to Improve Students' Critical Thinking Skills and Sustainable Awareness in Learning Environmental Pollution, *Jurnal Penelitian dan Pembelajaran IPA*, vol. 10, no. 1, pp. 115-145. DOI: <https://doi.org/10.30870/jppi.v10i1.24008>.
- Anyanwu, R, Le Grange, L & Beets, P 2015. Climate change science: the literacy of geography teachers in the Western Cape Province, South Africa, *South African Journal of Education*, vol. 35 no.3, pp.1-9.
- Aubry, TJ, Farquharson, JI, Rowell, CR, Watt, SF, Pinel, V, Beckett, F, Fasullo, J, Hopcroft, PO, Pyle, DM, Schmidt, A & Sykes, JS 2022. Impact of climate change on volcanic processes: Current understanding and future challenges, *Bulletin of Volcanology*, vol.84, no.6, 1-11. <https://doi.org/10.1007/s00445-022-01562-8>
- Barrett, D & Younas, A 2024, Induction, deduction and abduction. *Evidence-Based Nursing*, vol.27, no.1, pp. 6-7. <https://doi.org/10.1136/ebnurs-2023-103873>
- Ben Zvi Assaraf, O, Dawson, V., Eilam, E, Gokpinar, T, Goldman, D, Naugauker, N, Putri, GAP, Subiantoro, AW, Tolppanen, S, White, PJ, Widdop Quinton, H, & Dillon, J 2024. Climate change education implementation: The voices of policymakers, professional development providers, and teachers in five

- countries, *International Journal of Science Education*, vol. 23, 14572. <https://doi.org/10.1080/09500693.2024.2314572>
- Bernstein, B. 2003. Social class and pedagogical practice. In Bernstein, B., *The Structuring of pedagogic discourse, Volume IV: Class, codes and control* (Chapter 10, pp.196-217), London: Routledge
- Boakye, C 2015. Climate Change Education: The Role of Pre-Tertiary Science Curricula in Ghana, *SAGE Open*, vol. 5, no. 2, pp. 1-10. DOI: 10.1177/2158244015614611
- Conaty, F 2021. Abduction as a Methodological Approach to Case Study Research in Management Accounting — An Illustrative Cas, *Accounting, Finance & Governance Review*, vol. 27. <https://doi.org/10.52399/001c.22171>
- Creswell, JW 1994. *Research design: Qualitative and quantitative approaches*. London: Sage Publications.
- Cutter-Mackenzie, A & Rousell, D, 2019. Education for what? Shaping the field of climate change education with children and young people as co-researchers, *Children's Geographies*, vol. 17, no.1, pp.90-104.
- Department of Basic Education 2011a. *National curriculum statement (NSC), Curriculum and assessment policy statement (CAPS) Natural sciences senior phase grades 7 – 9*. Pretoria: Government Printer.
- Department of Basic Education, 2011b. *National curriculum statement (NSC), Curriculum and assessment policy statement (CAPS) Social sciences senior phase grades 7 – 9*. Pretoria: Government Printer.
- Dodson, JC, Dérer, P Cafaro, P & Götmark, F 2020. Population growth and climate change: Addressing the overlooked threat multiplier, *Science of the Total Environment*, vol. 748, pp. 1-10. <https://doi.org/10.1016/j.scitotenv.2020.141346>
- Eames, CW, Monroe, MC, White, PJ & Ardoin, NM, 2024. Engaging Environmental Education Through PISA: Leveraging Curriculum as a Political Process, *Australian Journal of Environmental Education*, vol.40, no. 3, pp.601-611.
- Eilam, E 2023. Teaching climate change in primary schools: an interdisciplinary approach, *Australian Journal of Environmental Education*, vol. 39 no.1, pp.125-127.
- Gough, N., 2024. Science Fiction, Global Warming and Environmental Education in the Capitalocene, *Australian Journal of Environmental Education*, vol. 40 no.3, pp.537-548.
- Grant, C & Osanloo, A 2014. Understanding, selecting, and integrating a theoretical framework in dissertation research: creating the blueprint for your “house,” *Administrative Issues Journal: Connecting Education, Practice, and Research*, vol.14, no.2, pp. 12-26. doi: 10.1046/j.0266-4909.2003.0005.x

- Hadie SNH 2024. ABC of a scoping review: a simplified JBI scoping review guideline, *Education in Medicine Journal*, vol. 16, no.2, pp. 85–197. <https://doi.org/10.21315/eimj2024.16.2.14>
- Igamba, J 2023. Climate Change In South Africa: 21 Stunning Facts About South Africa’s Climate Breakdown. Accessed from: <https://www.greenpeace.org/africa/en/blogs/54171/climate-change-in-south-africa-21-stunning-facts-about-south-africas-climate-breakdown/>, On 28 November 2024
- Jorgenson, SN, Stephens, JC & White, B 2019. Environmental education in transition: A critical review of recent research on climate change and energy education, *The Journal of Environmental Education*, vol.50.no.3, pp.160-171.
- Khan, JA, Raman, AM, Sambamoorthy, N & Prashanth, K 2023. Research methodology: Methods, approaches and techniques. Tamil Nadu, India: San International Scientific Publications
- Kopelke, D 2012. *Environmental education through listening to children*. D.Ed. Thesis, Queensland, Australia: Queensland University of Technology.
- Le Grange, L 2016. Think piece: Sustainability education and (curriculum) improvisation, *Southern African Journal of Environmental Education*, vol. 32, pp.26-36.
- Levac, D, Colquhoun, H & O’Brien, KK 2010. Scoping studies: advancing the methodology. *Implementation Science*, vol.5, pp. 1-9.
- Lucas, AM 1972. *Environment and environmental education: Conceptual Issues and Curriculum Implications*. PhD Thesis, Ohio: The Ohio State University.
- Martine, G 2009. Population dynamics and policies in the context of global climate Change”. In Guzmán, J.M., Martine, G., McGranahan, G., Schensul, D. & Tacoli, C. (Eds), *Population dynamics and climate change* (pp. 9 – 30). New York: United Nations Population Fund (UNFPA) and International Institute for Environment and Development (IIED).
- McBride, BB, Brewer, CA, Berkowitz, AR, & Borrie, WT 2013. Environmental literacy, ecological literacy, Ecoliteracy: What do we mean and how did we get here? *Ecosphere*, vol.4, no.5, pp.1-20. Article 67.
- McKenzie, M 2021. Climate change education and communication in global review: tracking progress through national submissions to the UNFCCC Secretariat, *Environmental Education Research*, vol.27, no.5, pp.631-651, DOI: 10.1080/13504622.2021.1903838.
- Monroe, MC, Plate, RR, Oxarart, A, Bowers, A & Chaves, WA 2017. Identifying effective climate change education strategies: a systemic review of the research, *Environmental Education*

- Research*, vol.26, no.6, pp.791-812.
- Munn, Z, Pollock, D, Khalil, H, Alexander, L, Mclnerney, P, Godfrey, CM, Peters, M & Tricco, AC 2022. What are scoping reviews? Providing a formal definition of scoping reviews as a type of evidence synthesis, *JBIE Evidence Synthesis*, vol.20, pp.950-952. <https://doi.org/10.11124/JBIES-21-00483>
- Nsubuga, Y 2008. A Bernstein analysis of the integration of natural resource management in the curriculum of a rural disadvantaged school, *Southern African Journal of Environmental Education*, vol.25, 98-112.
- Nuangchalerm, P & El Islami, RAZ 2018. Context of Science on Environmental Conservation: Comparative Study between Thai and Indonesian Novice Science Teacher Students, *Jurnal Penelitian dan Pembelajaran IPA*, vol.4, no.1, pp.60-67. <https://doi.org/10.30870/jppi.v4i1.3349>
- Obame-Nkoghe, J, Agossou, AE, Mboowa, G 2024. Climate-influenced vector-borne diseases in Africa: a call to empower the next generation of African researchers for sustainable solutions, *Infectious Diseases of Poverty*, vol.13, Article #26, 2-10. <https://doi.org/10.1186/s40249-024-01193-5>
- Ojala, M 2012. Hope and climate change: the importance of hope for environmental engagement among young people, *Environmental Education Research*, vol.18, no.5, pp. 625-642. DOI: 10.1080/13504622.2011.637157
- Ojwang, JA 2024. African health experts warn of climate change & rising vector-borne diseases. Accessed on 23 June 2024 from <https://news.mongabay.com/2024/05/african-health-experts-warn-of-climate-change-rising-vector-borne-diseases/>
- Phuong, LTH, Biesbroek, GR & Wals 2018. Barriers and enablers to climate change adaptation in hierarchical governance systems: the case of Vietnam, *Journal of environmental policy & planning*, vol. 20. No.4, pp.518-532.
- Reddy, C 2011. Environmental education and teacher development: Engaging a dual curriculum challenge, Stellenbosch: Stellenbosch University Language Centre.
- Reddy, C 2021. Environmental education, social justice and teacher education: Enabling meaningful environmental learning in local context, *South African Journal of Higher Education*, vol.35, no.1, pp. 161-177. <https://doi.org/10.20853/35-1-4427>
- Robock, A 2000. Volcanic eruptions and climate, *Reviews of Geophysics*, vol.38, pp. 191-219
- Sadler, J & Grattan, J 1999. Volcanoes as agents of past environmental change. *Global and Planetary Change*, vol. 21, no.1-3, pp. 181-196. [https://doi.org/10.1016/S0921-8181\(99\)00014-4](https://doi.org/10.1016/S0921-8181(99)00014-4)

- Solomon, CG, Salas, RN, Malina, D, Sacks, CA, Hardin, CC, Prewitt, E, Lee, TH, Rubin, EJ 2022. Fossil-Fuel Pollution and Climate Change, *New England Journal of Medicine*, vol.387, pp.1969-1978. DOI: 10.1056/NEJMra2200092
- Stahl, NA & King, JR 2020. Expanding approaches for research: Understanding and using trustworthiness in qualitative research, *Journal of Developmental Education*, vol.44, no.1, pp.26-28.
- Steg, L & Vlek, C 2009. Encouraging pro-environmental behaviour: An integrative review and research agenda, *Journal of Environmental Psychology*, vol. 29, pp.309-317
- Swanwick, K 1994. Qualitative research: The relationship of intuition and analysis, *Bulletin of the Council for Research in Music Education*, vol.122, pp. 57-69
- Thomas, DR 2003. *A General Inductive Approach for Qualitative Data Analysis*. Auckland, New Zealand: School of Population Health, University of Auckland.
- Tolppanen, S & Sirpa K 2022. Limits of caring: pre-service teachers' reasons for not taking high-impact actions to mitigate climate change, *Environmental Education Research*, vol. 28, no. 7, pp. 986-1002.
- United Nations 2015. Transforming our world: The 2030 Agenda for sustainable development (A/RES/70/1). New York, NY: UN General Assembly. Retrieved from <https://sdgs.un.org/2030agenda> on 20 August 2024
- Vesterinen, VM, Tolppanen, S & Aksela, M 2016. Toward citizenship science education: what students do to make the world a better place? *International Journal of Science Education*, vol. 38, no.1, pp.30-50. DOI: 10.1080/09500693.2015.1125035
- Wilson V. 2014. Research Methods: Scoping Studies, *Evidence Based Library and Information Practice*, vol.9, pp.97-99.
- Yan, L & Fengfeng, L 2008. Building a harmonious society and ECE for sustainable development. In Pramling Samuelsson, I. & Kaga, Y. (Eds.); *The contribution of early childhood education to a sustainable society*, Paris: UNESCO.
- Zhang, Y & Wildemuth, BM 2009. Qualitative analysis of content. In B. Wildemuth (Ed.), *Applications of social research methods to questions in information and library science* (pp.308-319). Westport, Connecticut: Libraries Unlimited