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Partnership

RESEARCH BRIEF
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Assessing the training and teaching materials to implement climate change education in South Africa

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RESEARCH OVERVIEW

More frequent and powerful extreme events, including flooding, droughts, and rising heat waves, are expected in a country like South Africa, which is particularly exposed to the effects of climate change. Because of the uncertainty surrounding climate change, everyone must be prepared to meet any unexpected event in the future, but most importantly, to make informed decisions about it now. The study of climate change's causes, effects, and consequences, as well as solutions, plays an essential role in education. As a result, to design and carry out effective climate change education (CCE), teachers must acquire extensive knowledge and develop locally relevant pedagogical strategies.

Teachers interested in tackling climate change confront the issue of incorporating it into their already overburdened school curriculum and the lack of contextualized resources pertinent to their learners' environments. Theoretically, teaching socio-scientific concepts about climate change is challenging because it involves many different disciplines. Due to its moral and ethical repercussions, it is also a contentious subject to debate in the classroom. Teachers are currently worried about how to address climate change and what efficient teaching methods to employ. Studies reveal that teachers feel underprepared in their science content backgrounds to adequately handle climate change science in their courses.

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PROJECT SUMMARY

This research brief evaluates the training and teaching materials used in secondary school teachers' professional development (TPD) to incorporate climate change education (CCE) into the curriculum, using a South African case study from the KIC-CCE project. The study employs Merrill's First Principles of Instruction (FPI) to analyse the effectiveness of TPD and its contributions to CCE instruction.

KEY FINDINGS

- The "Sustainability Practices Box" was utilised to stimulate **active learning and address climate change impacts** on water provision, soil management, biodiversity conservation, and food production.
- Learning was **promoted through real-world problems**, activation of teachers' existing knowledge, demonstration of new knowledge using various methods, and application of knowledge in lesson plan design and reflective sessions.
- Teachers **integrated new knowledge into school and community projects**, and their creativity was fostered through storytelling and role-play activities.
- The **training materials and methods effectively incorporated FPI principles**, enhancing teachers' ability to teach climate change concepts and implement related projects in their schools.

OBJECTIVES

This research brief is based on the assessment of the training and teaching materials used in secondary school teachers' professional development (TPD) to incorporate CCE into the curriculum. For this purpose, a South African case study framed in the KIC-CCE project [2] was chosen. Therefore, based on Merril's First Principles of Instruction (FPI), the effectiveness of TPD and contributions to CCE instruction in secondary schools was analyzed through the following research questions.

- What teaching materials related to climate change are used during the KIC- CCE training to improve climate change education?
- To what extent were the First Principles of Instruction present during the KIC- CCE training?
- How were the First Principles of Instruction implemented during the KIC-CCE training?

FIRST PRINCIPLES OF INSTRUCTION: A FRAMEWORK TO ASSESS COURSE QUALITY

A set of five prescriptive instructional principles that may be applied to every learning circumstance which are based on three properties (Figure 1). First, learning will be promoted directly by implementing these five principles. Second, these principles can be implemented in any instructional method. Third, these principles, rather than being learning-oriented, are design-oriented.

PROBLEM STATEMENT

The 2030 Agenda of the United Nations and its 17 Sustainable Development Goals [1] link education and climate change, aiming for inclusive and equitable education while combating climate change. South Africa, significantly impacted by climate change and a notable contributor to global greenhouse gas emissions due to its fossil-fuel-powered economy, does not yet prioritise education as a strategic resource to address these issues. This results in insufficient interaction between the education and environment sectors, fragmenting scientific knowledge, policy, and practice. The absence of a comprehensive national strategy leads to a lack of coordination among governmental entities in combating climate change.

Secondary school teachers face challenges due to a lack of contextualised resources relevant to learners' environments and the education system's capacity to address global issues. Teachers need a general understanding of basic scientific concepts related to climate change and sustainability to effectively teach this content. The lack of teaching capacity, effective climate change pedagogical practices, and curriculum-aligned project-based learning further complicates this challenge. Additionally, achieving this goal requires learner-centred, participatory, and inclusive instruction.

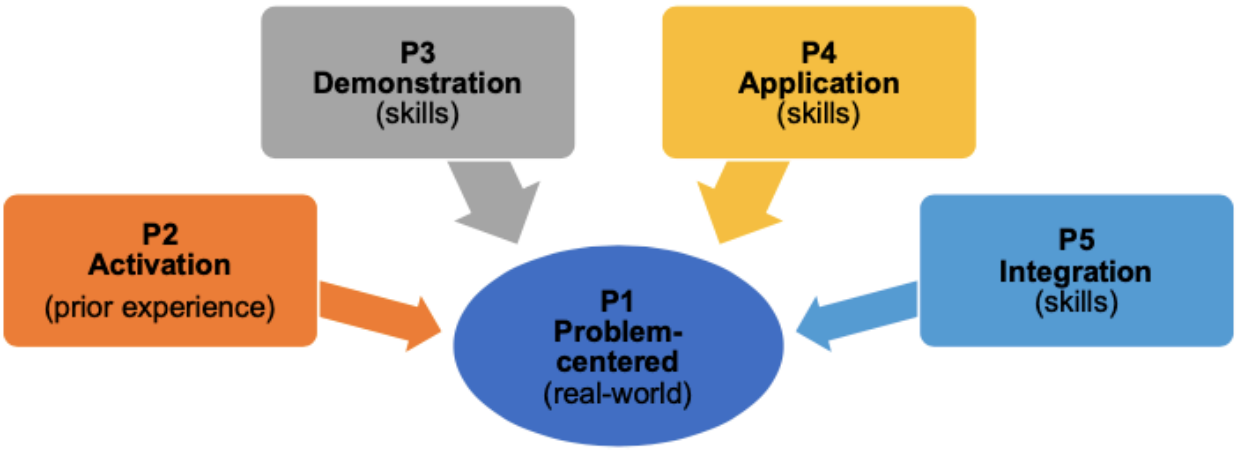

Figure 1: The first principles of instruction required for effective learning (Merrill, 2002)

[1] Goal 4 "Quality Education" and goal 13 "Climate Action".

[2] In 2019, the Keep It Cool: Climate Change Education (KIC-CCE) project in partnership with VVOB-Education for Development, GreenMatter and FUNDISA organizations started. The Rhodes University, University of Fort Hare, University of KwaZulu-Natal, University of Zululand, and the University of Venda were involved. The project aims to make CCE part of the school and classroom practice and the surrounding communities. The project's overall objective is to utilise the education sector as a strategic resource in South Africa's transition towards a more climate-resilient society. Two hundred geography and natural sciences teachers, from grade 10 to 12 and grade 7 to 9, respectively, were trained in climate change and environmental education. One hundred secondary schools in three provinces: Eastern Cape, KwaZulu-Natal, and Limpopo, were chosen.

KEY FINDINGS

PREVALENCE OF FPI AT TEACHERS' LEVEL

- Learning was promoted using real-world problems that illustrate climate change impacts on water provision, soil management, biodiversity conservation, and food production.
- The "Sustainability Practices Box" was used to stimulate active learning in the classroom aimed to mitigate, adapt to, or build resilience in the face of climate change.
- Teachers' existing knowledge was activated as a foundation for new knowledge through discussions, whiteboards, group work activities, take-away assessments, on-course tasks, and while creating new lesson plans.
- New knowledge was demonstrated through Examples and non-examples for concepts, case studies, demonstrations for procedures, and visualization for processes related to climate change
- Learning was promoted when teachers' knowledge was applied for designing their own lesson plans, the Portfolio of Evidence, and during reflective sessions.
- Teachers' new knowledge was integrated into the learners' world through the implementation of school and community change projects. Besides, Teachers' creativity was promoted through storytelling and role-play activities.

PREVALENCE OF FPI AT STUDENTS' LEVEL

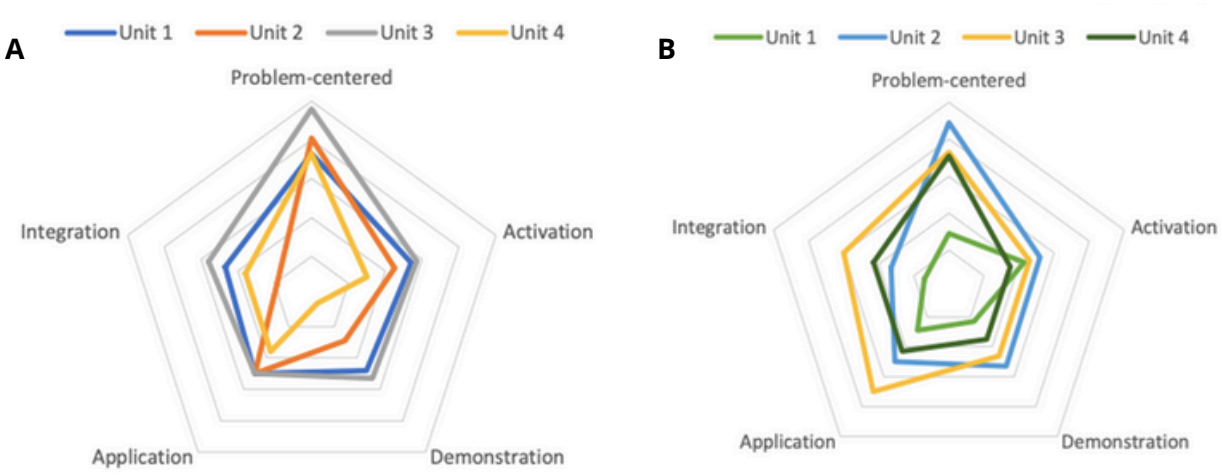

Figure 2: The prevalence of First Principles of Instruction (FPI) at the student level in (A) Natural Science and (B) Geography

At the student level the distribution of lesson plans and examples for Geography and Natural Science subjects was not equal. Indeed, out of 61 lesson plans and examples, geography has 15 lesson plans and seven examples, whereas natural sciences has 27 and 12.

In general, the FPI are present in both subjects throughout the lesson plans and examples included in the units. They follow a relatively similar pattern but in a different extension. The most visible difference is in the Demonstration principle when giving examples and non-examples for concepts and providing visualization for a process in geography and natural sciences, respectively. In addition, Unit 4 does not provide enough demonstration for both subjects. One reason for this could be because they are examples from prior Units (1,2,3), in which the lesson plan does indeed include more significant details. In other words, the examples in Unit 4 are extensions of Unit 1, 2, and 3 lesson plans. The last unit aims to encourage learners to develop their own school and community change projects for both subjects. Therefore, flexibility and autonomy on the topic and the associated teaching method are expected from teachers. The LORET teaching methodology, on the other hand, is strongly recommended for project design and implementation.

DISCUSSION

The close relationship between CCE and TPD becomes evident when examining climate change. The rationale is that an objective CCE debate cannot occur unless relevant challenges in a contextualized scenario are included.

- **The role that CCE plays in South Africa** is an immediate call to action! The country is extremely sensitive to climate change's effects. Especially, the provinces of Limpopo, Eastern Cape, and KwaZulu-Natal would experience more frequent floods and severe rainfall. The South African education system enforces CCE at a policy level, however, it remains a weakness in practice due to a lack of coherence and inter-departmental collaboration among governmental institutions and local stakeholders.
- **The importance of TPD in climate change** at a school level is still not strong enough. As a result, teachers are unsure which teaching methods or effective educational strategies to employ. TPD is crucial for scientific and social reasons, meaning that training teachers and providing them with relevant teaching materials are not enough. Socio-cultural issues within and beyond the classroom impact climate change education and climate action.
- No studies related to climate change and the use of the FPI were discovered. Therefore, its **contribution in climate change instruction** and potential set of criteria for measuring instruction quality.
- **The climate change teaching materials used during the training are locally relevant for the South African context.** They provide teachers with a conceptual foundation for the topic linked to the CAPS purpose and principles. Teachers are also educated on the teaching methods and strategies to adopt to foster change-oriented learning based on the FUNDISA approach as shown in Figure 3.

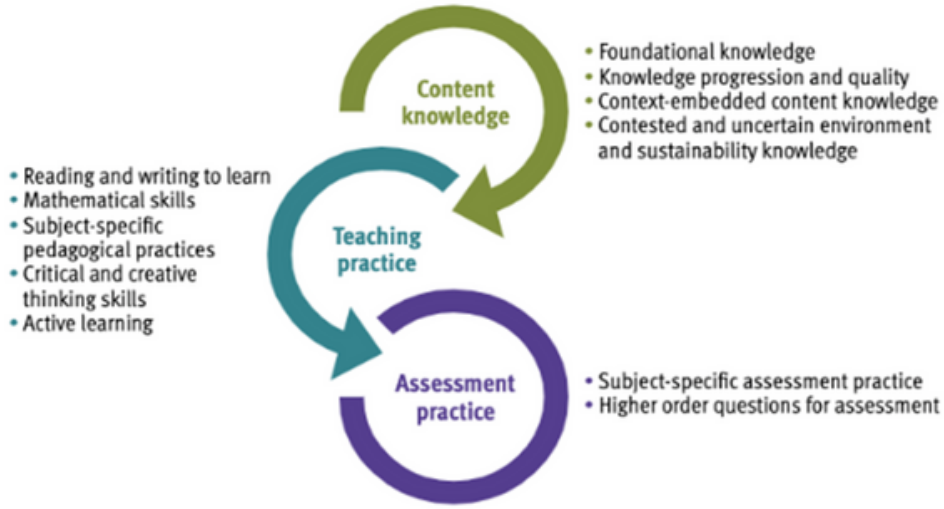

Figure 3: The Fundisa approach for teachers and educators adopted in their professional development courses (Schudel et al., 2021, p.13)

CONCLUSION

South Africa is severely impacted by climate change, making it a top priority on the government's agenda. Education is crucial for sustainable development and combating climate change, as it equips students with the necessary attitudes, information, skills, and values for informed decision-making. However, education is not yet seen as a strategic sector for climate change mitigation and adaptation, leading to a fragmentation between scientific knowledge, policy, and practice. There is a lack of climate change-focused education and curriculum, posing challenges for teachers in terms of professional development and locally relevant teaching materials. Research on teachers' professional development in climate change is scarce, which this study confirms.

In conclusion, while a good education is essential, it is insufficient without providing teachers with content and pedagogy knowledge. Effective teaching strategies are particularly needed for controversial topics like climate change, which involve additional ethical considerations. This thesis emphasizes the importance of Climate Change Education (CCE) in promoting sustainability, addressing challenges, and offering solutions.

RECOMMENDATIONS

Adopt Merrill's First Principles in the future professional development courses and learning and teaching support materials.

- This instructional design model is highly recommended to the Department of Basic Education because of its strategic and planning significance in curriculum and pedagogy in formal educational contexts.
- These principles have proven to help develop learning courses while contributing to the existing research gap between climate change education and teachers' professional development.

Use of climate change games and simulations as educational and engagement tools in primary and secondary schools.

- This technique is gaining traction as an effective strategy to involve students in climate change education.
- According to Wu & Lee (2015), it is an innovative educational technique that combines a range of learning areas to encourage creativity, fun, and autonomy while also involving students in solving climate change challenges firsthand.

Promote climate change as a significant component of science education programs while keeping the environmental education and education for sustainable development approaches in mind.

- CCE should take a truly multidisciplinary approach, incorporating it into ESD and, more significantly, teaching climate change as a discipline rather than a cross- disciplinary subject.

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