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Implementation of Teacher Capacitation Programs to Integrate Climate Change Education: The Case Study of Geography Teaching in South African Secondary Schools

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Abstract. Countries all over the world are experiencing the devastating havoc of climate change. Drastic efforts directed at integrating climate change education into the school curriculum in South African Secondary schools have been unsuccessful due to a lack of training support for teachers teaching Climate Change Education in secondary schools. The purpose of this paper was to explore the role of teacher capacitation programs in assisting Geography teacher to integrate climate change education in their lessons. Shulman's Model of Pedagogical Reasoning served as theoretical lenses for the study. Five secondary schools out of twenty which participated in the five days' training program conducted by one higher education institution were purposefully selected. Data for the study was generated through one-on-one semi-structured interviews conducted with five participating Geography teachers in the selected schools according to the geographical location and close proximity to the training provider. It emerged from the data that teachers were lacking content and pedagogical knowledge on Climate Change Education and this capacitation program assisted in bridging that gap. The study concludes that training programs were according to selected Geography teachers' views responsible for the improved pedagogical practices in the classroom. It is therefore recommended that teacher professional development programs on Climate Change Education for Geography teachers be organized on a continuous basis.

Keywords: teacher training; pedagogical practice; climate change education; secondary school

1. Introduction and Background

In the current era of global political and economic instability, with rising inequality and social unrest, climate change education (CCE) should play an important role in society. The devastating effect of climate change on the environment all over the world is a major concern to world leaders and the efforts by the governments in addressing the menace of this global challenge through the organization of different conferences have not yielded the desired result (Pearce, Brown, Nerlick & Koteyco 2015). With the introduction of Curriculum and

Assessment Policy Statement in 2011 the measures aimed at addressing the problem of climate change in South Africa, resulted into integration of CCE into the school curriculum across all subjects (Aylett, 2015). Despite the integration of CCE into the curriculum, little or no result has been achieved in terms of teaching and learning the topic in the classroom (Dawson & Carson, 2020). For instance, it appears from the literature that Geography teachers' literacy levels of climate change are low and are therefore, unable to teach content on climate change (Anyawu, La Grange, & Beets, 2015). It is important to note as stated by Dawson and Carson (2020) that much evidence-based research has not been done on CCE teachers' professional development. Yet, the importance of professional development of teachers in CCE is key to the implementation of Geography curriculum-aligned and locally relevant CCE in the classroom (Drewes, Henderson & Mouza 2018). Despite the role of professional development in increasing teachers' capacitation, concerted efforts have not been made at improving understanding and preparedness to address climate change in terms of research and development (Drewes et al., 2018). Opuni-Frimpong, Essel, Opuni-Frimpong & Obeng (2022) confirm that in Ghana and most African countries, the biggest hurdle to properly teaching Climate Change Education in most subjects was amongst other factors the lack of in-service training for teachers. Furthermore, integrating climate change into the educational system can be a difficult task that necessitates genuine nationalist will, a realistic curriculum development guide, and ongoing work on the part of instructors. A large portion of climate change education (CCE) effectively takes place in the curriculum of a structured school system, and its coordination primarily depends on one key stakeholder – the teacher.

The introduction of CCE into the CAPS document was a welcome development by stakeholders in environmental education, but little or no effort has been made to put in place appropriate training programs to empower teachers in the field of CCE to develop pedagogical skills that will enable them to adequately teach the subject. Smart, Sinclair, Benavot, Bernard, Chabbott, Russell and Williams (2020) in their view noted that CCE teachers do not have appropriate pedagogical skills but use the textbook method of teaching without recourse to the curriculum alignment and locally relevant and effective CCE in their classrooms. According to Shulman's (1986) as cited in Favier, Van Gorp, Cyvin and Cyvin (2021) Pedagogical Content Knowledge (PCK) framework, (future) teachers need to have knowledge in the fields of Pedagogy (P) and Content (C), and knowledge at the intersection of these fields. To be able to plan and implement efficient climate change adaptation education, they must acquire a broad knowledge base. The Keep-It-Cool -Climate Change Education (KIC-CCE) project which five South Africa universities and Fundisa for Change (a non-governmental organization (NGO) with experience in supporting teacher in-service training programs on sustainable development) is expected to fill this gap through the teacher capacitation program. The KIC-CCE project is targeted at conducting continuous professional teacher development (CPTD) for Geography and Natural Sciences teachers by developing and providing CCE materials for these teachers and developing innovative curriculum-aligned CCE change projects which involve teachers, learners, and communities. It also supports the establishment of professional learning communities (PLCs).

The KIC-CCE initiative is a collaborative project between the Department of Basic Education (DBE), and the Department of Forestry and Fisheries (DEFF), Higher Education Institutions (HEIs) that provide teacher education training, and four Non-governmental organizations (NGOs) with experience in supporting in-service training for secondary school teachers in education for sustainable development. This paper, therefore, focused on the implementation of teachers' capacitation programs to integrate CCE in twenty selected secondary schools in Amathole Education District in South Africa. It aimed to determine the levels of content and pedagogical content knowledge held by Geography teachers before being involved in the capacity program and the ways in which this intervention program added to that knowledge.

Waldron, Mallon, Barry, and Martinez Sainz (2020) define CCE as a learning area where young learners are made aware of their environment in order to foster the development of critical and creative thinking as well as the strengthening of their capacity to address environmental issues in their community. It involves imaginatively preparing kids and teenagers for a future that is rapidly changing, unknown, risky, and perhaps dangerous (Stevenson, Nicholls & Whitehouse, 2017). Young people must therefore be taught about the effects of their actions and inaction on the environment and how these effects affect their wellbeing. The promotion of teacher professional development programs for teachers instructing CCE in secondary schools in South Africa has not received enough attention. According to Monroe, Plate, Oxarart, Bowers, and Chaves (2019), this may be to blame for secondary schools' lack of techniques for teaching about climate change, which is what this study attempted to solve. The findings of this study may help pre-service training programs offered by higher education institutions and the Department of Basic Education create in-service training programs to support teachers who are teaching CC in their classrooms. This study is intended to assist teachers of CC in developing their pedagogical and content understanding.

2. Research Questions

This paper was guided by the following research question:

- How are teacher capacitation programs assisting Geography teachers to integrate CCE in their lessons?

3. Theoretical Framework

Based on Shulman's (1986; 1987) and Gudmundsdottir and Shulman's (2006) Model. The Model of Pedagogical Reasoning, the expert and novice teachers are compared and contrasted. According to this model, teachers prepare for lessons by consulting the following sources of knowledge: content knowledge, pedagogical content knowledge, curriculum knowledge, general pedagogical knowledge, knowledge of goals and purposes, knowledge of learners, and knowledge of educational contexts, settings, and governance. According to Shulman, the process of instructional reasoning and action is made possible by three sources of understanding. In order to make a subject topic "teachable," the model explains how a teacher must change their knowledge of it. Vast knowledge sources are tapped during this transformation process, with pedagogical content knowledge being the most significant. The teacher differs from the subject matter

expert in that they possess a different level of knowledge and comprehension of their field. The knowledge of learners, general pedagogical knowledge, and pedagogical content knowledge are all foundations upon which pedagogical content knowledge is constructed (Gudmundsdottir & Shulman, 2006). The Model of Pedagogical Reasoning is suitable for the study in that it assists to explain the effect of teachers' continuous professional development on pedagogical practice that will enhance curriculum-aligned and locally relevant CCE in their classrooms.

4. Literature Review

National teacher education policies (DHET, 2015) that are being implemented currently include the reformulation and restructuring of teacher education programs to align with the "new" national qualifications framework for higher education. The updated policy emphasizes environmental issues and includes them in the teacher education curriculum (Reddy, 2021).

4.1 The concepts of climate change and climate change education

In defining the climate McKeown and Hopkins (2010) state that the climate part obviously falls under the umbrella of the natural sciences and has traditionally been taught in geography (e.g., climatology) and earth science (e.g., meteorology). Different authors have attempted to define climate change education given the devastating effect on the environment globally. In an attempt to give an acceptable definition of climate change education, the intergovernmental panel on climate change (IPCC), describes climate change as noticeable and variable changes that occur in the environment over a long period (Minx, Callaghan, Lamb, Garard & Edenhofer 2017). Anderson (2010) viewed climate change education as an education that gave people the opportunity to act in a way that will have a positive impact on their environment. It involves activities that will inculcate in the learner's positive attitudes such as lifestyles, and economic and social activities that will reduce excessive production of greenhouse gasses (Anderson, 2010). It is important to emphasise the need to inculcate a positive attitude in the ways we interact with our environment. This change of attitude is expected to come from the teaching and learning of climate change in the Geography lessons. Favier, *et al* (2021) state that mitigating climate change is urgent and giant leaps forward are necessary to avoid catastrophic climate change. In order to prevent catastrophic climate change, it is urgent to mitigate climate change and huge advancements are required. Only the introduction of climate change education to children when they are school-age could be successful in changing society as a whole. In order to address young people as future citizens and decision-makers, education must provide them with knowledge of the wicked problem of climate change and the skills necessary to contribute to its solution. This will go a long way to finding a lasting solution to the problems confronting our environment. Researchers in the field of climate change education have identified human activities against our environment. Ferguson (2019) and McKeown and Hopkins (2010) were of the view that climate change is a complete alteration of the composition of the atmosphere due to human activities that are a detriment to the environment. The practical climate change knowledge does not preexist, but rather develops in response to local issues and the questions generated by context-specific problems requiring "research" approaches that are context-sensitive. This is also consistent

with the contextualized nature of the practicum periods in which students participate, as it provides a localized context with its issues and problems (Reddy, 2021).

Climate change is a problem that we must learn to adapt to and find a way of mitigating through our social and economic relationship with the environment (Mochizuki & Bryan, 2015). This is an indication that for us to be able to have a sustainable environment, citizens should be informed of the danger climate change poses to societies and the government should be at the forefront of creating awareness through education from primary schools to higher institutions of learning (Stevenson et al., 2017). However, the teaching and learning of climate change in the classroom should create awareness on the part of the learners of the grave consequences that our behavior can cause the socio economic and sustainable development of our society. Much effort at creating awareness on the need to protect the environment through education should be intensified by the government and other stakeholders. Since climate change is a global challenge and it appears that governments are willing to address the havoc it has created by embarking on education and integrating it into school curricula, efforts should be made to ensure that teacher development programs are embedded into higher education curricula to develop strategies that will equip teachers to deal with the climate change education in the classroom (Anyanwu et al., 2015).

Further to seminal work by Stevenson et al., (2017), climate change education involves preparing young people for a rapidly changing, uncertain, risky, and possibly destructive future created by human activities. This implies that the goal of climate change education is to support learners to acquire necessary knowledge, skills, dispositions and values that will enable them to interact with their environment and provide solutions to future challenges in their environment. The role of professional development is crucial in preparing learners on how to interact with the environment in a sustainable manner. Stevenson et al., (2017) further reveal that this can only be realized when there is a professional development program for climate change education for teachers that will provide them with pedagogical skills needed for teaching and learning climate change education in the classrooms.

4.2 Teacher continuous teacher professional development programs in South Africa

Continuous professional teacher development (CPTD) is an aspect of teacher education that deals with in-service training for practicing teachers that are aimed at developing their teaching practice and content knowledge (Thenga et al., 2020). While supporting the view above, Johnson (2011) and Lunds (2009) are of the view that teacher professional development program will provide necessary skills for teachers to understand scientific evidence around climate change. However, the benefits of professional development on teacher competence and pedagogical development have not been appreciated adequately (Leibowitz, Bozalek, Van Schalkwyk & Winberg 2015; Cheon, Reeve, Lee, & Lee 2018). It is noteworthy to say that despite the importance of professional development for a successful pedagogical practice, much has not been done in the area of research to successfully design an appropriate in-service training framework for serving

climate change teachers on curriculum-aligned and locally relevant climate change education in their classrooms.

CPTD is classified as individual or collaborative (Patton, Parker & Tannehill 2015). While collaborative teacher development focuses on the development of teachers as a community or in partnership with one another, the individual program focuses on personal or professional growth (Patton et al., 2015; Avalos, 2011). The KIC-CCE project is an initiative of the Department of Basic Education (DBE) in collaboration with other stakeholders like the Department of Forestry and Fisheries (DEFF), Higher Education Institution (HEI) that specialized in capacity development for teachers including Geography teachers, and four Non-Governmental Organization that are climate change focused. The HEIs provide the training capacitation program for the participating Geography teachers selected for the research. The KIC-CCE training project is a short program that is organized to strengthen teacher capacitation for curriculum-aligned locally relevant climate change education in their classrooms.

5. Methodology

This study used a case study design and adopted the qualitative approach. Case-study research is an in-depth investigation of contemporary phenomena in a real-life context, designed to address how and why questions of the research. It assists researchers to focus on the topic under investigation (Creswell & Creswell, 2018). Five secondary schools were selected from twenty schools in the Amathole West Education District based on geographical location and close proximity to the training provider. These are the schools that participated in the teacher capacitation program conducted by one higher education institution that were purposefully selected for the study. One Geography teacher from each school was selected. However, four geography teachers participated in one-on-one semi-structured interviews as the fifth one appeared to have some challenges during the interview session and opted out. To comply with anonymity issues, these teachers were given codes as GT1, GT2, GT3 and GT4. Geography teachers that participated in the five-day training program were adequately informed that they are free to opt out of the research at any time they wish. The researchers sought the consent of participating Geography teachers before engaging them in one-on-one semi structured interviews. Their consent was also sought before recording the interview. There was only one post-course interview session for each teacher which aimed to find out the level of teacher content and pedagogical knowledge of climate change education before and after the training program. The thematic approach of coding, sorting, and transcribing was used in analyzing information collected from the participants for the study. The Keep-it-cool-Climate-change-education (KIC-CCE) initiative is a collaborative project between the Department of Basic Education (DBE), and the Department of Forestry and Fisheries (DEFF), Higher Education Institutions (HEIs) that provide teacher education training, and four governmental organizations (NGOs) with experience in supporting in-service training for secondary school teachers in education for sustainable development.

6. Findings

In line with the research questions, data was presented and analyzed following the following themes:

6.1 Teachers' level of content and pedagogical knowledge before the teacher capacitation programs

6.1.1 Teacher pedagogical practice

The findings from the data collected revealed that Geography teachers do not have the pedagogical content knowledge to teach CCE before the training project by one HEI. Geography teachers did not have a specific method of teaching climate change education in their classrooms before the training project. Teaching was done using the teacher-centered approach without any instructional materials. One of the teachers specifically noted that:

"...we taught them without showing them the visual..."
(GT1).

Another geography teacher had this to say:

"...before the project starts my knowledge of climate change was not enough and how to relate it to learners, and also the methods. I did not know any assessment method..." (GT1).

The response from geography teacher one above reveals that geography teachers do not take climate change education seriously before the KIC-CCE training project. The KIC-CCE training project serves as an avenue for the participating geography teachers to develop an appropriate method of teaching that will bring about curriculum-aligned and locally relevant climate change education in their schools.

6.1.2 Teacher content knowledge

It is noteworthy to note that the geography teachers lack content knowledge of climate change concepts. A teacher with poor content knowledge cannot adequately teach climate change education in a way that will bring about curriculum-aligned locally relevant examples in their teaching. This training was not part of the in-service training offered by the Department of Basic Education (DBE). Geography teachers lack knowledge of climate change, adaptation, and mitigation before the project. As a result, they cannot align the content with the curriculum and use locally relevant examples in their teaching. This was the situation before the KIC-CCE training project. One of the geography teachers added that:

"...my understanding is there is the increase in the level of snowing place. I learned about climate change adaptation during the project. Before the training, I only have knowledge about climate change but little or no knowledge about adaptation and mitigation..." (GT4)

6.3 Contribution of capacitation intervention programs to geography teachers' content and pedagogical knowledge.

The capacitation intervention training program organized by one HEI was conceived to provide training and educational resources/materials support for geography teachers. Participants at the training were supported with educational materials as part of the training program. Geography teachers reported a significant improvement in their teaching as a result of the capacitation training program. One of the teachers specifically noted that:

"...I have improved my CCE content knowledge through the educational material/resources, improve my CCE lesson plan, teaching method, and lesson planning through the material/resources. The training also assisted me to use examples in the school environment that are relevant to my teaching in the classroom..."(GT1)

On whether participating teachers received curriculum-aligned and locally relevant CCE training from the project, the majority of the teachers expressed the view that the training they received assisted them in aligning their teaching with the curriculum and also enabled them to use locally relevant examples in their lessons. The data collected from the one-on-one interview conducted by the researchers and the analysis indicated that the majority of the Geography teachers that participated in the training program received curriculum-aligned and locally relevant support by trainers, to design and implement climate change education projects with students and communities. This statement is an indication that the training program has assisted Geography teachers in implementing effective CCE teaching in their lessons. The analysis also reveals that the CCE training program has positively assisted Geography teachers to enhance their CCE content and pedagogical knowledge.

"...I now use more relevant CCE educational material, teach learners to understand real-life climate change issues, help students to develop CCA and Mitigation solutions, and integrate CCE better in my Geography class. My students can now apply the CC concept in tackling real-life issues affecting men and women in the school community. Above all, the intervention has helped me to change my teaching strategies in the classroom..."(GT3)

This is in line with findings from the literature that support the claim that continuous professional development of Geography teachers can enhance their content and pedagogical knowledge to teach climate change in their lessons. Another teacher has this to say:

"I received curriculum-aligned and locally relevant CCE training. Now I use local examples in the school environment and community where the school is located to teach my learners in the classroom. This strategy enhances their understanding of CC topics in the geography lessons" (GT1)

Also, the analysis of data reveals that the majority of Geography teachers that participated in the training program have improved their CCE lesson planning as a result of the training. This revelation is an indication that the training program has capacitated the Geography teachers to be able to improve their lesson planning in the classroom. The majority of the Geography teachers that participated in the training program also improved their teaching methods as a result of the CCE training program. The training program was responsible for an improved method of teaching CCE by Geography teachers in their classrooms.

6.4 Extent to which the project interventions contributed to improved pedagogical practice

The data revealed that the selected Geography teachers were now able to teach climate change better after the training program and could use locally relevant examples in their environment. According to Geography teachers, the training enables them to help learners to understand real-life issues about CCE and how to deal with these issues in a more responsible and sustainable manner. Another finding that emerged from the interviews was that those teachers who participated in the five-day training program were now able to teach CC concepts like adaptation and mitigation in the Geography classroom.

Findings also reveal that participating Geography teachers can now integrate CCE better into geography teaching as a result of the training they received from the project. The majority of the participating Geography teachers from the finding are now better able to apply CC concepts to proffer solutions to problems in their school and immediate communities. It also emerged from the analysis that a substantial number of Geography teachers that participated in the training program were able to significantly improve their pedagogical knowledge in the classroom as a result of the training project and attendance of meetings of PLCs. A Geography teacher has this to say:

"I have been participating in the PLC meeting unlike some teachers from other schools. The PLC is an effective space and process for improving my pedagogical practice. I have improved my pedagogical practice as a result of my participation in the CCE PLC." (GT4)

7. Discussion of Findings

The capacitation of Geography teachers in terms of developing their content knowledge, the pedagogical skills in a way that will bring about curriculum alignment and effective locally relevant examples have received limited attention from stakeholders and indeed government (Smart et al., 2020; Monroe et al., 2019). The data collected indicates that the four Geography teachers had little knowledge of climate change education and lack the required pedagogical skills that can help them to teach climate change education in their classroom before the KIC-CCE training. This justified assertions by Opuni-Frimpong, *et al.* (2022). It also emerged from the data that the level of knowledge and pedagogical skills for climate change education improved significantly as a result of the teacher capacitation program. Another finding from the analysis reveals that Geography teachers do not take climate change education seriously before the KIC-CCE training project.

This is an indication that Geography teachers attitudes also contributed to their poor performance in the classrooms. The situation before the training project requires an urgent attention which the KIC-CCE training project was designed to address. Results from the data analysis also show that geography teachers that participated in the study do not have professional training that will enable them to teach topics on climate change education in their classroom. This position is in line with prior literature and the views of Johnson (2011) and Lunds (2009) which emphasized that teachers need continuous professional development programs to enable them to develop climate change content knowledge and pedagogical skills to teach the topics in their lessons. However, Thenga et al., (2020) emphasize that to teach climate change education effectively, the Department of Basic Education should as a matter of priority provide a periodic CPTD program that will capacitate Geography teachers to teach climate change in secondary schools in South Africa. This become imperative in view of the findings which reveals that majority of the Geography teachers after the training were able to teach effectively CC concept like adaptation and mitigation in the Geography classroom. This according to them should be part of the pre-service teachers' program in the universities and also for serving teachers on a continuous basis. This is important going by the result of findings which reveal that Geography teachers lack content knowledge of climate change education before the KIC-CCE project. The KIC-CCE training by one University in the Eastern Cape was utilized by the Geography teachers who are responsible for the teaching of climate change education in the classroom. The training project provided by the KIC-CCE project was responsible for the change observed in the Geography teachers' knowledge of climate change concepts as indicated in the result of the findings. This training program and educational resources/materials provided by the KIC-CCE project assisted Geography teachers to integrate climate change education into their teaching by utilizing locally relevant examples in their communities. Geography teachers that participated in the KIC-CCE training project were able to improve their lesson planning technique, content knowledge, and teaching method as a result of the training and the educational materials/resources support they received from the project. This position is in line with the view expressed by Shulman (1986). According to the theory, teachers prepare for lessons by consulting the following sources of knowledge: content knowledge, pedagogical content knowledge, curriculum knowledge, general pedagogical knowledge, knowledge of goals and purposes, knowledge of learners, and knowledge of educational contexts, settings, and governance. This theory has provided an understanding that to develop pedagogical content knowledge in Geography teaching, teachers need to prepare for their lessons ahead before going to the classroom. This has made it possible for teachers to integrate climate change education into their teaching in the classroom. Apart from this, teachers can utilize examples that are relevant to their local environment in their teaching in the classroom. This cannot be achieved without the training project organized by one HEI in the Eastern Cape. This assertion also showed that the KIC-CCE training program provided by one Higher Education Institution in the Eastern Cape was, according to Geography teachers' views, responsible for the improved pedagogical practices. These results from the data analyzed above indicate that CPTD is an important causal mechanism that is responsible for teachers'

improved teaching practice, particularly in integrating climate change education topics into their Geography classroom using locally relevant examples in their environment.

8. Conclusion

The result of the findings reveals that Geography teachers were just teaching climate change without recourse to any strategy. The majority of these teachers were found to lack content knowledge and pedagogical knowledge related to climate change concepts as such they were unable to effectively teach the topic in their lessons. Also noted from the findings is the lack of training support for teachers especially Geography teachers in the discharge of their duties in the classroom. Lack of in-service training has affected their capacity to effectively align the curriculum and use locally relevant and effective examples while teaching climate change education in their lessons. The paper concludes that geography teachers lacked content knowledge, lesson planning skills, and teaching methods before the capacitation training program which affected their teaching in the classroom. This means therefore that the training programs were according Geography teachers view responsible for the improved pedagogical practice of geography teachers in the classroom. Furthermore,

9. Recommendations

Based on the findings of the study recommends that continuous professional teacher development programs on Climate Change Education for Geography teachers be organized on a continuous basis. Since it emerged from the data that Geography teachers were of the view that capacitation programs were impacting positively on the pedagogical practices, it is also recommended that CCE be adequately integrated into the teacher education pre-service programs. Furthermore, HEIs, the Department of Higher Education and Training, and the Department of Basic Education should collaborate in that direction to see how to integrate CPTD programs for climate change education into the University curriculum. Furthermore, a quantitative study which will focus on how consistent has been the improvement of Geography teachers' pedagogical practices as a result of CCE teachers capacitation programs.

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