The Journal for Transdisciplinary Research in Southern Africa
ISSN: (Online) 2415-2005, (Print) 1817-4434

Transdisciplinary approaches to integrating inclusivity and sustainability in teacher education

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Dates:
Received: 22 Oct. 2025
Accepted: 12 Jan. 2026
Published: 05 Feb. 2026

How to cite this article:
De Souza B. Transdisciplinary approaches to integrating inclusivity and sustainability in teacher education. J transdiscipl res S Afr. 2026;22(1), a1673. https://doi.org/10.4102/td.v22i1.1673

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Research in Southern Africa has shown that teacher education is currently fragmented into discrete modules or policy priorities. This status poses a recognised challenge in education as it sets up Education for Sustainable Development (ESD) and inclusive education as competing agendas that are typically addressed separately. In response, this study investigated how transdisciplinary research in education, understood as the co-production of knowledge among researchers, policymakers, and practitioners, can help to address the interconnected challenges of inclusivity, sustainability and teacher preparedness in complex teaching and learning settings. The study focused on the Sustainability Starts with Teachers programme in Malawi, Tanzania and Eswatini to provide an empirical and reflective account of implementing a transdisciplinary approach in teacher education. A formative interventionist design, located in a critical realist philosophy and operationalised through a nested case study methodology in interviews and workshops, was used to investigate how teacher educators enact inclusion-oriented ESD. Through bioecological and sociocultural theoretical analysis, the results showed that collaborative and context-responsive engagement supports teacher educators in aligning policy aspirations with classroom realities. This alignment entails that inclusivity and sustainability are intertwined because inclusive pedagogies strengthen the equity of sustainability initiatives while sustainability education enhances the transformative potential of inclusive teaching.

Transdisciplinary Contribution: The key outcome of the study was the Sustainable Inclusive Pedagogical Proficiency Process (SIP3) model. The SIP3 model actualises transdisciplinary collaboration to drive systemic educational change through interconnected processes of social and ecological transformation.

Keywords: critical realism; education for sustainable development; inclusive education; Southern Africa; teacher education; transdisciplinary research.

Introduction

Inclusive education, Education for Sustainable Development (ESD) and teacher education have long been central pillars of educational research and policy, particularly in the global commitment to Sustainable Development Goal 4 (SDG 4), which calls for inclusive and equitable quality education and lifelong learning opportunities for all.[1] Despite their shared positioning in SDG 4, these domains are rarely treated as interconnected. Inclusive education is interpreted as ensuring participation and learning for all learners, especially those historically marginalised. Education for Sustainable Development, by contrast, focuses on developing the knowledge, competencies and agency required to navigate social, economic and ecological risks in an increasingly complex world. Teacher education shapes the pedagogical, ethical and professional capacities required for both. However, policy, practice and research typically address these agendas in parallel and not as mutually strengthening processes in teacher preparation. Evidence of this fragmentation is well documented. For example, a European scoping review found that although inclusion is mentioned in ESD policy discourse, the two fields are less integrated in practice, with ESD rarely considering disability or broader inclusion-oriented pedagogies.[2]

Similarly, teacher education programmes across multiple continents tend to separate content on inclusion, sustainability and pedagogy into discrete modules or policy strands.[3,4,5] This separation obscures the deep structural and ethical connections between the goals of equity and sustainability. The consequences of this fragmentation are visible in Southern Africa. O'Donoghue and Rončević[6] argue that neither ESD nor inclusive education can be reduced to only mainstreaming learners with special needs, as this is a narrow practice that places learners with disabilities in regular classrooms without addressing systemic barriers. They contend that ESD has expanded to include

competencies needed for sustainable living, while inclusive education has evolved into a challenging and transformative endeavour requiring that educational systems rethink how they conceptualise diversity, participation and social cohesion. In their view,[6] meeting the challenges of sustainable and equitable futures requires a reconceptualisation of the educational enterprise itself.

This study emerges from this problem space. Although scholars such as Lawrence[7] and Klein[8] advocate for transdisciplinarity, an approach that brings together diverse knowledge systems to address complex societal challenges, empirical applications of transdisciplinary research in teacher education remain limited. Much of the existing ESD research focuses primarily on policy commitments or curriculum design.[9] This approach provides insufficient insight into the pedagogical practices through which teacher educators enact sustainability and inclusion in institutional contexts.[1] Equally under-examined is how research processes themselves might generate professional learning or conceptual change among teacher educators.

In this study, transdisciplinary societal problem-solving refers to the collaborative process through which researchers, teacher educators and policymakers jointly identify educational challenges and work together to design context-sensitive pedagogical responses.[10] These collaborative spaces were intentionally structured to promote reflection, using theoretical tools from bioecological systems theory and sociocultural learning theory. Bioecological theory articulates the multi-level systems shaping educators' work, while sociocultural theory supports reflective processes that enable participants to examine, question and transform their pedagogical assumptions. The study, therefore, seeks to understand both how teacher educators integrate inclusion and sustainability in practice and how engagement in a transdisciplinary research process transforms their conceptual understandings and pedagogical strategies.

The main research question is: how can a transdisciplinary research approach enhance teacher education by integrating ESD and inclusive education to advance sustainable and equitable teaching practices?

Three sub-questions further shape the study:

1. How do teacher educators enact the integration of ESD and inclusive education in their diverse institutional and classroom contexts?
2. In what ways does transdisciplinary collaboration shape methodological, conceptual and pedagogical transformation in teacher education?
3. How can a coherent framework connect empirical practice with reflective transdisciplinary inquiry for strengthening inclusive and sustainable teacher education?

The significance of this study lies in demonstrating that transdisciplinary engagement can act simultaneously as a research method and a professional development process. Disciplinary boundaries have constrained teacher education by presenting inclusion and sustainability as separate agendas and not as interconnected imperatives. The transdisciplinary approach adopted here enabled educators to co-create new understandings, collectively interrogate existing practices and conceptualise pedagogical innovations responsive to their sociocultural contexts. Therefore, this study contributes to three scholarly conversations:

1. Empirical insights into teacher educators' practices across three Southern African contexts.
2. Methodological insights into how transdisciplinarity can function as a formative intervention.
3. Theoretical insights into how bioecological and sociocultural perspectives can articulate the relationship between macro-level structures and micro-level pedagogical agency.

Literature review

This review critically examines the existing literature to clarify these concepts, their historical and theoretical underpinnings, and their intersections and tensions. The review also synthesises debates around transdisciplinarity and identifies how these theoretical tenets shaped the intervention in this study.

Inclusive education: Competing definitions and evolving perspectives

Inclusive education has undergone significant conceptual evolution. Early interpretations equated inclusion with the mainstreaming of learners with disabilities, i.e. placing learners with special educational needs into regular classrooms with minimal structural or pedagogical change. This approach emerged from integrationist models that sought to physically relocate learners without transforming learning environments. However, as scholars have long argued, mainstreaming typically leaves systemic inequalities intact by focusing on learner placement and not restructuring schooling cultures, pedagogies and resources.[11] Contemporary perspectives in inclusive education therefore emphasise participation, belonging and meaningful learning for all learners, and not merely accommodating disabilities. The literature emphasises that inclusion is a rights-based and justice-oriented process, requiring educational systems to become universally accessible, responsive and participatory.[1] This shift broadens inclusion to include social, cultural, linguistic, economic and gender-related forms of exclusion. This approach recognises that learners experience multiple and intersecting inequities.

In Southern African debates, inclusive education is framed not as a remedial support strategy but as a fundamental rethinking of the educational enterprise. O'Donoghue and Rončević[6] argue that addressing inclusion should involve expanding how education conceptualises learners, learning environments and societal challenges. Their argument is particularly relevant for contexts characterised by resource

constraints, heterogeneous classrooms and structural inequalities. Thus, inclusion is best understood as a multidimensional and systemic process requiring transformation of curriculum, pedagogy, assessment and institutional culture.[12]

This definition underpins this study and guides its focus on how teacher educators reinterpreted and enacted inclusive principles beyond narrow mainstreaming practices.

Education for sustainable development: From environmentalism to transformative learning

Education for Sustainable Development has similarly expanded in scope. The earlier focus of ESD centred on ecological awareness and conservation but now encompasses social justice, economic equity, democratic participation and global citizenship.[3] Tilbury[9] notes that ESD has evolved as an expansion in modern education that equips learners with learning competencies to live in a changing world. This transformation implies that ESD addresses not only environmental issues but also the sociocultural, economic and political systems in which those issues arise. Despite this expansion, research shows continued conceptual fragmentation. In their scoping review, Rončević and Rieckmann[2] found that inclusion is mostly invoked only normatively in ESD literature, with a limited focus on disability or broader exclusion. This approach results in ESD initiatives that inadvertently reproduce inequities by overlooking who participates, or is excluded, from sustainability efforts.

Scholars[1,2] argue for inclusion-oriented ESD, which integrates human rights, social justice and empowerment into sustainability education. This approach respects learners' diverse identities, barriers and contexts, thereby positioning ESD as a catalyst for equitable social transformation and not just as a purely environmental agenda.

Teacher education: The process of integration and tension

Teacher education is where inclusive education and ESD converge in practice. Even so, the literature highlights the lack of coherence between these agendas in teacher training programmes. Stevenson et al.[4] report that sustainability is embedded inconsistently across modules, with teacher educators lacking clarity on how to integrate ESD into disciplinary teaching. Similar gaps exist in inclusive education, in which teacher educators may be trained in special needs education but not in broader inclusive pedagogies addressing sociocultural and structural exclusion.[1] Sorkos and Hajisoteriou[5] argue that inclusive and sustainable education requires teachers to hold intercultural competence, ecological literacy and relational pedagogical skills, but teacher education systems inadequately prepare them for these intersecting demands. This disconnect sustains the fragmentation of curricula and contributes to the false perception that sustainability and inclusion are competing priorities.[2] Consequently, scholars call for conceptual frameworks and teacher education reforms that treat inclusivity and sustainability as interfacing dimensions of quality education, which is responsive to the aspirations of SDG 4.[1,2,4,5]

Transdisciplinarity: A praxis for integrating fragmented agendas

The complexity of integrating inclusion and sustainability in teacher education requires theoretical and methodological approaches that transcend disciplinary boundaries. Transdisciplinarity is recognised as a promising praxis for navigating this complexity. Transdisciplinarity is defined as the co-production of knowledge across academic, professional and community domains to address societal problems.[7,8] It emphasises collaboration, contextual knowledge, reflexivity and systems thinking. Klein[8] argues that transdisciplinarity is especially suited to problems characterised by uncertainty, multiple stakeholders and socioecological interdependence. Education fits this description well. Polk[10] further contends that transdisciplinary research generates both societal problem-solving and conceptual innovation, thereby making it distinct from interdisciplinary approaches that merely combine academic disciplines. For teacher education, this concept means bridging the gap among policy, practice, theory and community contexts. Lawrence[7] emphasises that methodological clarity and participatory structures are needed to ensure that transdisciplinary work does not become a pretence but is genuinely transformative.

Theoretical framework

This study adopts an integrated theoretical framework grounded in Bronfenbrenner's bioecological systems theory[13] and Vygotsky's sociocultural theory.[14] This combination was not only conceptually coherent but also methodologically necessary for a research design that sought to demonstrate both the systemic and interactional dimensions of teacher education. Because the study examined how teacher educators in Malawi, Tanzania and Eswatini engaged with the interconnected demands of inclusive education and ESD while participating in a transdisciplinary research process, the study required a framework capable of capturing the complexity across multiple levels of influence and across multiple forms of learning. These two theories offered complementary strengths that enabled the study to analyse how the practices of teacher educators were shaped, mediated and transformed in broader ecological, institutional and sociocultural environments.

Bronfenbrenner's bioecological theory[13] was particularly important for situating the actions of teacher educators in the layered systems that shape their work. His Process–Person–Context–Time model helped the study examine how inclusive and sustainable pedagogical practices emerge through dynamic interactions between individuals and the multiple systems they inhabit. This examination occurred from the immediate microsystems of classroom interactions and professional workshops, through mesosystemic relationships across institutional departments, to exosystemic forces such as

national curricula and policy mandates, and finally the macrosystemic cultural values that influence how disability, diversity and sustainability are understood in each country. The model also allowed the study to consider temporal dynamics by acknowledging that the transdisciplinary intervention unfolded across iterative cycles of experimentation and reflection that shaped the development of teacher educators over time. Without this bioecological perspective, the study would have risked interpreting teaching practices as individual choices and not as responses to complex structural conditions that simultaneously enable and constrain possibilities for inclusive, sustainable education.[1]

While Bronfenbrenner provided a way of understanding where and how systemic pressures operate, Vygotsky's sociocultural theory[14] offered insight into the interactive processes through which teacher educators learned, negotiated meaning and transformed their practices during the intervention. As the study employed a formative and transdisciplinary approach, the collaborative workshops, dialogues and co-design activities functioned as socially mediated learning spaces. Vygotsky's concepts of the Actual Developmental Level and the Zone of Proximal Development (ZPD) were applied to design these spaces as zones in which teacher educators could move from their existing understandings of inclusive pedagogy and ESD towards more integrated and critical perspectives, with support from peers, researchers, policymakers and community voices. These interactions, structured purposefully through transdisciplinary dialogue, were mediational tools that allowed participants to question assumptions, share context-rich experiences, test new ideas and internalise emerging practices. Thus, Vygotsky's theory did not merely inform the interpretation of reflective processes. It also shaped the intervention itself by guiding the kinds of activities used for conceptual and pedagogical transformation.

The combination of these two theories was essential for the study's contribution. Bronfenbrenner enabled the research to identify and analyse the broader ecological and structural forces (policy constraints, cultural norms and institutional histories) that influence the attempts of teacher educators to bring together inclusion and sustainability. Meanwhile, Vygotsky allowed the study to trace how change occurred at the micro-level through social interaction, guided reflection and co-construction of knowledge in the transdisciplinary process.

This dual perspective resonated with the study's aim of understanding not only what teacher educators do but also how transdisciplinary research itself becomes a mechanism for societal problem-solving.[10] In this study, societal problem-solving referred to the collaborative identification of educational inequalities, environmental vulnerabilities or curriculum rigidities, and the shared development of context-appropriate pedagogical strategies to address them. Such collaborative problem-solving required a theoretical framework sensitive both to the influence of structural forces and to the generative potential of social learning processes. In short, this framework made it possible to analyse how teacher educators navigated the tensions between macro-level structures and micro-level practices, and how transdisciplinary collaboration opened up new developmental trajectories for their professional growth. In this way, Bronfenbrenner[13] and Vygotsky[14] provided the conceptual and methodological grounding necessary for a study that sought to understand teacher education not as separate agendas but as a dynamic, socially mediated and systemically embedded process of transformation.

Research methods and design

Study design

This qualitative study employed a transdisciplinary research design grounded in a formative interventionist approach,[15] situated in a critical realist philosophical perspective.[16,17] The approach was structured as an iterative and multi-phased process in which empirical inquiry and reflective methodological engagement informed one another. The design integrated data generation and reflection in a sequence of interconnected phases that formed the expansive learning cycle characteristic of formative interventionist research.[15] This integration allowed the study to examine not only how inclusive education and ESD were being enacted in teacher education contexts but also how the research process itself operated as a catalyst for conceptual and pedagogical transformation, essentially a transdisciplinary approach.[18]

The design unfolded through five overlapping phases aligned with Engeström's[15] expansive learning trajectory, which guided the nested case study methodology.[19]

1. In the initial inception phase, I worked with teacher educators in Malawi, Tanzania and Eswatini to establish the object of joint inquiry, clarify contradictions in their existing ESD Change Projects, and surface the assumptions they held about inclusive education and sustainability. This early phase generated baseline empirical data on practices, understandings and institutional conditions, while also initiating the first layer of reflective engagement as participants began questioning their taken-for-granted practices.
2. In the situational analysis phase, the nested case design enabled systematic analysis across micro-level experiences of teacher educators and macro-level institutional and policy structures shaping their pedagogical work. This phase produced empirical accounts (through interviews and workshop observations) of how inclusivity and sustainability were interpreted and enacted. At the same time, these empirical contradictions became the basis for methodological reflection, as participants analysed how their institutional systems either enabled or constrained inclusive and sustainable pedagogical practices.
3. The practical orientation phase deepened the integration of empirical and reflective work by supporting participants in redesigning or strengthening aspects of their ESD Change Projects. Here, transdisciplinary collaboration played a formative role as empirical findings from their own sites were brought into dialogic

reflection with theoretical tools from Bronfenbrenner[13] and Vygotsky,[14] enabling participants to reconceptualise their professional practices.

4. This was followed by the formative intervention phase, in which redesigned practices were implemented, tested and further refined in collaborative workshop sessions. This phase marked the highest degree of methodological reflexivity as teacher educators collectively analysed their emerging practices, interrogating how new forms of agency and capability were being developed, and how these shifts aligned with broader socioecological and sociocultural structures.
5. Finally, the consolidation phase involved recursive reflection across cases. This stage drew together empirical evidence and methodological insights to generate an empirical–reflective account. This phase allowed for abductive and retroductive reasoning within a critical realist perspective,[16,17] thereby supporting the development of explanatory propositions about how inclusive and sustainable pedagogical practices emerge and stabilise in teacher education systems. The process also enabled the derivation of a framework connecting empirical practice with reflective transdisciplinary inquiry. This framework contributed to the articulation of mechanisms necessary for strengthening inclusive teacher education in ESD contexts.

Setting

The research was conducted across teacher education institutions in Malawi, Tanzania and Eswatini, selected purposively to represent diverse sociocultural, geographical and policy contexts shaping teacher education reform in Southern Africa. These institutions comprised a mix of public universities and teacher training colleges. Some were located in urban centres and others in rural areas. This choice reflected the differentiated educational ecosystems in which teacher educators work. Across the three countries, the participating institutions offered a range of teacher preparation pathways, including certificates and diplomas for early career teachers, bachelor's degrees for primary and secondary educators, and, in the case of the universities, postgraduate qualifications at master's level and above. This variation was significant for the study because it enabled an examination of how inclusive and sustainable pedagogies are conceptualised and enacted in programmes of differing duration, qualification level and institutional mandate.

The institution in Malawi aligned with the country's typical structure of 1-year certificate programmes housed in primary teacher training colleges. Their curricula generally included inclusive education as a compulsory component embedded in broader education studies modules, although not always offered as a standalone course. Tanzania's participating institution reflected the system of training teachers for bachelor's degrees and, increasingly, for master's-level qualifications. In these settings, inclusive education is incorporated in foundational education units and not as an independent subject, while ESD tends to appear in some courses or in cross-cutting curriculum themes. Eswatini's institution offered a 3-year diploma programme preparing teachers for primary and secondary school levels. As in the other countries, inclusive education was typically positioned as part of core education studies but not always formalised as its own module; ESD appeared more sporadically through environmental education or life-skills components and not through programme-wide integration.

The diversity of institutional types was essential for the study's transdisciplinary focus. Working across rural and urban universities and colleges allowed the research to investigate how contextual factors, such as resource availability, community expectations, staffing profiles and policy pressures, influenced the efforts of teacher educators to integrate inclusive education and ESD. In rural institutions, challenges related to limited infrastructure, limited access to specialised support services and broader community vulnerabilities shaped pedagogical possibilities. In urban institutions, the pressures of larger class sizes, higher policy visibility and broader programme offerings created different forms of complexity. This variation provided empirical material for understanding how teacher educators negotiated the integration of inclusion and sustainability within the constraints and affordances of their institutional environments.

All institutions were engaged in efforts to strengthen inclusive and sustainable pedagogies through their involvement in the Sustainability Starts with Teachers programme. This effort meant that participants were not passive recipients of the research process but were already positioned in institutional cultures grappling with how best to address systemic challenges related to equity, quality and sustainability. The multi-context design, therefore, allowed comparative analysis not only across national education systems but also across institutional mandates, programme structures, qualification levels and geographic settings. This diversity was crucial for understanding how ESD and inclusive education principles are interpreted, operationalised, and, in some cases, reimagined across Southern African teacher education landscapes.

Study population and sampling strategy

The study population consisted of teacher educators working in the diverse teacher training systems of Malawi, Tanzania and Eswatini. These were lecturers directly responsible for preparing future teachers at certificate, diploma and degree levels. A purposive sampling strategy[19] was used to identify participants who were actively engaged in initiatives aimed at integrating inclusive education and ESD into their teaching, curriculum development or institutional projects. This sampling approach ensured that participants were not selected solely on the basis of availability, but because they held relevant pedagogical and institutional responsibilities that aligned with the study's transdisciplinary focus. The final sample comprised 12 interview participants across the three countries, supplemented by approximately 24 participants involved in the collaborative workshops. Representation from each institution reflected the size and structure of participating sites: Malawi contributed five

participants, Tanzania four and Eswatini three. This distribution preserved analytical depth while maintaining the comparative integrity of the nested case study.

The teacher educators involved in the study brought varied professional backgrounds and qualifications, thereby reflecting the different teacher education pathways in each national context. Most lecturers held at least a bachelor's degree in education or a related field, while many possessed master's degrees, and several were pursuing or had completed further postgraduate studies. Their teaching experience ranged from early-career lecturers in their first 3 years of service to senior educators with more than a decade of experience, including department heads and programme coordinators. This variation enriched the data by allowing the study to capture perspectives across different stages of academic identity development, from novice lecturers navigating new curricula to experienced educators shaping programme-level reforms.

Participants' prior exposure to inclusive education also varied. Some had been teaching aspects of inclusive pedagogy for several years in core education studies modules, while others encountered inclusive education more indirectly through broader curriculum theory or educational foundations courses. Inclusive education was not always taught as a standalone subject in the participating institutions, meaning many lecturers addressed inclusivity through cross-cutting themes embedded in other modules. As a result, the number of years for which participants had explicitly taught inclusive education ranged from one to over 10 years, depending on institutional curriculum structures and individual teaching portfolios. In addition to inclusive education or ESD-related content, participants also taught subjects such as curriculum studies, educational psychology, environmental education, science education, social studies and teaching methodology courses. This breadth of teaching responsibilities was important because it revealed the multiple entry points through which inclusive and sustainable pedagogies could potentially be integrated across teacher education curricula.

The variation in participants' roles enabled the study to analyse the experiences of teacher educators across the three levels of the nested case design. Those positioned at the micro-level were typically lecturers with direct teaching responsibilities, whose engagement centred on classroom practices, student supervision and the development of inclusive and sustainability-oriented learning activities. Participants operating at the meso-level included senior lecturers, departmental leaders or programme coordinators involved in curriculum planning, institutional decision-making or staff development processes. Their insights demonstrated the organisational and structural dynamics that influenced how inclusive and sustainable teaching practices were adopted or resisted in departments. At the macro-level, a smaller number of participants held roles that connected them with national policy directives or regional programmes. These individuals acted as conduits between institutional practices and broader policy, quality assurance and ministerial expectations. Therefore, the final sample captured the complexity and diversity of the experiences of teacher educators across institutional hierarchies and national contexts.

Intervention

The formative interventionist approach[15] used in this study positioned teacher educators as active co-researchers rather than passive recipients of an externally designed programme. The intervention unfolded through a series of structured, dialogic workshops and iterative cycles of planning, testing and reflection in each country. In total, nine workshops were conducted across the three national contexts, with three in Malawi, three in Tanzania and three in Eswatini. While the number of workshops was consistent across countries, their structure and pacing were adapted to each institutional environment to ensure alignment with local academic calendars, resource conditions and institutional reform priorities. Across all three contexts, the workshops were the principal spaces for collaborative pedagogical innovation. The content of the workshops was layered to support the formative intervention cycle. Early sessions focused on diagnostic reflection, in which participants mapped current practices, identified contradictions between policy and classroom realities and examined institutional expectations related to inclusive education and ESD. This stage drew heavily on Bronfenbrenner's bioecological perspectives and Vygotsky's sociocultural concepts to help participants articulate the systemic forces shaping their work. These discussions generated the first set of empirical data while simultaneously creating the conceptual foundation for designing context-relevant interventions.

Building on the diagnostic phase, the workshops moved into collaborative experimentation, in which participants co-designed and tested pedagogical strategies for integrating ESD and inclusive education. The strategies identified as new emerged from a collective analysis of the contradictions in existing practice. For example, teacher educators noted that lecture-based teaching usually reproduced exclusionary dynamics and failed to connect with sustainability realities in local communities. In response, they co-developed approaches such as community-based learning, learner-centred problem-posing pedagogy, participatory assessment and local resource-driven curriculum adaptation. These strategies were considered new not because they were globally novel but because they represented a departure from prevailing instructional norms in their institutions.

Participants themselves validated their novelty by comparing them with their established teaching routines, institutional guidelines and previous curriculum documentation.

The implementation of these strategies occurred between workshop cycles, during which participants trialled them in their classrooms or professional responsibilities. These trials produced a second layer of empirical data as

teacher educators documented outcomes, challenges and unexpected shifts. Subsequent workshops then functioned as collective reflection spaces, where participants shared their experiences, analysed the effectiveness of the strategies and explored how contextual factors, such as class size, language diversity, resource constraints or community relationships, shaped the success of their innovations. This reflective process echoed Vygotsky's ZPD by enabling educators to move beyond their existing pedagogical understandings through socially mediated dialogue with colleagues.

Although the workshop content followed a consistent structure across Malawi, Tanzania and Eswatini, the contexts differed in meaningful ways. The rural college in Malawi, for example, placed greater emphasis on community engagement strategies because of its proximity to village schools and diverse learner populations. Tanzanian participants prioritised curricular alignment as a result of strong national curriculum directives, while Eswatini's participants focused on integrating inclusive and sustainable pedagogies into subject methodology courses. Despite these contextual differences, all three sites shared similar structural constraints such as limited resources, pressure to meet national examination requirements and fragmented institutional approaches to inclusion and sustainability. These similarities allowed for cross-case learning during collective reflection sessions, while contextual differences ensured that strategy development remained grounded in local realities, not just imposed templates.

Data generation and analysis

The data generation between 2021 and 2022 aligned with the implementation period of the Sustainability Starts with Teachers programme in Malawi, Tanzania and Eswatini. Two data sources were used to capture the complexity of the experiences of teacher educators and to triangulate perspectives across individuals, institutions and national contexts. The primary dataset consisted of 12 semi-structured interviews with teacher educators (five from Malawi, four from Tanzania and three from Eswatini). These interviews explored participants' understandings of inclusive education and ESD, their curriculum responsibilities, their experiences in the intervention workshops and the institutional conditions that shaped their work. In addition to interviews, the study generated extensive participatory observation data, which included field notes from all nine workshops, involving approximately 24 participants across the three countries.

All data were transcribed and analysed by using a thematic analysis approach guided by both deductive and inductive reasoning.[20] Deductively, the initial coding categories were informed by the study's theoretical framework, which drew on Bronfenbrenner's[13] bioecological systems theory and Vygotsky's[14] sociocultural concepts. These categories included: ecological constraints and affordances, social mediation and collaboration, pedagogical experimentation, professional identity shifts and institutional contradictions. Inductively, additional codes were developed in response to patterns emerging from the data. These codes reflected the ecological, social and pedagogical dimensions of teacher learning, which were central to the study.

Guided by a critical realist orientation,[17] the analysis unfolded across three interconnected levels. At the empirical level, I identified observable practices and participants' descriptions of their workshop engagement and pedagogical experimentation. At the actual level, I examined the underlying mechanisms, such as institutional norms, curriculum structures and professional hierarchies, which influenced these practices. At the real level, I interpreted how deep-seated socio-political and cultural forces shaped what was possible for teacher educators working towards inclusive and sustainable pedagogy. This stratified analysis made it possible to link individual experiences with broader structural conditions. This linkage enabled the study to move beyond descriptive accounts. Importantly, the data generation and interpretation occurred not only analytically but also methodologically. Some moments were analysed both as evidence of professional learning and as reflections of how research functions as an intervention in itself. These double readings were central to the hybrid empirical–reflective design, which sought to understand how transdisciplinary engagement reshaped professional agency.[21] It is important to note that this article presents only a focused subset of a much larger dataset generated for my doctoral thesis,[22] from which other articles with different foci have been published.[1,23,24] The full project involved extensive interviews, workshops, observations, document analysis, participant journals and cross-case analyses that are beyond the scope of a single journal paper.

Ethical considerations

Ethical approval for this study was granted by the Rhodes University Education Faculty Research Ethics Committee (Approval Number: 2021-4989-6408). The research adhered to established ethical guidelines for educational research, which emphasise voluntary participation, informed consent, transparency and protection of participants' dignity and privacy.

These guidelines were particularly relevant given the participatory and reflexive nature of the study, in which teacher educators were co-researchers in the design and analysis of pedagogical strategies. All participants provided informed consent prior to data generation. However, ethical engagement extended beyond formal consent procedures. Consistent with participatory and transdisciplinary research practice, the study employed continuous and iterative negotiation of consent, acknowledging that participants' levels of comfort and involvement could shift as collaborative workshops unfolded. Participants were invited to review interview transcripts and preliminary thematic interpretations as part of a member-checking[19] process to ensure accurate representation of their experiences and to grant them agency in how their voices were used in the research.

Given the small and identifiable nature of some institutional contexts, particular care was taken to ensure anonymity. All

data presented in this article use anonymised index codes. For example, *I2-M* refers to Interview Participant #2 in Malawi, and *W3-M* to Workshop Participant #3 in Malawi. This anonymisation approach aligns with ethical recommendations for research conducted in small educational communities in which personal identifiers may be easily inferred.

Results

When addressing interconnected domains such as inclusive education, ESD and teacher education, analytical clarity is required not only at the conceptual level but also in relation to observable pedagogical practices and outcomes. In this study, findings are therefore presented as empirically grounded themes that show how teacher educators enacted inclusion-oriented ESD in practice, what changed through the transdisciplinary process, and where constraints persisted. The findings draw on interview data and workshop reflections across three national cases: Malawi, Tanzania and Eswatini. Five themes emerged from the analysis:

1. Reframing inclusion through transdisciplinary pedagogies
2. Education for Sustainable Development as a catalyst for empowerment and context-responsive practice
3. Interdependence of teacher education, inclusion and sustainability
4. Structural and resource constraints shaping practice
5. Transformative outcomes of the transdisciplinary process

Reframing inclusion through transdisciplinary pedagogies

Prior to engagement in the transdisciplinary workshops, many participants described inclusive education primarily in narrow and learner-deficit terms. They equated inclusion with accommodating learners with disabilities or special needs through individual adjustments. This baseline understanding was evident in early workshop discussions and initial interviews, in which inclusion was framed as an add-on responsibility rather than as a guiding pedagogical principle. Through transdisciplinary dialogue and collaborative reflection, participants began to reframe inclusion as a systemic and pedagogical process involving curriculum design, classroom interaction and institutional culture. This shift was articulated by a Malawian teacher educator who described inclusion as 'making sure every learner feels at home and restructuring the environment, the curriculum, and the practices accordingly' (I3-M). This reframing was not merely conceptual. It was accompanied by specific pedagogical adaptations.

In Malawi, teacher educators described adapting learning resources and peer learning arrangements to enable participation: 'In our classes, we involve every learner regardless of their disabilities. For example, one of our visually impaired students records lessons on an iPad so she can review them later' (I1-M). In Tanzania, reframing occurred through lesson planning practices in teacher education modules, in which inclusion was embedded from the outset rather than addressed retrospectively: 'We make sure that when student teachers plan lessons, they include activities that any learner can do regardless of ability. Inclusion is not an afterthought. It's how we teach from the beginning' (I2-T). In Eswatini, participants emphasised social belonging and participation, particularly for learners facing material or socio-economic exclusion: 'Inclusive education is about creating belonging. Even if a learner has no material resources, they must feel they are part of the learning community' (I1-E).

From a sociocultural perspective,[14] these practices reflect socially mediated learning, in which professional understandings were reshaped through dialogue and shared problem-solving. Using Vygotsky's framework, one can interpret this reframing as movement from participants' Actual Developmental Level, in which inclusion was understood narrowly, towards a ZPD in which inclusive pedagogy became a collective and scaffolded practice embedded in teaching routines, rather than a separate obligation.

Education for sustainable development as a catalyst for empowerment and context-responsive practice

Across all three contexts, participants understood ESD not simply as environmental content but as a practical pedagogical approach linking classroom learning to community challenges. This understanding was evidenced through concrete examples of teaching and learning activities, rather than abstract claims. In Malawi, ESD was enacted through community-linked projects embedded in teacher education: 'We make briquettes [*cooking charcoal*] from waste paper, which reduces littering and gives learners a skill they can use to earn a living' (W7-M). Here, empowerment was evident in skill development, local environmental problem-solving and income generation potential, rather than in attitudinal change alone. In Tanzania, ESD was framed as enabling teachers to address social and ecological challenges through education: 'ESD helps teachers become agents of change who can challenge harmful practices like deforestation and gender exclusion' (I3-T). In Eswatini, ESD practices emphasised school–community connectivity, with teacher educators designing projects that addressed local needs: 'ESD builds bridges between school and community through local problem-solving projects' (I4-E). Analysed through Bronfenbrenner's bioecological model,[13] these examples show how ESD practices linked micro-level classroom activities with meso- and macro-level community systems. The data indicate that transdisciplinary collaboration, particularly the involvement of community knowledge and peer dialogue, enabled ESD to function as a context-responsive pedagogical process, rather than as a decontextualised curriculum theme.

Interdependence of teacher education, inclusion and sustainability

Participants articulated that inclusion and sustainability could not be meaningfully addressed without changes in teacher education. This recognition emerged through reflection on their own roles as teacher educators, rather than through abstract policy discourse. A Malawian participant

stated: 'Teachers influence change … education systems need to be restructured, so that everybody is welcomed, and that begins with how teachers are trained' (I3-M). Similarly, a Tanzanian educator noted: 'Without teachers who understand sustainability and inclusion, SDG 4 is just a slogan' (I1-T). In Eswatini, participants described a growing awareness that both agendas share a common pedagogical foundation: 'We realised that inclusion and sustainability are two sides of the same coin, both are about participation and responsibility' (I2-E).

Theoretically, this theme reflects the formative interventionist nature of the study. Using Vygotsky's sociocultural theory,[14] the transdisciplinary workshops functioned as mediated learning spaces in which participants collectively examined contradictions between policy aspirations and pedagogical realities. From a bioecological perspective,[13] teacher educators emerged as meso-level actors that translate macro-level policy discourses into classroom-level practices. The findings therefore demonstrate not only the conceptual alignment but also the mechanism through which alignment occurred, namely, socially mediated professional learning in the research process itself.

Structural and resource constraints shaping practice

Progress in this study refers specifically to participants' increased pedagogical clarity and locally enacted practices, not to systemic resolution of structural constraints. Despite pedagogical innovation at the classroom and programme levels, participants reported persistent barriers. In Malawi, infrastructure and assistive resources remained limited: 'Our schools lack ramps and assistive materials for learners with mobility and visual challenges' (I1-M). In Tanzania, national curriculum frameworks constrained local innovation: 'Even when we innovate locally, the national framework dictates what we must teach and how we assess; it leaves no room for context' (I4-T). In Eswatini, participants highlighted capacity and funding gaps: 'We need more trained specialists in inclusive education and better funding for inclusive teacher training' (I3-E). When one uses Bronfenbrenner's model,[13] these findings illustrate misalignment between macro-level structures (policy, infrastructure and financing) and micro-level pedagogical agency. While educators adapted practices locally, systemic constraints limited the scalability and sustainability of these innovations.

Transformative outcomes of the transdisciplinary process

In this study, *transformative learning* is understood as a shift in professional assumptions, pedagogical identity and relational orientation, rather than as immediate structural change. Evidence of transformation emerged through participants' reflections on collaboration, responsibility and professional self-understanding. A Malawian workshop participant reflected: 'No one can work in isolation; we need each other to make education work. Even the community must be involved' (W3-M). In Tanzania, a participant described a change in ethical orientation: 'The project taught us that inclusion is about collaboration, not charity' (I5-T).

In Eswatini, a participant reflected on a shift in teaching purpose: 'I have learned that sustainability starts with how we teach, how we make learners think about others and the environment' (I5-E).

These statements indicate personal change at the level of professional values and identity, alongside a professional change in pedagogical practice. Participants also reported observable outcomes in their teaching contexts, including increased peer mentoring among student teachers, inclusive lesson planning and community-based sustainability activities such as tree planting. From a Vygotskian perspective,[14] these outcomes illustrate movement in the ZPD, in which collaborative reflection enabled participants to internalise new ways of thinking and acting. In this sense, transformation was incremental, relational and practice-based, rather than immediate or totalising.

Discussion

The findings of this study indicate that ESD, inclusive education and teacher education were experienced by participants as practically interconnected in their professional work, rather than as entirely separate reform agendas. This interconnection was most visible at the level of pedagogical decision-making, in which teacher educators described adapting lesson design, assessment practices and community engagement activities to address both inclusion and sustainability concerns simultaneously. In this respect, the study provides context-specific empirical support for arguments made by O'Donoghue and Rončević[6] in Southern Africa and Rončević and Rieckmann[2] in European contexts, while also showing how these relationships are enacted under conditions of resource constraint.

The study does not claim a systemic transformation of education systems. Instead, it demonstrates how localised pedagogical practices, developed through transdisciplinary engagement, enabled teacher educators to navigate systemic challenges such as social exclusion, environmental vulnerability and curriculum rigidity. These challenges, as documented in the findings, were not experienced merely as pedagogical problems but as structural and ecological conditions shaping practice, consistent with broader analyses of Southern African education systems.[1] The contribution of transdisciplinary research in this context lay in its capacity to create structured spaces for negotiation between macro-level policy expectations and micro-level classroom realities, as evidenced in participants' accounts of adapting national curricula, embedding inclusive lesson planning and linking ESD activities to community contexts. On this basis, the study demonstrates how educational change can be understood as unfolding in and across interconnected systems, rather than as linear reform processes.

The constructs integrated in this study are inclusive pedagogy (understood as practices that promote participation, belonging and access for diverse learners) and ESD-oriented

pedagogy (understood as teaching that links learning to social, economic and environmental sustainability challenges). The findings show that these constructs were not treated as parallel ambitions by participants but became interdependent in practice, particularly in lesson planning, assessment design and community engagement activities. Viewed through Bronfenbrenner's ecological framework,[13] inclusive pedagogy was enacted at multiple systemic levels, from classroom interaction and peer learning (microsystem), to institutional curriculum planning (mesosystem), to engagement with national policy constraints (exosystem). Similarly, ESD practices operated across these same levels, linking classroom activities to community livelihoods and environmental concerns. The evidence for this interdependence lies in participants' descriptions of practices such as inclusive lesson planning that embedded sustainability themes, and ESD projects that intentionally addressed learner diversity and access (Themes 1 and 2).

The study shows that inclusion and sustainability shared a common pedagogical logic in practice: both required cooperation, adaptability and responsiveness to contextual constraints. This finding aligns with Rončević and Rieckmann's[2] assertion that inclusion-oriented ESD foregrounds human rights, social justice and participation. However, the present study contributes by demonstrating how this logic was enacted in teacher education settings, rather than asserting it normatively. The synthesis achieved here is therefore practice-based, connecting inclusive participation, community relevance and sustainability-oriented learning in concrete teaching activities. This synthesis challenges the fragmentation of teacher education curricula identified by Stevenson et al.,[4] not by proposing wholesale curriculum reform but by illustrating how educators worked across existing curricular boundaries.

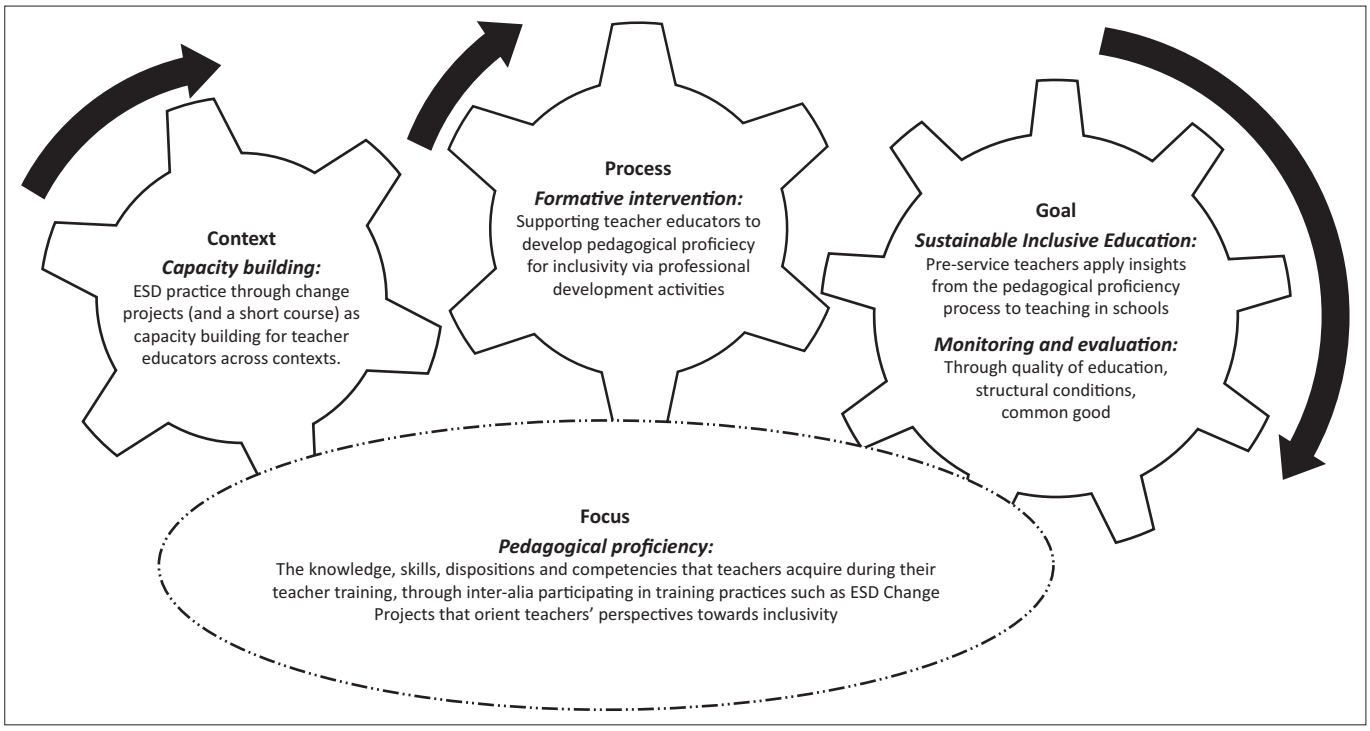
Central to the study's findings is the role of teacher educators as mediators between policy expectations and pedagogical practice. In Bronfenbrenner's schema,[13] teacher educators occupy a mesosystemic position, connecting national frameworks, institutional curricula and classroom enactment. Evidence of this mediating role is found in participants' accounts of adapting prescribed curricula to include inclusive lesson design, negotiating assessment requirements and embedding ESD projects in existing modules (Themes 1, 2 and 4).

This mediating work reflects Vygotsky's conception of learning as socially mediated,[14] in which professional understanding develops through dialogue, collaboration and shared problem-solving. In the study, transdisciplinary engagement was operationalised through collaborative workshops involving teacher educators and, in some cases, community-linked knowledge, in which participants analysed contradictions between policy and practice and co-designed pedagogical responses. These engagements were transdisciplinary, not simply because multiple actors were present but also because knowledge from different domains (academic theory, professional practice and local context) was brought into structured dialogue to address shared educational problems. The evidence for this lies in participants' reflections on changed assumptions about inclusion, collaboration and sustainability, as well as in documented pedagogical adaptations. Professional learning, therefore, emerged as a collective and reflective process, rather than as top-down training, consistent with a critical realist understanding of educational change as contingent and context-bound.[16]

Beyond its empirical insights, the study contributes to debates on transdisciplinarity as both a methodological and an epistemological approach. Methodologically, the formative interventionist design[15] positioned participants as active contributors to problem analysis and pedagogical redesign, rather than as passive research subjects. Evidence of this method is found in the workshops where participants identified contradictions in their own practices, tested new strategies and reflected collectively on outcomes (Themes 1, 3 and 5). These processes were reflexively transformative in a limited but meaningful sense: not because they produced immediate structural change but because they supported shifts in professional assumptions, ethical orientations and pedagogical reasoning, as reported by participants.[22] Epistemologically, the transdisciplinary approach enabled the integration of academic knowledge (theory), professional knowledge (teaching practice) and contextual knowledge (community realities). While the study does not claim to fully dismantle Western-centric paradigms, it demonstrates how local knowledge and lived experience informed pedagogical design, thereby complicating purely technocratic or externally imposed models of reform. From a critical realist perspective,[16,17] this integration supports analysis of not only what practices emerged but also why certain practices were possible or constrained in particular structural conditions. In this sense, transdisciplinary research functioned as a mechanism for both explanation and incremental change.[10]

One outcome of this analytical process was the development of the Sustainable Inclusive Pedagogical Proficiency Process (SIP3) model. This model is propounded in detail in my doctoral thesis.[22] The model, as shown in Figure 1, should be understood not as a predictive theory but as an analytical abstraction derived from recurring patterns in the data. The model synthesises observed relationships between individual pedagogical agency, institutional structures, and broader sustainability and inclusion goals. Consistent with Bronfenbrenner's bioecological model,[13] SIP3 conceptualises transformation as non-linear and iterative, shaped by interaction among systems rather than by isolated interventions. The model operationalises the study's empirical insights by offering a way to conceptualise how teacher educators develop proficiency in integrating inclusion and sustainability over time. The value of the model lies in its capacity to bridge empirical findings and practical reflection, particularly in resource-constrained settings in which comprehensive reform is unlikely.

The implications of these findings extend beyond the immediate cases, while remaining appropriately bounded. The study suggests that transdisciplinary approaches offer practical value for addressing the entangled challenges of



Source: De Souza B. Investigating the mainstreaming of inclusive education in teacher education practice for pedagogical proficiency through education for sustainable development change projects in Southern Africa [dissertation] [homepage on the Internet]. Grahamstown: Rhodes University; 2024 [cited 2025 Aug 18]; p. 225. Available from: http://hdl.handle.net/10962/480106[22]
ESD, Education for Sustainable Development.

FIGURE 1: Sustainable inclusive pedagogical proficiency process model.

inequality, sustainability and teacher preparation in Southern Africa.[1,2,6] However, the study does not claim that transdisciplinarity alone resolves structural inequities. Instead, the study shows how teacher education can function as a strategic praxis for incremental and context-responsive change, aligning with calls for integrative frameworks that link social justice, sustainability and pedagogy.[7] In this praxis, teacher education becomes both a constraint and a possibility.[4] Through professional formation manifested in ecological awareness, inclusive practice and reflective collaboration, teacher educators can contribute meaningfully to the aspirations of SDG 4.[1,2,5] The argument advanced here is therefore both empirical and cautiously normative: transdisciplinary approaches are not presented as universal solutions, but as necessary enabling conditions for coherent and contextually grounded educational reform.

Conclusion

This study addresses the fragmentation of inclusive education, ESD and teacher education in SDG 4 by showing, in practice, how these areas are interconnected rather than separate. Evidence from Malawi, Tanzania and Eswatini demonstrates that teacher educators negotiate inclusion and sustainability together under policy, institutional and resource constraints. The study shows how a transdisciplinary research approach can act as a context-sensitive enabler of integration. Through collaborative workshops, reflective dialogue and local experimentation, educators developed more coherent strategies for inclusive lesson planning, community-linked ESD and adaptive teaching. Theoretically, the study identifies social mediation, bioecological alignment and professional agency as key mechanisms that enable this integration. The study contributes to the limited body of transdisciplinary educator research in Southern Africa by providing empirical and practice-based evidence that counters overly abstract accounts in the literature. Key implications include the need for institutional, policy and resourcing support, as well as recognition that low-cost practices, such as peer collaboration, community projects and reflective workshops, can be effective and scalable. While limited in scope and duration, the study shows that transdisciplinary approaches offer a pragmatic pathway towards more inclusive and sustainable teacher education.

Acknowledgements

This article is based on research originally conducted as part of Ben de Souza's doctoral thesis titled 'Investigating the mainstreaming of inclusive education in teacher education practice for pedagogical proficiency through Education for Sustainable Development change projects in Southern Africa', submitted to the Faculty of Education, Rhodes University in 2024. The thesis was supervised by Heila Lotz-Sisitka. The supervisor was not involved in the preparation of this manuscript and was not listed as a co-author. The manuscript has since been revised and adapted for journal publication. The original thesis is publicly available at: http://hdl.handle.net/10962/480106.

This article is based on data from a larger study. Two other articles were published from the same thesis. The first article focusing on sustainability-oriented teacher education for inclusive education in Southern Africa has been published in

the *Journal of Education (University of KwaZulu-Natal)*, Issue 102. The second article focusing on education for sustainable development in teacher development for inclusive education in Malawi has been published in the *African Journal of Teacher Education and Development*, Issue 4. One other article was published based on the same study data, i.e. the data were not featured in the thesis. This article focuses on examining the role of Education for Sustainable Development (ESD) in strengthening inclusive education in teacher education: A Vygotskian analysis of change projects from Malawi and Eswatini has been published in the *Journal of Education (University of KwaZulu-Natal)*, Issue 96.

Competing interests

The author reported that they received funding from the National Research Foundation, Canon Collins Trust, and additional funds were provided by the SARChI Chair in Global Change and Social Learning Systems at Rhodes University through the Sustainability Starts with Teachers programme, which may be affected by the research reported in the enclosed publication. The author has disclosed those interests fully and has implemented an approved plan for managing any potential conflicts arising from their involvement. The terms of these funding arrangements have been reviewed and approved by the affiliated university in accordance with its policy on objectivity in research.

CRediT authorship contribution

Ben de Souza: Conceptualisation, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualisation, Writing – original draft, Writing – review & editing. The author confirms that this work is entirely their own, has reviewed the article, approved the final version for submission and publication, and takes full responsibility for the integrity of its findings.

Funding information

This work was supported by the doctoral scholarships awarded to the author by the National Research Foundation, Canon Collins Trust, and the SARChI Chair in Global Change and Social Learning Systems at Rhodes University through the Sustainability Starts with Teachers programme.

Data availability

The data that support the findings of this study are openly available in the Rhodes University research repository at https://doi.org/10.21504/RUR.26426032.v1.

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