The framing of course design tools for an online pre-service teacher training course to activate ESD in subject teaching[1]

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ABSTRACT

This study explores developing and implementing an online course to integrate Education for Sustainable Development (ESD) into the South African Curriculum Assessment Policy Statement (CAPS). The course design process emphasises the inclusion of Indigenous Knowledge Systems (IKS) and Sustainable Livelihoods as core components, fostering a transformative learning experience for teachers. Leveraging a Vygotskian action learning schema and expansive learning cycles, the course supports a co-engaged design research methodology to enhance teacher capacity in ESD. A 'theory of change' evaluation framework assesses the course's impact on curriculum strengthening. Key findings indicate that online teacher capacity-building programmes can effectively engage teachers, promote curriculum-activated ESD initiatives, and facilitate deeper integration of IKS and sustainable practices in school teaching. The hybrid design, combining online and face-to-face interactions, fosters a Professional Learning Community (PLC), which enhances teaching practices and learner engagement through real-world sustainability challenges.

Keywords: online learning, curriculum strengthening, course design, Indigenous knowledge systems, Education for Sustainable Development

INTRODUCTION

Like many other countries, South Africa faces severe impacts of climate change, water, energy, and food insecurity, among other critical issues (Carter & Gulati, 2014: 5). Aligned with the National Development Plan, the South African government is implementing the Sustainable Development Goals with all national policies orienting towards sustainable development (National Planning Commission, 2012). Foundational knowledge, competencies, and values are critical to South Africa's sustainable development, hence the need to strengthen Education for Sustainable Development (ESD) in the national curriculum (UNESCO, 2021: 4). The

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National Curriculum Statement in South Africa mandates that all subjects address human rights, social justice, inclusivity, and a healthy environment (Department of Basic Education, 2020: 22).

ESD addresses these matters of concern. It also empowers learners to make informed decisions and take responsible actions for environmental integrity, economic viability, and a just society for present and future generations while respecting cultural diversity (UNESCO 2021: 23). Therefore, it is essential to capacitate and prepare our teachers for the inclusion of ESD in the CAPS curriculum. The authors identified Indigenous Knowledge Systems (IKS) and Sustainable Livelihoods as ESD-related cross-cutting concerns that address the above principles that teachers and subject curriculum specialists need to work with to develop a relevant and sustainable curriculum that addresses actual sustainability matters of concern. To ensure the successful uptake of ESD competencies and knowledge in the CAPS curriculum, teachers must be prepared to teach for a sustainable future (Janse van Rensburg & Lotz-Sisitka, 2000: 45).

Responding to the urgency, including ESD-aligned work within the curriculum and teacher training programmes, teacher trainers and educators found themselves at a crossroads in the development process of online course design frameworks for pre- and in-service teacher capacity building. The paper aims to describe the iterative process of developing and applying such an ESD-aligned pre-and in-service teacher online course framework to support the Department of Basic Education (DBE) initiatives.

This article and the associated research are integral components of the Fundisa for Change programme, a national initiative to enhance teacher education for sustainable development in South Africa. The programme focuses on building the capacity of educators to integrate ESD into the curriculum effectively. By aligning with the Fundisa for Change framework, this study contributes to the broader goals of promoting sustainability practices and empowering teachers with the necessary skills and knowledge. The insights and outcomes from this research are intended to support and advance the objectives of the Fundisa for Change programme, fostering a more sustainable educational environment.

In this article, the authors propose an online course design framework as a course-activated process with teachers to integrate the cross-cutting areas of ESD, namely IKS and Sustainable Livelihoods, to strengthen the CAPS curriculum. This paper outlines a course framework for developing and evaluating a course for pre-and in-service teacher training for ESD curriculum activation in diverse subject fields to strengthen the CAPS curriculum. Therefore, our main research design questions are:

- Can an online course-mediated teacher intervention be developed to support ESD as a curriculum-strengthening process with the inclusion of IKS and Sustainable Livelihoods as integral concerns?
- Can an online teacher capacity-building programme engage teachers in ways that include curriculum-activated Education for Sustainable Development (ESD) initiatives in school subject teaching?

THEORETICAL FRAMEWORK

This paper is underpinned by a theoretical framework that integrates several educational theories to support the development of an online course to activate ESD in teacher training. The framework combines Vygotskian action learning principles, expansive learning cycles, the theory of change, and cultural-historical activity theory, creating a comprehensive approach to transformative learning (Figure 1).

Figure 1:
Phase One: Conceptualising the course design, emphasising the integration of ESD as a transformative learning process

1. Framing ESD as a Transformative Learning Process to inform ESD Course Framework and Design.
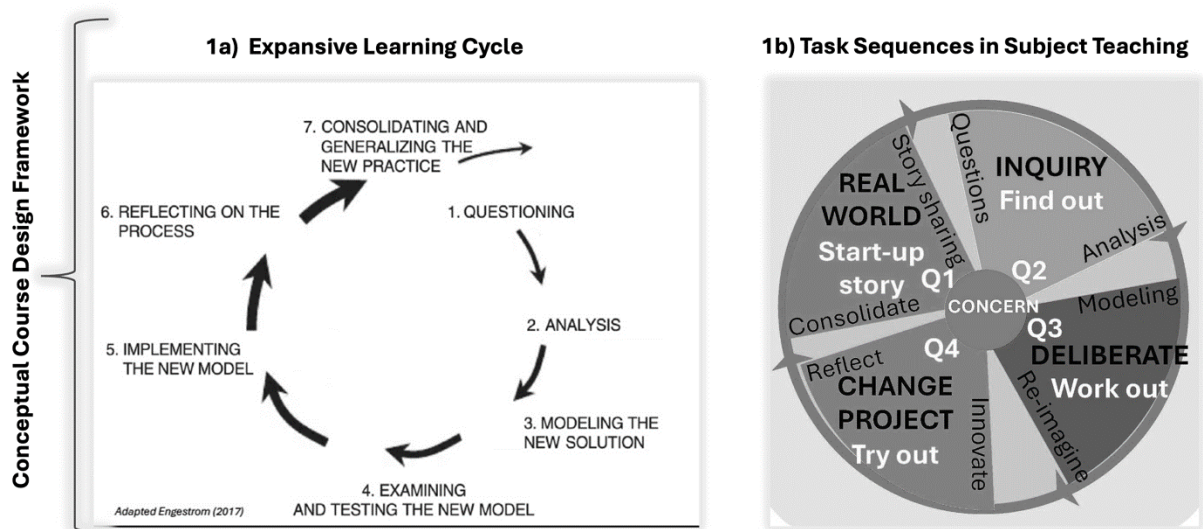
Vygotskian action learning principles

Lev Vygotsky's theories emphasise the social context of learning, highlighting the importance of interactions between learners and more knowledgeable others. This action learning schema informs the design of the ESD-aligned teacher capacity online course framework, promoting collaborative learning and co-construction of knowledge. By engaging teachers in a process where they actively participate and reflect on their practice, the course design aims to foster a deeper understanding and application of ESD principles in diverse educational contexts (Vygotsky, 1978: 56).

Expansive learning cycles

Engeström and Sannino's concept of expansive learning is central to the framework consisting of cycles of questioning, analysing, modelling, examining, implementing, reflecting, and consolidating (Figure 1). This approach is particularly suited to addressing complex, contextual matters of concern faced during the framework and course design process. It allows course designers and participants to go beyond their existing knowledge and practices to develop innovative solutions (Engeström & Sannino, 2010: 15).

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Theory of change

The theory of change framework is employed to structure and evaluate the course's impact. This approach involves mapping the desired outcomes and working backwards to identify the necessary pre-conditions and objectives (Figure 3). In this study, the theory of change helps clarify how the ESD-aligned teacher capacity online course framework can strengthen the uptake of IKS and sustainable livelihoods in the curriculum through teacher training (Weiss, 1995: 77).

Cultural-historical activity theory

The ESD-aligned online course framework design is also informed by cultural-historical activity theory, which views learning as a dynamic process mediated by cultural artefacts and social interactions. This perspective aligns with the course's emphasis on contextualising learning within the sustainability matters of concern and leveraging Indigenous knowledge and Sustainable Livelihoods as a valuable resource. The course can make ESD more relevant and impactful by situating the learning process within the teachers' and learners' cultural and historical contexts (Engeström, 2001: 34).

METHODOLOGY

Through this study, a pre-service teacher[2] course and five in-service teacher courses[3] were developed. This article reports on the pre-service teacher capacity-building programme. The project was divided into four phases that provide a comprehensive overview of the iterative methodological process of developing and implementing an ESD course framework for pre-service teacher training.

Phase One: Conceptualisation

The process began with Phase One, the foundational phase of conceptualising the course design, emphasising the integration of ESD as a transformative learning process (Figure 1). This initial step involves framing ESD within a theoretical model that supports knowledge-mediated learning, ensuring that the course design aligns with educational objectives and sustainability goals. The conceptual framework is informed by expansive learning cycles and Vygotskian action learning principles, which provide a well-balanced structure to support course development (Vygotsky, 1978: 56; Engeström & Sannino, 2010: 15).

LITERATURE REVIEW ON COURSE DESIGN

To clarify a suitable online course design, recent environmental education online courses and their designs were reviewed including the UNESCO Sustainability Starts with Teachers (UNESCO SST), the Fundisa for Change Education for Sustainable Development collaboration, and the recent production of a Handprints Teacher Education Handbook produced for ESD in school curriculum settings (O'Donoghue, Misser & Snow-Macleod, 2021: 15; van Staden & O'Donoghue, 2023: 23; van Staden & Lotz-Sisitka, 2023: 45). All the above-reviewed courses were initially face-to-face programmes that, with the advent of the COVID-19 pandemic, had

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[2] https://courses.fundisaforchange.co.za/courses/foodgarden/

[3] https://courses.fundisaforchange.co.za/

to shift to a virtual e-learning approach. These teacher education initiatives in southern Africa have developed ESD to be included as school-in-community initiatives that incorporate indigenous heritage knowledge (IKS) and activate change projects in curriculum settings (van Staden & O'Donoghue, 2023: 23). The development of these types of ESD-aligned online courses has informed this study on the design and development of online frameworks for interactive, situated learning that seeks to support sustainability practices and the engagement of teachers and teacher educators (van Staden & O'Donoghue, 2023: 45; O'Donoghue, Misser & Snow-Macleod, 2021: 15).

An additional in-depth literature review of models for online learning was conducted to strengthen this study. Specific models examined Blending with the Pedagogical Purpose model (Bosch, 2016: 3), the Multimodal Model for Online Education (Picciano, 2017: 48), and the Community of Inquiry framework developed by Garrison, Anderson, and Archer (2000: 88). Additionally, the work of Gogus (2023: 4), which adopted the Activity System Theory Framework to support effective online learning experiences, resonated with this research as it focuses on creating and enhancing online cognitive, teaching, and social presence through a cultural-historical approach.

CONCEPTUAL FRAMEWORK DEVELOPMENT

A sound conceptual framework for the online course design was established, informed by Vygotskian action learning principles and expansive learning cycles articulated by Engeström and Sannino (2010: 15). This framework and the task sequence in subject teaching guided the subsequent development and application of the course, supporting the process of framing ESD as a transformative process of knowledge-mediated learning (Figure 1) (Vygotsky, 1978: 56; Engeström & Sannino, 2010: 15).

Phase Two: Design research - Development of online learning platform and resources

Following the conceptualisation, the process moves into the design research phase. This phase was characterised by a co-engaged approach where teachers actively develop and refine the course. The design research process included deliberative workshops to surface IKS and Sustainable Livelihoods as matters of concern and incorporate them into curriculum topics. Start-up stories and lesson plans were developed to create engaging and contextually relevant content. This collaborative effort ensured that the course material was theoretically sound and practically applicable in real-world teaching scenarios (Weiss, 1995: 77).

Development of online learning platform and resources

The design team comprised three main members, each with distinct roles. The course designer and developer were responsible for the overall course structure and development. The two-course presenters, who also co-developed the materials, focused on delivering the course content. Together, they worked on two main aspects of development:

- Creation of an Online Learning Platform: Facilitated interactive and situated learning experiences.

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- Development of Resources: Compiled start-up activities and materials, providing case evidence on African Heritage Knowledge uncovered and recovered by researchers at an environmental learning research centre (Schudel & Lotz-Sisitka, 2021: 48).

Theoretical framework application

The theoretical underpinnings of the course were applied to develop practical, situated learning sequences that facilitated transformative learning. These sequences included questioning, inquiry, modelling, analysis, and application phases, all aimed at engaging teachers with real-world matters of concern (Edwards, 2014: 18; Engeström, 2010: 15).

Figure 2:
Phase 2 - the Design Research Phase

2. Design Research Process
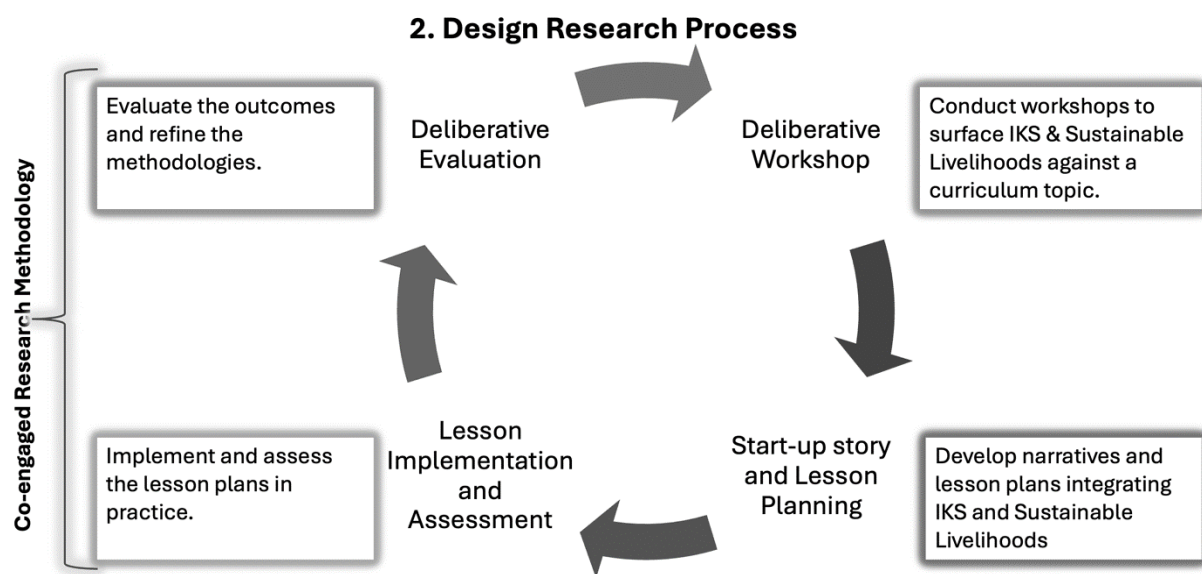
Phase 3: Pilot course implementation

The implementation phase, depicted in Figure 2, showcased the practical application of the developed course materials and involved a five-week pilot programme focused on Heritage Food Gardening. This phase included the actual teaching and learning activities, where the course was delivered to participants through a hybrid model of online and face-to-face sessions. This programme included practical contact sessions and curriculum-activated learning activities designed to promote sustainable livelihood practices through school-in-community ESD projects. Teachers participated in co-engaged lesson design research processes, enhancing their capacity to integrate ESD into their teaching practices (Schudel & Lotz-Sisitka, 2021: 33). The teachers engaged with the content, participated in hands-on activities, and implemented the lesson plans in their classrooms. This stage was crucial for gathering feedback and observing the practical impacts of the course design on teaching practices and learner engagement.

## Phase Four: Evaluation and iterative improvement

Finally, the evaluation and iterative improvement phase is highlighted in Figure 3. This involved continuous monitoring and assessment of the course's effectiveness, utilising a theory of change

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framework. The evaluation process included collecting data on teacher and learner outcomes, analysing the effectiveness of the teaching methods, and refining the course materials based on feedback. The course design was continuously evaluated and refined based on feedback from participating teachers and the Professional Learning Community (PLC). The evaluation process utilised a theory of change framework to assess the course's impact on strengthening the CAPS through ESD integration. This iterative cycle ensured that the course remained relevant and practical, continuously adapting to the needs of teachers and the educational context. Figure 3 depicts this dynamic and collaborative process, emphasising the importance of co-engagement, practical application, and continuous improvement in developing a successful ESD course framework (Engeström, 2001: 34).

Final course analysis and rollout

Based on the iterative development process, the final course design incorporated the theoretical and practical insights gained. The course included both online and face-to-face interactions, providing a hybrid learning model supporting teacher capacity building and ESD curriculum activation.

Figure 3:

Implementation Phase - Applying Theory of Change for ESD Course Framework
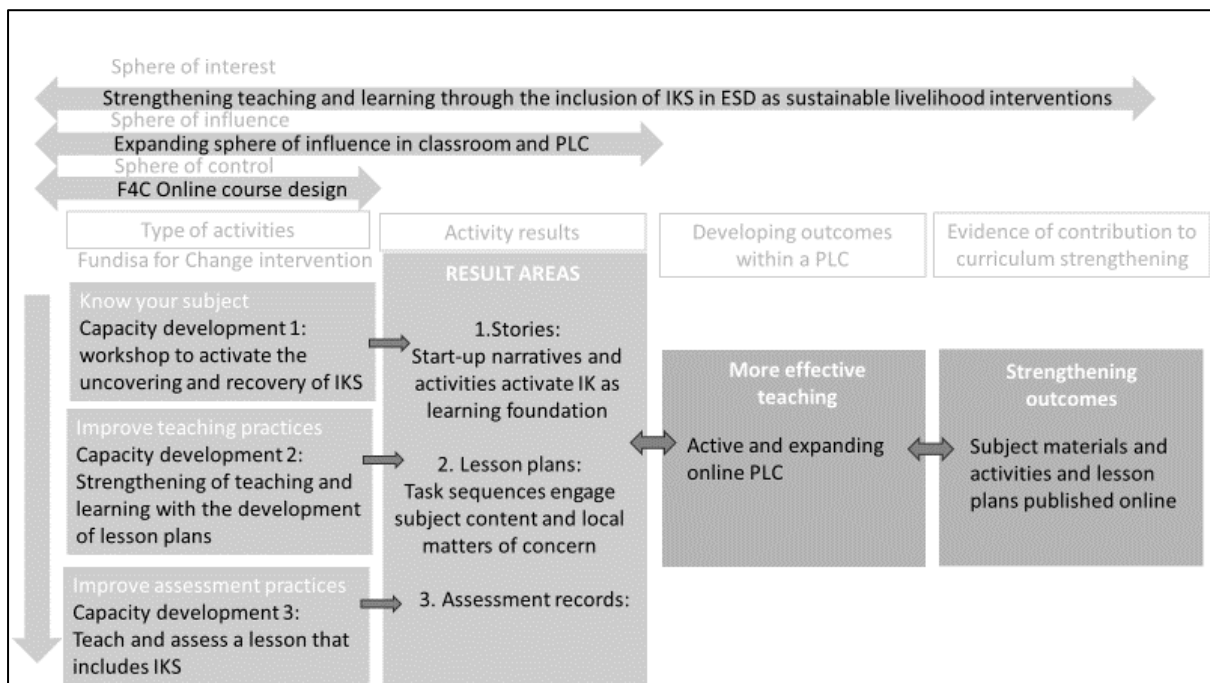
RESULTS

Phase 1: Framing ESD as a transformative process of knowledge-mediated learning

To design the ESD-aligned pre-service teacher capacity online course framework, we framed ESD as a transformative process of knowledge-mediated learning. Drawing on Vygotsky (1978: 86) and Engeström (2001: 133), we mapped out ESD as a transformative learning process

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through the application of the Expansive Learning cycle, which is a model for understanding and facilitating transformative learning (Figure 1).

Firstly, the expansive learning cycle was applied as an iterative process to map our course design and track the course framework and design development. A schematic model of the process (Figure 1) was developed as a learning sequence for knowledge-mediated social change. This model also enabled the conceptualisation of action learning progressions in school curriculum settings as co-engaged task sequences (Figure 1). This process informed a simplified task sequencing lesson planning progression developed for the Handprint CARE Teacher Education Handbook (Sarabhai et al., 2022: 45). The co-engaged task sequences focus on how ESD principles can be integrated into lesson planning and teaching. The key components of the co-engaged task sequences include:

1. Inquiry: Engaging students in finding out information through questions and investigations.
2. Analysis: Analysing the information gathered to understand the underlying issues and concepts.
3. Modelling: Creating models or representations of the new solutions or concepts learned.
4. Deliberate: Reflecting and re-imagining how these new solutions can be implemented in practice.
5. Change Project: Implementing small-scale curriculum-activated change projects to apply the new knowledge and solutions.
6. Real World: Using real-world scenarios and start-up stories to contextualise learning and make it relevant.
7. Reflect and Consolidate: Reflect on the outcomes of the curriculum-activated change projects and consolidate the learning to stabilise the new knowledge.

This schematic model of the process was developed as a learning sequence for knowledge-mediated social change, enabling the conceptualisation of action learning progressions in school curriculum settings as co-engaged task sequences. This model includes the analytical lenses for learning-led change provided by Engeström and Sannino (2010: 4). In course development and facilitation with pre-service teachers, the expansive learning cycle for transformative learning was integrated with curriculum task sequences as outlined by Edwards (2014: 22).

From this design, we developed the ESD-aligned online course framework for a Foundation Phase pre-service course in Food Gardening, effectively providing teachers with possibilities to integrate IKS and Sustainable Livelihoods into the curriculum and their lessons by utilising the expansive learning process and task sequence methods. Through a structured approach, the course encouraged teachers to reflect on past teaching practices, assess current food security issues, and develop action plans that harmonise traditional knowledge with modern sustainability practices. This process included stages such as questioning existing practices, analysing current conditions, modelling new solutions, and implementing and reflecting on these solutions in real-world scenarios. Each course module was structured according to the curriculum task sequence linked to expanding the past to the present towards the future. This

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reflective and iterative process enabled teachers to understand the value of IKS and its application in promoting sustainable livelihoods.

The model closely combines a cultural-historical approach to dialogical processes of social learning (Engeström & Sannino, 2010: 6) with Vygotskian action learning task sequences (Edwards, 2014: 25). This combination facilitated the engagement of sustainability matters of concern within curriculum settings by culturally situating curriculum and learning. Through a formative collaboration process, pre-service teachers developed materials that activated learning via real-world stories, including integrating IKS and Sustainable Livelihoods. This method encouraged participants to raise questions about matters of concern, co-engaged learning, change project interventions, evaluation, and reflection.

Informed by this body of theory and schematic starting points for lesson design, the course was developed as a situated process activated around the acquisition of subject knowledge as a foundation for ESD as a deliberative process of transformative learning that can be activated and supported in school curriculum settings through lesson design research with teachers.

Development of online learning platform and course materials

A co-engaged research methodology was developed for the online learning process to engage teachers in ESD. This began with a workshop where participating teachers surfaced and deliberated on IKS and Sustainable Livelihoods related to a curriculum topic. The aim was to generate 'start-up stories'[4] that would frame the teaching topic, fostering inquiry and data generation for later analysis and potential change projects. This methodology centred on story sharing to raise questions, gather data on concerns and explore possible interventions.

Pilot course implementation

During the pilot implementation, student teachers applied the 'teacher-as-researchers' approach (Stenhouse, 1975: 143). They developed and assessed lesson plans integrating IKS and Sustainable Livelihoods as ESD topics. These lesson plans were then offered for in-depth analysis and feedback to clarify ESD methodologies for including intergenerational heritage in curriculum settings. This phase emphasised collaborative learning and the iterative development of teaching materials, ensuring that the integration of IKS and Sustainable Livelihoods was practical and effective.

Evaluation

The evaluation phase involved analysing the start-up stories, lesson plans and assignments created by the course participants, pre-service teachers. This analysis aimed to refine ESD methodologies for incorporating IKS and Sustainable Livelihoods into the curriculum. Feedback from this phase was crucial in identifying the strengths and areas for improvement in the teaching materials and strategies developed during the pilot implementation. The evaluation focused on both the content and the pedagogical approaches used.

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[4] Click here to access an example of one of these start-up stories:

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Co-engaged methodological approach

The design research process was approached as a co-engaged deliberative process involving teachers in generative pedagogical interventions towards the inclusion of IKS and Sustainable livelihoods in teaching and learning settings within the CAPS curriculum. This collaborative approach ensured that the research was grounded in real classroom experiences and responsive to the needs and insights of teachers. The co-engaged methodology fostered a supportive environment for experimenting with and refining new teaching strategies.

Applying theory of change to course development

The theoretical framework for ESD and the lesson design research schema for professional development work with teachers had to align with the DBE policy for strengthening the CAPS Curriculum, so we developed a theory of change evaluation framework that aligns with and is suitable for the proposed course.

Following the conventions of a 'theory of change' approach to evaluation research, the result areas are mapped out around the ESD curriculum planning and lesson design areas of:

- Content as situated narrative in relation to sustainability concerns (Know your subject: Strengthened subject knowledge)
- Active learning methodology and learner engagement (Improved teaching practices: Strengthened relevance and learner engagement)
- Expansion of assessment to include both knowledge acquisition and a broader view of learning outcomes. (Improved assessment practices: Significant learning and academic performance)

The 'theory of change' schema mapped out in Figure 3 enables an assessment of progressive performance using the data generated in online course assignments. It shows how these can be reviewed as curriculum-strengthening evidence for reporting against the DBE curriculum-strengthening imperative of including IKS and Sustainable livelihoods as ESD matters of concern.

Applying the Theory of Change in this research involved using narrative inclusion—questioning, analysis, modelling, implementation, and reflection—to create a coherent and ethically grounded approach to integrating IKS and sustainable livelihoods in subject teaching. Data analysis clarified ESD models of process, highlighting the transformative potential of these methodologies in enhancing teacher capacity and promoting sustainable education practices. This iterative and reflective approach ensured continuous improvement and adaptation of teaching strategies to better integrate IKS and sustainable livelihoods and support sustainable livelihoods.

Following this structured approach, the Life Orientation: Healthy Living course aimed to develop an ESD-aligned online learning platform and course materials that effectively integrated IKS and Sustainable Livelihoods to support sustainable education practices, strengthening teacher capacity and promoting a deeper understanding of sustainability among students. Figure 3 outlines the process of applying the Theory of Change to the ESD Course Framework.

Figure 3 illustrates a comprehensive framework for integrating IKS situated in ESD as sustainable Livelihood interventions through the Fundisa for Change programme. This framework outlines the spheres of interest, influence, and control, along with the types of activities, their results, and the ultimate outcomes. The process focuses on strengthening teaching and learning through the inclusion of IKS in ESD to support Sustainable Livelihood interventions. It expands the sphere of influence within classrooms and PLCs, aiming to integrate these practices broadly. The Sphere of Control centres are designing the Fundisa for Change online course, the primary tool for implementing this framework. By following this framework, the Fundisa for Change course designers aimed to create a sustainable and scalable model for integrating IKS and Sustainable Livelihoods into educational practices, ultimately leading to more effective teaching and strengthened curriculum outcomes.

DISCUSSION

This formative research on ESD course design focused on developing an ESD model of process as a course design framework for an online course supported by face-to-face practical sessions. The aim was to prepare a course-mediated process to support teacher-design research interventions and a theory of change framework for monitoring and evaluating the course in line with the imperative strengthening of the CAPS curriculum. Through the course's development, continuous monitoring, and evaluation, we gained valuable insights into the different aspects of such a framework and reconceptualisation process.

The theoretical framework, informed by the Vygotskian action learning schema, framed ESD as a transformative learning process (Vygotskian, 1978: 57). This framework is essential for developing a teacher capacity-building course that encourages teachers to engage deeply with subject content and deliberate on matters of concern in the classroom. The proposed theoretical framework for ESD and teacher design research supports curriculum-activated ESD initiatives, emphasising the importance of IKS and Sustainable Livelihoods (Figure 2). The expansive learning cycle facilitated the development of lesson plans that engage learners with real-world stories of change and shared concerns (Figure 1). This framework supports the design of a course that mediates teaching and learning processes, resulting in curriculum-activated ESD initiatives that strengthen the CAPS curriculum and the uptake of ESD matters of concern, IKS, and Sustainable Livelihoods (Engeström & Sannino, 2010: 15; Edwards, 2014: 25).

The co-engaged design process enabled active participation from course participants and the development of a PLC. Through deliberative workshops, teachers identified or created start-up stories shared lesson implementations and participated in evaluations. The hybrid design of online and face-to-face sessions, coupled with practical tasks, helped track and develop competencies in ESD lesson design, learning mediation, and change project support. This approach emphasised situating learning in real-world contexts, mediating learner-led inquiries, analysing inquiry data, and enacting small-scale change projects. The co-engaged course design research approach significantly strengthened subject knowledge, teaching practices, and learner engagement, improving academic performance (Stenhouse, 1988: 45; McKernan, 2008: 23).

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The online course, developed using the Fundisa for Change Theory of Change schema, was structured to enhance teacher capacity in specific areas (Figure 3). Each module consisted of three sessions, starting with a workshop that focused on subject knowledge, teaching practices, and assessment practices linked to IKS and Sustainable livelihoods in ESD. The first unit addressed subject knowledge, IKS and Sustainable livelihoods through story-sharing and start-up narratives. The second unit focused on lesson plan design and task sequences for curriculum activation, while the third unit covered significant learning through assessment practices. Practical tasks and assessments allowed teachers to engage actively with the course material and contribute as design researchers. The course culminated in a curriculum-oriented change project assignment, integrating ESD matters of concern into classroom settings (O'Donoghue, Misser & Snow-Macleod, 2021: 39; van Staden & Lotz-Sisitka, 2023: 12).

Based on the Theory of Change, the evaluation process allowed researchers to assess the course's outcomes and its contribution to curriculum strengthening. By tracking participants' progress and addressing challenges, the course facilitators ensured that the course effectively developed teacher capacities. Linking capacity-building areas to result in areas simplified the evaluation, highlighting the active and expanding online PLC and the contribution to curriculum strengthening (Garrison, Anderson & Archer, 2000: 89; Gogus, 2023: 7).

While the online learning platform presented some challenges, such as participants' partial engagement and navigation difficulties, it also offered co-engaged curriculum activation and teacher training opportunities. To address these challenges, an initial session introducing the online platform is recommended to ensure participants understand the course's structure and how to engage fully with the content. Overall, the course demonstrated that an online teacher capacity-building programme could effectively engage teachers and support curriculum-activated ESD initiatives, fostering a deeper understanding and integration of IKS and sustainable livelihoods in school subject teaching (Bosch, 2016: 12; Picciano, 2017: 42).

CONCLUSION

Based on the findings from our discussion, an online (digital) course-mediated teacher intervention process to support ESD for curriculum strengthening, with the inclusion of IKS and Sustainable Livelihoods as integral concerns, is indeed possible. This is achievable when situated within an ESD Theory of Change course design framework and implemented as an active, co-engaged design research process (Figures 2, 3).

Our research confirms that an online course-mediated teacher intervention can effectively support ESD as a curriculum-strengthening process. The inclusion of IKS and Sustainable Livelihoods as cross-cutting concerns enriches the curriculum by providing a comprehensive framework for transformative learning. By employing a theoretical framework informed by Vygotskian action learning, the course design facilitated the integration of real-world stories of change and shared concerns into lesson planning. The expansive learning cycle supported teachers in developing and implementing ESD initiatives that enhance the CAPS curriculum, promoting sustainable education practices.

Our findings demonstrate that online teacher capacity-building programmes can engage teachers in meaningful ways, including curriculum-activated ESD initiatives in school subject

teaching. The structured modules, aligned with the Fundisa for Change Theory of Change schema, allowed teachers to engage deeply with subject content, lesson plan design, assessment development, and practical activities. By participating in the online course, teachers could develop and refine their teaching practices, supported by a PLC that fostered collaborative learning and knowledge generation. This co-engaged research process empowered teachers to monitor their contributions to the curriculum-strengthening process, ensuring that ESD matters of concern, IKS, and sustainable livelihoods are effectively integrated into their teaching practices.

In summary, the online course framework design facilitated a comprehensive approach to teacher capacity building, enabling course participants to engage with subject knowledge through situated learning. The framework supported improved teaching and assessment practices. It fostered active participation in ESD initiatives, demonstrating the potential for significant curriculum strengthening through a well-structured, co-engaged online learning platform.

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