

## ENHANCING RURAL LIFE SCIENCES TEACHERS' PRACTICAL WORK COMPETENCIES THROUGH A COLLABORATIVE APPROACH TO TEACHER PROFESSIONAL DEVELOPMENT

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### Abstract

This study explores how rural Life Sciences teachers' practical work competencies can be enhanced through a collaborative approach to teacher professional development. Practical work is central to the South African Life Sciences curriculum; however, many rural science teachers face challenges due to geographical isolation, resource constraints, and limited access to training. While the KwaZulu-Natal Department of Education offers workshops, these primarily target Grade 12 teachers and are aimed at addressing persistent matric underperformance. Diagnostic reports from 2020 to 2024 have consistently shown that most matric learners struggle with practical-based questions, reflecting a broader issue which may suggest that many Life Sciences teachers, particularly in rural areas, either do not conduct practical work or lack the necessary competencies. Also, existing workshops do not seem to adequately equip teachers with practical work skills suited to resource-limited contexts. Consequently, little is known about effective interventions for enhancing Life Sciences teachers' practical competencies, which are critical to improving learner outcomes. This participatory action research study explores whether a local university, in collaboration with education stakeholders, can contribute towards upskilling in-service Life Sciences teachers in rural schools, particularly those teaching Grades 10 and 11 by enhancing their practical work competencies. The results of the study showed that to support practical work competencies in rural contexts, professional development should (i) be collaboratively designed and responsive to local needs; (ii) include hands-on training with follow-up support; (iii) provide curriculum-aligned, low-cost resources; and (iv) foster peer networks for continued learning and reflection. The findings from the analysis reveals that long-term success depends on sustained partnerships between universities, schools, and education departments, with teachers actively contributing to shaping and improving professional development workshops.

**Keywords:** *Practical work, teacher professional development, improvisational teaching and learning strategies and collaborative partnerships.*

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### 1. Introduction

In South Africa, practical investigations are an essential component of the Life Sciences curriculum, particularly in the Further Education and Training (FET) phase (Grades 10–12). According to the Curriculum and Assessment Policy Statement (CAPS) (Department of Basic education [DBE], 2011), these investigations are designed to cultivate learners' inquiry skills, scientific reasoning, and understanding of scientific processes. However, in many rural schools, practical work is not being implemented effectively due to lack of infrastructure and underlying teacher beliefs and attitudes (Xaba & Sondlo, 2022). The Life Sciences matric diagnostic reports of over the past five years (2019-2022) from the DBE, have consistently highlighted poor learner performance in questions requiring experimental design, data analysis, and scientific interpretation. This trend signals a deeper pedagogical issue: the underdevelopment of Life Sciences teachers' practical work competencies and the lack of systemic support for their professional growth especially in under-resourced settings. In provinces such as KwaZulu-Natal, rural teachers face significant contextual challenges including inadequate laboratory infrastructure, shortages of consumables and equipment, overcrowded classrooms, and limited access to subject-specific professional development due to their isolated geographical locations. While teacher workshops are widely recognised as a crucial mechanism for building teachers' content knowledge and pedagogical content knowledge (PCK), the current models of workshops delivery seem to be often superficial, exam-focused, and short-term. These workshops typically target Grade 12 content, neglecting foundational teaching in Grades 10 and 11, and fail to provide sustained, context-sensitive support that empowers teachers to adapt practical activities using

locally available materials. As such, the professional development landscape often reproduces inequality, leaving rural teachers isolated and underprepared to meet curriculum demands.

Research by Adebayo et al. (2020), Kibirige et al. (2021), and Chuene and Tiane (2024) highlights the importance of teacher PD programmes that are collaborative, situated, and continuous. Chuene and Tiane (2024) emphasise that science teachers in rural contexts require more than ‘content updates’, but rather need structured opportunities to share practices, co-develop teaching strategies, reflect on their own learning, and receive ongoing support that is tailored to their realities. Moreover, in-service teachers, particularly those who graduated more than a decade ago, frequently report insufficient training in conducting and assessing practical work, further reinforcing the need for responsive professional development initiatives. Thus, the key guiding research question of this paper was “How can rural Life Sciences teachers’ practical work competencies be enhanced through a collaborative approach to teacher professional development?” The paper contributes to the growing body of literature on equitable, sustainable models of professional development for science educators in marginalised contexts. It also offers practical insights for policymakers and higher education institutions aiming to enhance the impact of teacher workshops and other forms of in-service training in rural schools.

## **2. Rural science teachers’ competencies for integrating practical investigations**

CAPS allows teachers a degree of flexibility to adapt practical investigations using locally available materials. However, this assumes that teachers possess the pedagogical content knowledge (PCK) required to design meaningful investigations, improvise effectively, and link theory with practice. Boateng and Maliwa (2024) assert that PCK plays a critical role in shaping learner achievement, and its absence is particularly pronounced in rural schools. Several studies point to significant gaps in Life Sciences teachers' ability to conduct scientific investigations due to limited training in inquiry-based methodologies (Chuene & Tiane, 2024; Furiwai & Singh-Pillay, 2020). Many teachers are unprepared to compensate for the lack of resources through innovative teaching strategies, and few have been exposed to digital laboratories or virtual simulations that could serve as alternatives. As a result, their teaching remains rooted in traditional content transmission, with limited learner engagement or application of investigative skills. Chuene and Tiane (2024) emphasises that strengthening teachers’ capacity to improvise with available materials and integrate digital tools is essential. Similarly, Boateng and Maliwa (2024) advocate for equipping teachers with both theoretical knowledge and hands-on skills to foster inquiry-based learning. Teachers themselves have acknowledged a lack of sufficient training and support from subject advisors, reinforcing the need for targeted professional development (Chuene & Tiane, 2024). Communities of practice have been suggested as a promising model to improve instructional practices. By providing platforms for collaboration, knowledge-sharing, and mutual support, such communities can enhance teachers’ confidence and competence in delivering practical lessons (Chuene & Tiane, 2024). However, for these interventions to be successful, they must be rooted in an understanding of the specific constraints faced by rural teachers.

## **3. Teacher professional development in the South African context**

Given the competency gaps and resource constraints identified, teacher professional development (PD) emerges as a critical lever for change. Teacher PD refers to structured initiatives aimed at enhancing teachers’ knowledge, instructional techniques, and professional growth (Ajani, 2020; Gumbo, 2020). When well-designed, teacher PD has the potential to improve PCK and support the implementation of inquiry-based learning in science classrooms (Xaba & Sondlo, 2022). However, research has highlighted serious shortcomings in existing teacher PD programmes for South African teachers. Ajani (2020) and Gumbo (2020) argue that many teacher PD workshops are often generic in design, fail to focus on subject-specific challenges, and are disconnected from the daily realities of rural classrooms. Teachers are often treated as passive recipients of knowledge, which limits the effectiveness of PD efforts. Mxenge and Bertram (2023) confirm that short-term workshops rarely translate into sustained improvements in classroom practice. Despite these challenges, context-sensitive PD models show promise. Sibisi and Sibisi (2024) report that subject-specific interventions targeting Life Sciences teachers in under-resourced schools led to measurable improvements in both conceptual understanding and classroom application. However, they caution that such gains are limited when resource provisioning is not addressed concurrently. Gumbo (2020) calls for ongoing evaluation to track the long-term effects of PD, while Akuma and Callaghan (2020) argue for the integration of inquiry-based methodologies. Furthermore, Furiwai and Singh-Pillay (2020) recommend aligning PD with CAPS goals and ensuring that participating schools receive appropriate teaching materials.

#### 4. Method

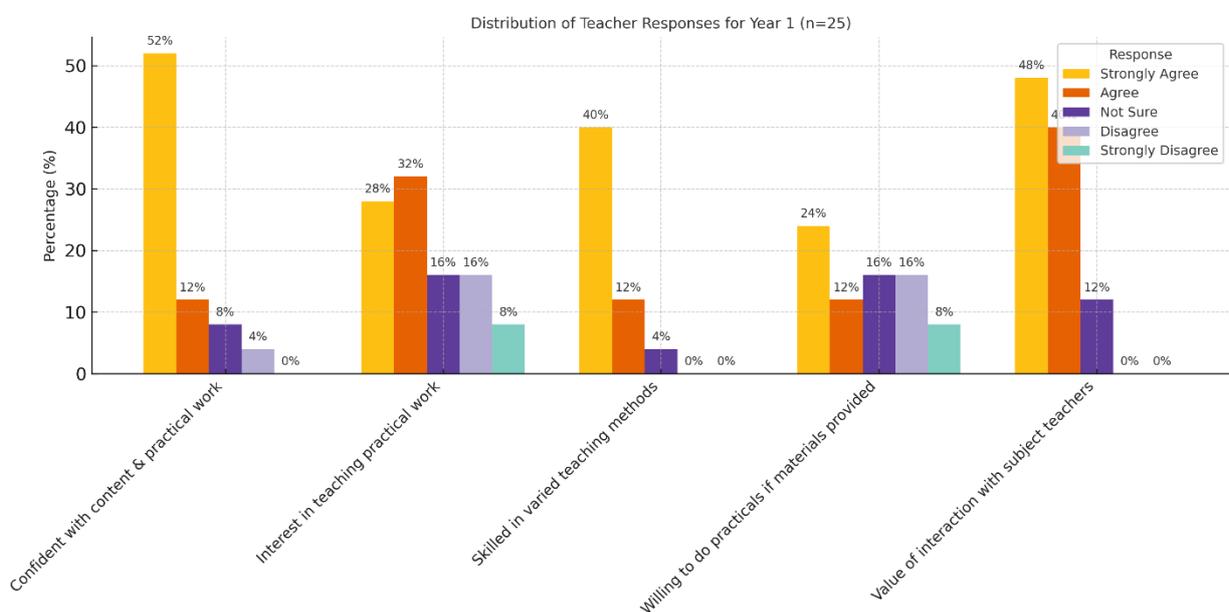
A mixed-methods approach (Creswell, 2014) was employed to capture both quantitative patterns and qualitative insights. Twenty-five Grade 10 and 11 Life Sciences teachers from secondary schools in Zululand, KwaZulu-Natal were purposively selected based on school contexts marked by limited resources, poor performance in school-based assessments (SBA) for practical work, and geographic isolation. Teaching experience among participants ranged from 1-25 years. The study adopted a participatory action research (PAR) design embedded within a bigger project of a teacher PD initiative which is in collaboration with the KwaZulu-Natal DBE and conducted over four workshop cycles yearly. PAR was selected for its emphasis on collaboration, context-sensitive problem-solving, and iterative reflection through cycles of planning, acting, observing, and reflecting (Cresswell,2014). This design was well suited to working alongside Life Sciences teachers to co-develop practical teaching strategies responsive to their realities. Prior to each session, subject advisors consulted with the participating teachers to determine the content and practical activities to be covered during the two-day PD workshops, which informed planning in collaboration with university-based science education specialists. At the end of each session, reflective discussions were held to review what worked, identify gaps, and plan improvements for the next PD workshop. This design allowed the project to remain responsive to the evolving needs and insights of the participating Life Sciences teachers.

Data collection involved a Likert-scale questionnaire with both open and closed-ended items, administered during the fourth teacher PD workshop cycle. Items focused on confidence in teaching content and practical work, skill development, collaboration, interest in integrating practical work and improvised teaching strategies. The questionnaire was kept brief to encourage authentic responses during the limited five-hour sessions held over two days of each term. Additionally, one-hour semi-structured interviews were conducted with teachers who volunteered, offering deeper insight into the motivations and contextual factors underlying their questionnaire responses. Interviews were audio-recorded, transcribed, and analysed thematically. Quantitative data were analysed descriptively using frequencies and percentages. Researcher triangulation was applied during the coding process to ensure rigour and consistency of the data and findings. Ethical clearance was obtained from the university and the DBE. All participants gave informed consent, and pseudonyms were used to protect confidentiality, with participation remaining voluntary throughout.

#### 5. Data analysis and findings

The findings reflect teacher responses during Year 1 of the teacher PD workshops (n=25) and align with the study’s aim to enhance practical teaching competencies in rural contexts, see Figure 1 below.

Figure 1. Descriptive data of the teachers’ survey responses.



As depicted in Figure 1 above, over 64% of teachers reported increased confidence in managing content and practical work, with 52% strongly agreeing. This indicates that structured, hands-on training can indeed strengthen teacher self-efficacy which is an essential factor in effective Life Sciences instruction. While 60% expressed interest in conducting practical work, a significant 24% remained hesitant. One teacher noted, “...some of us are old and we really want to gain more knowledge about practical work so we can help our learners perform better, especially since most of us teach in schools lacking resources... We often rely on textbooks to facilitate practical engagement, which is frustrating but what can we do that is all we know and are used to...” The remarks reveal the critical tensions between capability and motivation as well as experiential and/or generational barriers. Thus, showing that motivation alone cannot overcome deeply rooted systemic and behavioural or attitude barriers. For teacher PD initiatives to be enhanced, they must focus beyond skill-building but rather aim to boost confidence, address deeply rooted traditional instructional habits, boost and provide sustained as well as resource-sensitive support that enables meaningful pedagogical transformation.

The data also reveals that only 36% indicated readiness to implement practicals even if materials were provided, suggesting that resources alone are insufficient without clear guidance, planning support, and time allocation. As one teacher shared “...some of our schools do not even have electricity or any resources so it will be difficult for us to do some of the practical work or even use the simulations that you have shown us...” This reinforces the importance of continuous and hands-on focused workshops, embedded in real teaching contexts. In response, the university procured and distributed practical science materials to participating schools in the following year (see Figure 2 below). This shift demonstrates the importance of educational partnerships in ensuring the sustainability and effectiveness of teacher PD programmes.

Figure 2. Resources procured by the university and distributed to the participating teachers at each school.



This practical support in the end of Year 1 likely contributed to improved teacher responses and enhanced classroom implementation.

Although 52% felt skilled in using varied teaching methods and technologies, 44% disagreed or felt unprepared. These results support Mxenge and Bertram (2023)'s findings that teacher PD need to be iterative, rather than one-off or short term. Encouragingly, 88% valued collaboration with peers, affirming the importance of professional learning communities. As one teacher shared, “...even planning together helped us feel less alone.” This confirms the value of structured, peer-based support in overcoming isolation and fostering sustained growth.

## 6. Discussion of results and conclusion

To respond to the research question that guided the study which is “How can rural Life Sciences teachers’ practical work competencies be enhanced through a collaborative approach to teacher professional development?” The results of the study showed that to support practical work competencies in rural contexts, professional development should (i) be collaboratively designed and responsive to local needs; (ii) include hands-on training with follow-up support; (iii) provide curriculum-aligned, low-cost resources;

and (iv) foster peer networks for continued learning and reflection. The findings from the analysis reveals that long-term success depends on sustained partnerships between universities, schools, and education departments, with teachers actively contributing to shaping and improving PD workshops.

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