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Bridging Theory and Practice: Exploring Curriculum and Social Networks in Preparing Pre-Service Teachers for Science Teaching in the Foundation Phase

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Abstract. This study explores how the Bachelor of Education Foundation Phase curriculum and learning support systems (peer, mentor, and institutional support structures) shape pre-service teachers' (PSTs) preparedness to teach science-related themes (science concepts and processes embedded within the Life Skills curriculum) in South African primary schools. Although early science education is crucial for foundational learning, science remains marginalised within the Life Skills curriculum, limiting PSTs' exposure to discipline-specific content and pedagogy. Guided by three research questions, the study examines: (i) how the Bachelor of Education Foundation Phase curriculum equips PSTs to teach science-related content; (ii) the influence of peer and mentor networks on PSTs' professional development and confidence; and (iii) the role of institutional support structures in shaping science teaching readiness. A qualitative case study design, using purposive sampling, was employed, with data collected through a questionnaire and document analysis of third- and fourth-year Life Skills modules. Thematic analysis, underpinned by pedagogical content knowledge and social network theory, revealed key challenges including limited practicum exposure, a lack of science-specific mentorship (reported by 88% of participants), and inadequate emphasis on science pedagogy. In response, the study introduces the Integrated Pedagogical Network Support framework to bridge the theory-practice gap and support PST development. The findings call for curriculum reform to prioritise science pedagogy, structured mentorship, and strengthened peer learning opportunities. This study contributes a contextually grounded framework that may inform the reimagining of teacher education programmes in South Africa and comparable contexts.

Keywords: Curriculum Design; Foundation Phase; Pedagogical Content Knowledge; Professional Development; Social Network Theory

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1. Introduction

The preparation of pre-service teachers (PSTs) to teach science in the early years has become a growing concern in South Africa and globally. Foundational exposure to science is crucial in developing learners' curiosity, critical thinking, and problem-solving skills—competencies that are increasingly essential for navigating contemporary environmental and societal challenges. However, in the South African Foundation Phase (Grades R to 3), science is not taught as a distinct subject but is instead integrated into the Life Skills curriculum. This integration has often led to the marginalisation of science-related themes, which are taught in fragmented, superficial, or incidental ways (Mavuru & Pila, 2021). Consequently, young learners may enter higher grades without the foundational scientific knowledge and inquiry skills necessary for continued scientific learning.

This marginalisation also poses serious challenges for teacher preparation. Many Bachelor of Education (B.Ed.) Foundation Phase programmes fail to provide PSTs with adequate science content knowledge, structured pedagogical training, or meaningful practicum experiences in teaching science. Research shows that this lack of preparation undermines PSTs' confidence, limits their ability to implement inquiry-based science instruction, and negatively affects their long-term professional development (Seneviratne et al., 2019). While studies have recognised the importance of pedagogical content knowledge in teacher preparation, there remains a limited understanding of how curriculum structure and learning support systems—including peer collaboration and institutional support—jointly shape PSTs' readiness to teach science in the Foundation Phase.

This study addresses this conceptual and empirical gap by exploring how the B.Ed. Foundation Phase curriculum, along with structured learning support systems, influences PSTs' professional development in teaching science-related themes. The research is grounded in two interrelated theoretical frameworks. First, pedagogical content knowledge is used to assess the coherence between science content and pedagogy in the curriculum. Second, social network theory provides a lens for understanding how peer and institutional relationships contribute to professional learning and self-efficacy. These frameworks inform the development of the Integrated Pedagogical Network Support (IPNS) model proposed in this study, which seeks to bridge the gap between theory and practice in science teacher education.

In response to the research problem, the study was guided by the following questions:

1. How does the B.Ed. Foundation Phase curriculum equip PSTs to teach science-related content?
2. In what ways do peer networks shape PSTs' professional development and confidence in teaching science?
3. How do institutional support structures influence PSTs' readiness and self-efficacy in teaching science-related themes?

2. Literature Review

This literature review explores how curriculum design and learning support systems influence PSTs' preparedness to teach science-related themes in the Foundation Phase. The review is structured to address three interrelated dimensions of science teacher preparation, which align with the study's research questions: (i) how curriculum structures shape PSTs' pedagogical competence; (ii) the influence of peer collaboration on their professional development and confidence; and (iii) the role of institutional support in enhancing readiness to teach science.

In the South African Foundation Phase, science is integrated within the Life Skills curriculum and is not taught as a standalone subject. While this integrated model supports holistic development, it has led to the marginalisation of science content, resulting in fragmented and superficial learning experiences for both learners and PSTs (Mnguni & Gasa, 2024). Research indicates that this structural arrangement weakens scientific inquiry, limits learners' early engagement with science, and constrains the development of PSTs' content knowledge and pedagogical confidence (Sæleset & Friedrichsen, 2021). Curriculum, broadly defined, comprises intended content, instructional approaches, and assessment strategies.

However, its impact depends on how well PSTs are prepared to implement it in real classrooms (Coşkun Yaşar & Aslan, 2021; Pieters et al., 2019). The CAPS document for the FP, while comprehensive, has been criticised for providing limited guidance on practical science pedagogy, particularly in resource-constrained contexts (Bester & Conway, 2021; Morolong, 2019). Du Plessis and Letshwene (2020) found that many PSTs struggle to apply the current Curriculum Assessment Policy Statements in science teaching due to a lack of practicum exposure and limited integration of science themes into university coursework. Meiring (2019) further notes that inadequate modelling of science pedagogy during teacher training contributes to low self-efficacy and uncertainty. These issues are intensified by assessment regimes that favour written outputs over hands-on, inquiry-based teaching, thereby reinforcing the theory-practice divide (Ojo & Mathabathe, 2021).

Beyond curriculum content, peer networks play a crucial yet often underappreciated role in PSTs' professional development. Peer interactions provide opportunities for emotional support, collaborative learning, and identity construction (Liou, 2025). In South African teacher education programmes, PSTs frequently engage in group work, lesson planning, and micro-teaching as part of Life Skills modules (Adebola, 2022; Sithole, 2023). However, these collaborative opportunities are often unstructured and do not include science-specific feedback or reflective dialogue.

Stears et al. (2019) argue that when group tasks are designed generically, they can mask individual learning needs and fail to support the development of disciplinary pedagogical skills. Despite this, research demonstrates that positive peer interactions can significantly enhance PSTs' confidence and motivation to teach science (Gorospe, 2022; Schuster et al., 2021). Zhai et al. (2024) show that

PSTs' science teaching identity is shaped by their experiences of collaboration, with supportive peer networks reinforcing pedagogical resilience. However, Lekhu (2023) reports that few teacher education programmes embed structured peer learning opportunities with follow-up feedback, co-teaching, or peer review focused on science instruction. As a result, peer networks remain an underused mechanism for strengthening PSTs' practical readiness to teach science-related themes.

Institutional support structures—especially practicum placement, science-specific mentorship, and academic supervision—are critical to shaping PSTs' classroom readiness. From a professional learning perspective, mentorship offers scaffolding, feedback, and real-world modelling that theory alone cannot provide. Yet, research highlights that science-specific mentorship is rare in many South African teacher education programmes (Du Plessis & Letshwene, 2020). PSTs are frequently placed in schools where science is deprioritised or not modelled, contributing to stress, confusion, and disengagement from science teaching (Kihwele & Mtandi, 2020; Van der Merwe, 2022). Misalignment between university coursework and school placements is another challenge.

Ndabankulu (2023) and Arasomwan and Mashiya (2021) found that PSTs were often expected to teach science without having seen effective classroom examples or received proper instructional feedback. These disconnects weaken PSTs' capacity to enact pedagogical content knowledge and build a confident teaching identity in science. Institutional actors—lecturers, mentors, and supervisors—must therefore be engaged in a more coordinated, science-focused support model that links curriculum to real teaching practice.

The reviewed literature identifies critical gaps in how science is conceptualised and supported in the FP, particularly regarding curriculum coherence, peer collaboration, and institutional scaffolding. These gaps justify the need for a more integrated theoretical model that not only addresses subject-specific pedagogy but also considers the social and systemic structures that mediate PSTs' professional learning. The following section presents the theoretical framework guiding this study.

2.1 Theoretical Framework

This study is underpinned by three theoretical perspectives: pedagogical content knowledge, social network theory, and the IPNS framework. These frameworks provide complementary insights into the content, pedagogical, and relational dimensions of science teacher preparation.

PCK, as conceptualised by Shulman (1986), refers to a teacher's ability to blend subject matter knowledge with appropriate instructional strategies. In the Foundation Phase, where science is embedded in the Life Skills curriculum, PCK is essential for helping PSTs design inquiry-based lessons that are developmentally appropriate. Neumann et al. (2019) assert that science teaching in early childhood requires a nuanced understanding of how to translate abstract scientific ideas into hands-on learning experiences (Zhao, 2024). PCK thus enables analysis of the extent to which curriculum and teacher education programmes foster these competencies. However, PCK focuses primarily on the individual teacher's cognitive and pedagogical development (Reza Adel & Azari Noughabi, 2023). It does not account for the relational and systemic factors—such as collaboration, mentorship, or institutional support—that influence how this knowledge is developed and applied in context.

The SNT complements PCK by foregrounding the role of social relationships in shaping professional learning. From this perspective, PSTs acquire knowledge not in isolation but through dynamic interactions with peers, mentors, and institutional actors (Klärner et al., 2022; Stadtfeld et al., 2019). In resource-constrained contexts such as South Africa, where formal mentoring is often lacking, informal peer networks and school-based relationships become essential sources of support and knowledge (Mafugu et al., 2024). The SNT helps map these learning networks and assess how they mediate PSTs' access to feedback, modelling, and professional growth. However, the SNT does not provide tools that assess the discipline-specific pedagogical development required for science teaching. It explains *how* learning happens socially, but not *what* is being learned or whether the pedagogical content is appropriate for early science instruction.

Given the partial explanatory power of PCK and SNT on their own, this study introduces the IPNS framework. The IPNS synthesises the pedagogical depth of PCK with the relational structure of SNT to address the complexity of preparing PSTs for science teaching in the Foundation Phase. The framework acknowledges that effective teacher preparation must involve both mastery of content-specific pedagogy and access to structured, collaborative support systems. In contexts where science is marginalised and support structures are uneven, the IPNS offers a holistic model for developing PSTs' confidence and competence.

It proposes that PSTs' readiness emerges from the intersection of three interdependent components: curriculum content (PCK), peer learning and identity development (SNT), and institutional support mechanisms (mentorship, practicum, supervision). This framing enables a more nuanced analysis of how teacher education programmes can bridge the gap between theory and practice in early science education. By offering a context-responsive framework, the IPNS contributes both conceptually and practically to efforts aimed at strengthening science teacher preparation in the Foundation Phase.

3. Methodology

This section outlines the research approach, design, sampling strategy, data collection methods, data analysis procedures, trustworthiness measures, and ethical considerations employed to examine how the Foundation Phase B.Ed. curriculum and support networks influence PSTs' preparedness to teach science-related themes.

3.1 Research Approach

This study followed a qualitative research approach, selected to capture the in-depth, contextualised experiences of PSTs. A qualitative lens was particularly suitable for investigating complex educational phenomena such as curriculum engagement, mentorship, and professional identity development in relation to early science teaching. The approach aligned with the interpretive paradigm and was used to elicit the perspectives and meaning-making processes of PSTs within their teacher education context (Tanlaka & Aryal, 2025).

3.2 Research Design

An interpretive case study design was adopted to allow a detailed and context-bound exploration of PSTs' professional learning experiences during their third and fourth years of training (Faisal, 2024). This design enabled the researcher to holistically investigate how curriculum structures and learning support systems influence PSTs' preparedness to teach science in the Foundation Phase. The case study approach was appropriate for studying real-life educational practices within their institutional settings and for understanding how individual experiences are shaped by broader curricular and institutional dynamics (Almazroui, 2023).

3.3 Sampling Strategy

In this study, purposive sampling was employed to select participants who had direct exposure to Life Skills modules and could meaningfully reflect on science-related themes in the curriculum, consistent with the approach described by Nyimbili and Nyimbili (2024). The sample consisted of 38 third- and fourth-year B.Ed. Foundation Phase students at a South African university. These participants were selected because they had completed or were actively engaged in Life Skills modules that included science-related content. In addition to student participants, the study purposively selected module guides from third- and fourth-year Life Skills courses for document analysis. These modules were targeted because of their relevance to the development of pedagogical content knowledge and instructional strategies for science-related teaching in the Foundation Phase.

3.4 Data Collection Methods

This study employed a self-administered online questionnaire and document analysis to gather qualitative data. Although a questionnaire was used, it functioned primarily as a tool to explore PSTs' professional learning experiences, focusing on their exposure to science-related content, support structures, and confidence in teaching. The 26-item questionnaire included open-ended questions that generated narrative responses and a few closed-ended items used solely to provide contextual background on participants perceived preparedness and access to support.

A pilot was conducted with a small group of PSTs to refine question clarity and ensure alignment with the research objectives. While the questionnaire included some structured items, it was not intended for statistical inference (Oo et al., 2022); rather, it was used to generate contextual and interpretive insights aligned with a qualitative research paradigm (Wiesner, 2022).

Document analysis was conducted on two Life Skills module guides—one from the third year and one from the fourth year—selected for their relevance to science themes. The analysis explored how science content was integrated, focusing on intended learning outcomes, pedagogical strategies, assessment tasks, and conceptual emphasis. The process followed established document analysis procedures (Morgan, 2022), contributing to a deeper understanding of curriculum structure and its implications for science teaching readiness (Sepadi & Molapo, 2024).

3.5 Data Analysis

The data were analysed using thematic narrative analysis, suitable for capturing the complexity of participants' experiences while allowing for theoretical interpretation (Ahmed et al., 2025). A combined deductive and inductive coding strategy was applied. Deductive codes were developed based on the study's conceptual framework (Fife & Gossner, 2024), namely, pedagogical content knowledge, social network theory, and the IPNS model. Inductive codes were generated from emergent patterns within the data.

Coding proceeded through multiple cycles, during which themes were refined, categorised, and aligned with the research questions (Rosen et al., 2023). Triangulation was applied by comparing themes emerging from the questionnaire responses with insights derived from the document analysis (Sridharan, 2021). Quantitative data from closed-ended questionnaire items were summarised using descriptive statistics (frequencies and percentages) for contextual interpretation only and were not subjected to thematic coding. Pseudonyms have been used for all participants.

3.6 Trustworthiness

To ensure trustworthiness, the study employed the established criteria of credibility, transferability, dependability, and confirmability. Credibility was supported through the piloting of instruments, regular consultation with academic supervisors, and peer feedback during analysis (Xie et al., 2023). Thick description of the research context, participant profiles, and curriculum documents enabled transferability (Lim, 2025). Dependability was enhanced by maintaining a transparent record of research procedures and decision making. Confirmability was ensured by documenting the analytical process and incorporating peer review to reduce researcher bias (Nazar et al., 2023).

3.7 Ethical Considerations

Ethical clearance was obtained from the University of the Free State (Ref: UFS-HSD2022/2073). All participants were informed about the study's purpose and procedures and gave voluntary, informed consent before participation. Participation was anonymous, and no identifying personal information was collected. Module documents used for analysis were publicly available to enrolled students and did not contain confidential material. All procedures adhered to the ethical principles of voluntary participation, academic integrity, respect for persons, and confidentiality (Almutairi, 2022).

4. Findings and Discussion

This section presents prepares derived from the questionnaire and document analysis, addressing the two research questions: (1) How does the Foundation

Phase B.Ed. curriculum prepare PSTs to teach science-related themes? and (2) How do peer, mentor, and institutional support networks influence PSTs' professional development and confidence in teaching science-related content? The data are interpreted using pedagogical content knowledge and social network theory, which jointly underpin the IPNS framework. These theoretical lenses highlight the disconnect between curriculum expectations and practice, and the role of social–professional relationships in enhancing teacher preparedness.

4.1 Curriculum Preparation for Science Teaching

Findings from both the questionnaire and document analysis highlight three key issues regarding the Foundation Phase B.Ed. curriculum's role in preparing PSTs to teach science-related themes: (i) inconsistent application of inquiry-based learning, (ii) assessment practices that prioritise theory over practicum, and (iii) a persistent gap between curricular intentions and practical readiness.

4.1.1 Inquiry-based learning and interdisciplinary integration

The reviewed module guide for *Life Skills Teaching and Facilitation (LSTF 4705)*, a fourth-year course, promotes inquiry-based and interdisciplinary learning. For example, PSTs are required to design integrated lessons linking themes such as environmental sustainability with the arts or human anatomy with physical education. These curricular intentions align with pedagogical content knowledge principles, particularly the adaptation of content for learner-centred teaching. However, only 21% of questionnaire respondents stated that their training was *"very well"* aligned with the realities of science teaching, while 53% were uncertain or ambivalent. This indicates a lack of reinforced practice-based engagement.

As one participant explained, *"I was kind of taught how to integrate science but at my school, I still have not taught Life Skills, my mentor teacher only made me teach English, so I do not know"* (Nomsa). This highlights how practicum constraints often prevent PSTs from applying inquiry-based strategies, limiting their development as confident science educators.

4.1.2 Assessment practices and limited practicum exposure

While modules such as *LSTF 4705* include mock lesson planning and reflective tasks, participants reported limited opportunities to apply these during their practicum. Assessment remained largely theoretical, with few classroom-based feedback loops. One PST noted: *"I wasn't given science topics to teach, so I missed out on getting feedback or help with them" (Tapiwa).*

This illustrates how current assessment design fails to support iterative, real-world practice—an essential process in building pedagogical depth and content mastery within the PCK framework. The questionnaire data reinforces this concern: only 32% of PSTs (12 out of 38) reported having taught science-related themes during their practicum, while 68% (26 participants) stated they had not engaged with science teaching at all. This gap between curricular expectations and school-based learning environments signals a disconnect that restricts opportunities for meaningful pedagogical enactment.

4.1.3 Disconnect between curriculum content and practical readiness
Despite explicit references to scientific literacy and pedagogical goals in the curriculum documents, the analysis found these were not effectively scaffolded into classroom practice or reflective learning. Just 12% of PSTs reported explicitly teaching science content during their practicum, while the remainder described only vague or incidental references, often framed within environmental or health-related themes. Such limited engagement undermines the formation of a robust science teacher identity. As Rusznyak and Walton (2022) argue, authentic and repeated practice is critical for shaping professional confidence and pedagogical clarity. Without targeted practicum structures to support this development, PSTs risk entering classrooms underprepared to deliver effective science instruction in the Foundation Phase.

4.2 Influence of Support Structures
The findings underscore the critical role of support structures, particularly peer collaboration, mentorship, and institutional scaffolding, in shaping PSTs' professional development and confidence in teaching science-related themes. These relational networks, interpreted through the social network theory, either foster or hinder PSTs' ability to transform pedagogical knowledge into meaningful practice.

4.2.1 Peer collaboration and informal learning networks
Peer collaboration was consistently highlighted as a source of emotional and instructional support. PSTs relied on classmates to co-plan lessons, share teaching resources, and discuss classroom challenges during Life Skills modules. However, these interactions were largely informal and often lacked structured, curriculum-aligned feedback. One participant noted, *"We helped each other plan lessons, but sometimes you needed real feedback from someone who's taught before."* This finding resonates with the social network theory, which posits that while informal networks can facilitate learning, their efficacy is constrained without formal reinforcement. The lack of faculty-led peer learning structures means that collaborative exchanges, though helpful, remain peripheral to the formal development of science pedagogical content knowledge.

4.2.2 Mentorship and school-based support
Access to mentorship during school-based placements was limited. Only 29% (11 participants) reported receiving structured mentorship or additional resources, while 71% (27 participants) indicated they had no such support. This scarcity of guided, hands-on learning reinforces gaps in experiential learning opportunities—an essential component of professional growth as posited by SNT.

Claudia reflected, *"I did not receive any help because [I] was not exposed to science-related themes at the school,"* highlighting how the absence of mentorship constrained opportunities to consolidate theory into practice. Conversely, Kawiyu noted, *"Mentorship programmes were valuable, as [my] mentor consistently provided guidance and support,"* exemplifying how effective mentorship can facilitate confidence and instructional clarity.

This inconsistency is reflected in both the social network theory and pedagogical content knowledge frameworks, which argue that without intentional modelling and feedback, PSTs struggle to internalise and apply pedagogical strategies, particularly in science education (Whalen et al., 2019). The findings suggest that the presence of experienced mentors is crucial for contextualising science teaching and bridging the gap between university coursework and classroom demands.

4.2.3 Institutional variability and missed learning opportunities
Institutional support was uneven across campuses and practicum schools, resulting in highly variable learning experiences. For example, only 21% (8 participants) reported receiving formal classroom observation or feedback during their practicum. This lack of structured oversight limits reflective learning and hinders PSTs' ability to refine their teaching strategies. Precious, when asked about additional support, simply stated, *"None,"* illustrating the absence of institutionally coordinated learning reinforcement.

Nevertheless, microteaching and observation of peers or experienced teachers were identified by some as beneficial. Tapiwa shared, *"Microteaching sessions and workshops prepared [me] for practical placements by providing a clear idea of what to expect in schools."* These opportunities, although sporadic, exemplify the value of situated learning experiences in building PSTs' confidence and readiness. The social network and social cognitive theory reinforce that observation and modelling within professional communities are critical for enhancing teaching self-efficacy (Walker et al., 2024).

However, the inconsistent availability of these practices underscores the need for systemic integration within teacher training programmes. In sum, while peer, mentor, and institutional support structures exist, their uneven implementation contributes to fragmented professional learning. Structured mentorship, formalised peer networks, and institutionally supported practicum feedback are essential for transforming pedagogical theory into actionable teaching strategies, particularly in science education within the Foundation Phase.

4.3 The IPNS Framework: A Model for Integrated Development
The IPNS Framework (see Figure 1) presents a strategic model for addressing the fragmented experiences of PSTs in Foundation Phase science teaching. Synthesising the core elements of pedagogical content knowledge, social network theory, and responsive curriculum design, the framework positions integrated support structures—mentorship, peer learning, and inquiry-based practice—as central to effective teacher preparation.

Figure 1 illustrates how curriculum design, grounded in strong theoretical and content foundations, must be supported by scaffolded professional learning networks. These networks facilitate the practical application of theory, enabling PSTs to transition from conceptual understanding to confident and competent science teaching. By embedding mentorship, peer interaction, and experiential teaching opportunities within the teacher education process, the IPNS framework responds to both pedagogical gaps and institutional inconsistencies identified in this study. The model illustrates the integration of PCK, SNT, and curriculum design through structured support mechanisms to produce confident and competent PSTs for science teaching.

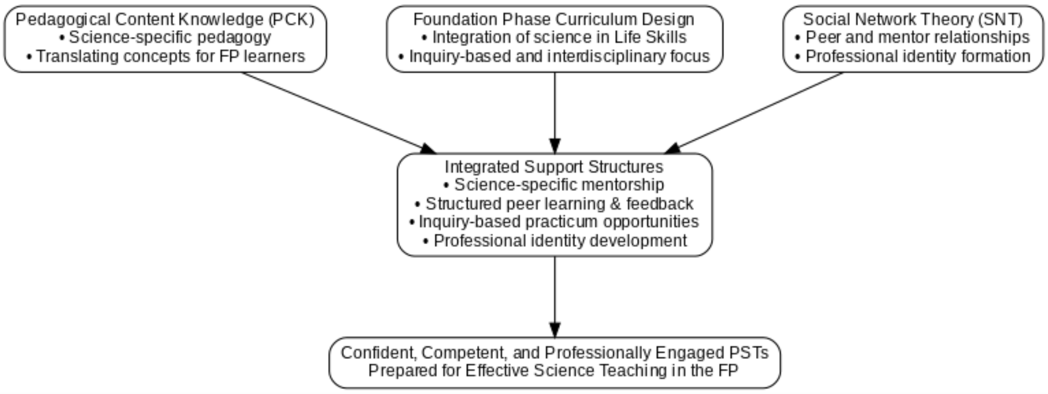

Figure 1: The Integrated Pedagogical Network Support Framework

5. Conclusion and Recommendations

This study investigated how the Foundation Phase B.Ed. curriculum and related support structures influence PSTs' preparedness to teach science-related themes. The findings reveal a significant disconnect between the curriculum's pedagogical intentions—particularly its emphasis on inquiry-based and interdisciplinary learning—and PSTs' practical experiences during school placements. While modules such as LSTF 4705 promote integrated science learning, many PSTs reported limited opportunities to apply these concepts in real classrooms.

Additionally, mentorship, peer observation, and feedback were inconsistently implemented, leaving many participants to self-navigate their professional development. These challenges reflect a broader misalignment between theoretical preparation and practice-based confidence. Drawing from pedagogical content knowledge and social network theory, the study underscores the need for more structured, experiential, and collaborative learning to enable effective science teaching in the Foundation Phase.

To address these challenges, this study introduces the IPNS framework—a context-sensitive model that integrates curriculum design, scaffolded mentorship, and collaborative learning communities. The framework offers a structured approach to strengthening the link between curriculum intentions and practical competence, grounded in South African realities. Based on the findings, four key recommendations are proposed: (1) embedding microteaching and supervised practicum aligned with Life Skills assessments; (2) establishing structured peer mentorship and faculty coaching systems; (3) requiring reflective teaching portfolios to track professional growth; and (4) pursuing longitudinal studies to trace PSTs' science teaching competence from training into their early career.

These interventions aim to bridge the persistent theory–practice divide, promote sustainable teacher development, and enhance the quality of science education in the Foundation Phase. By reimagining the support mechanisms surrounding

PSTs, the study contributes to the broader goal of preparing confident, competent, and scientifically literate educators.

6. Limitations

This study was conducted at a single university with a small sample size (n = 38), which limits the generalisability of the findings. The use of self-reported questionnaire data may introduce bias, and the absence of interviews or classroom observations restricted deeper validation. Although document analysis was used for triangulation, future research should include multiple institutions and data sources to enhance the reliability and broader applicability of the IPNS framework.

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