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Teaching Science anew in the Foundation Phase: Reimagining pre-service teacher learning for Inclusive Early Pedagogy

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ABSTRACT
This study investigated how pre-service teachers (PSTs) in South Africa experience professional learning opportunities that influence their preparedness to teach Science in the Foundation Phase. Grounded in the principles of the Scholarship of Teaching and Learning (SoTL), the study employed thematic narrative analysis of focus group interviews and group reflections with 18 third- and fourth-year Bachelor of Education (B.Ed.) students from a South African university. The participants included eleven fourth-year and seven third-year students, representing diverse linguistic, gender, and residential backgrounds. The study is underpinned by three complementary theoretical perspectives: Pedagogical Content Knowledge (PCK), Social Network Theory (SNT), and the Integrated Pedagogical Network Support (IPNS) framework. Together, these frameworks guided the interpretation of the findings by enabling an exploration of how curriculum design, practicum exposure, and professional learning networks shape PSTs' confidence, professional learning, and emerging identities as Foundation Phase Science teachers. The findings revealed that while participants valued collaboration, mentorship, and reflective dialogue, they encountered limited structured, practice-based opportunities to integrate inclusive and inquiry-based science pedagogy during their training. The study recommends embedding supervised practicum experiences, formalised peer mentoring systems, and professional learning communities into teacher preparation programmes. By aligning teacher education with SoTL principles of inclusivity, collaboration, and innovation, this research contributes a contextually relevant framework for preparing confident, competent, and inquiry-oriented Science educators for the early years.

Keywords: Scholarship of Teaching and Learning, inclusive pedagogy, early science education, professional identity, pre-service teachers.

INTRODUCTION
Across the globe, and particularly in South Africa, the preparation of pre-service teachers (PSTs) to teach science effectively in the early years has become a pressing concern. Foundational science education plays a pivotal role in nurturing children's curiosity, critical thinking, and problem-solving

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abilities, which are essential skills for addressing contemporary environmental and social challenges.[1] Yet, in the South African Foundation Phase (FP) (Grades R–3), science is embedded within the Life Skills curriculum rather than taught as a discrete subject.[2] This arrangement has often resulted in the marginalisation of science learning, with scientific concepts introduced sporadically and superficially instead of through systematic, inquiry-oriented teaching approaches.[3] Such marginalisation has profound implications for teacher preparation. Research highlights and many Bachelor of Education (B.Ed.) programmes provide limited science-specific content knowledge, offer insufficient opportunities for pedagogical training, and lack structured practicum experiences to prepare PSTs for real-world classroom realities.[4] This gap between PSTs' expectations formed during teacher preparation and the realities encountered in classroom contexts has been described in the literature as reality shock, a challenge that may negatively influence professional confidence, preparedness, and early professional development if insufficiently addressed.[5] Consequently, PSTs often graduate without the confidence or professional competence to engage learners meaningfully in science lessons, thereby limiting the development of their identities as capable Foundation Phase science educators andperpetuating a cycle where science remains underrepresented in early childhood education.[6]

Addressing these challenges requires a fundamental rethinking of teacher preparation programmes, a shift towards what the Scholarship of Teaching and Learning (SoTL) terms *teaching anew and differently*. SoTL advocates for innovative, reflective, and inclusive pedagogies, encouraging teacher educators to move beyond traditional content delivery toward approaches that emphasise professional learning communities, collaborative inquiry, and ongoing mentorship.[7] Rather than limiting attention to curriculum content alone, SoTL principles highlight the importance of supporting PSTs as active learners of teaching, enabling them to critically reflect on their experiences, engage with peers and mentors, and adapt their practices to diverse classroom contexts.[8] In doing so, PSTs are not only supported pedagogically but are also positioned to develop stronger professional confidence and emerging identities as science teachers in the FP.

This study draws on two interrelated theoretical perspectives, Pedagogical Content Knowledge (PCK) and Social Network Theory (SNT), which underpin the Integrated Pedagogical Network Support (IPNS) framework proposed in this study. PCK provides a framework for exploring how PSTs integrate science content with effective teaching strategies, while SNT highlights the influence of peers, mentors, and institutional support structures on PSTs' professional identity formation and confidence.[9] Together, these frameworks underpin the IPNS model proposed in this study, which seeks to bridge the persistent

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1 Olivia de los Santos et al., "Scientific Thinking Promotes the Development of Critical Thinking in Primary Education," *Education Sciences* 15, no. 9 (September 8, 2025): 1174, https://doi.org/10.3390/educsci15091174.

2 Michele Stears, Angela A. James, and Saritha Beni, "Teaching Science in the Foundation Phase: Where Are the Gaps and How Are They Accounted For?," *South African Journal of Childhood Education* 9, no. 1 (2019): 1–9; Nasaret Ruswa and Zukiswa Nhase, "Bridging Theory and Practice: Exploring Curriculum and Social Networks in Preparing Pre-Service Teachers for Science Teaching in the Foundation Phase," *International Journal of Learning, Teaching and Educational Research* 24, no. 9 (2025): 346–360, https://doi.org/10.26803/ijlter.24.9.17

3 Lydia Mavuru and Oniccah Koketso Pila, "Pre-Service Teachers' Preparedness and Confidence in Teaching Life Sciences Topics: What Do They Lack?," 2021.

4 Kumudu Seneviratne, "Teachers' Sense of Efficacy: A Challenge for Professional Development toward Teaching Science as Inquiry," *Science Education International*, 2019.

5 Nasaret Tjirumbi, Beginner Teachers' Experiences of Professional Identity Development during an Induction Programme in the Free State (Master's dissertation, University of the Free State, 2021).

6 Sarah J Carrier et al., "Teachers as Learners: Outdoor Elementary Science," *The Electronic Journal for Research in Science & Mathematics Education* 27, no. 2 (2023): 1–24.

7 Kayoung Kim, "Find Your PEOPLE: Scholarship of Teaching and Learning (SoTL) Community of Care," *Routledge Open Research* 2 (2023): 14.

8 Annalene Grace E. Co, Charmaine Ruth G. Abella, and Fhrizz S. De Jesus, "Teaching Outside Specialization from the Perspective of Science Teachers," *OALib* 08, no. 08 (2021): 1–13, https://doi.org/10.4236/oalib.1107725.

9 Mahbub Sarkar et al., "Pedagogical Content Knowledge (PCK) in Higher Education: A Systematic Scoping Review," *Teaching and Teacher Education* 144 (July 2024): 104608, https://doi.org/10.1016/j.tate.2024.104608; Sükrü Hangul and Ilknur Senturk, "Analyzing Teachers' Interactions through Social Network Analysis: A Multi-Case Study of Three Schools in Van, Turkey.," *New Waves-Educational Research and Development Journal* 22, no. 2 (2019): 16–36; Leslie F Meiring, "Foundation Phase Science Teacher Identity: Exploring Evolutionary Module Development to Promote Science Teaching Self-Efficacy," *South African Journal of Childhood Education* 9, no. 1 (2019): 1–11.

divide between theory, practice, and professional learning support in science teacher education.[10] Guided by SoTL principles, this study investigates three critical questions:

- How do professional learning experiences influence PSTs' teaching identities, confidence, and readiness to teach science in the Foundation Phase?
- In what ways do peer collaboration, mentorship, and institutional networks enable or constrain inclusive and inquiry-based science pedagogy?
- How can teacher education programmes integrate SoTL principles to prepare PSTs to teach science *anew and differently*?

By centring student voices and highlighting inclusive, collaborative, and reflective professional learning practices, this research contributes to current debates on transforming early science education in South Africa.[11] It offers insights into how teacher education programmes can better align curriculum, pedagogy, and professional support systems to prepare competent, confident, and innovative science educators for the FP, while also strengthening PSTs' professional identities as inclusive early years science teachers.

LITERATURE REVIEW

Calls to reimagine early childhood science education have intensified globally, reflecting growing concern that teacher education programmes continue to graduate PSTs without the confidence, practical experience, or pedagogical repertoire needed to make science meaningful in the FP.[12] Despite widespread recognition that early exposure to science cultivates curiosity, critical thinking, and problem solving, research consistently indicates that science remains marginalised within many early years' curricula.[13] In parallel, studies focusing on teacher education structures highlight that prevailing training models continue to privilege theoretical knowledge over sustained opportunities for practice, limiting PSTs' development of applied PCK for science teaching.[14] Furthermore, professional learning structures intended to bridge this gap, such as mentoring, peer collaboration, and structured practicum support, are often unevenly designed or entirely absent, particularly within FP teacher preparation contexts.[15] In the South African context, where structured induction and ongoing professional support for novice teachers are inconsistently implemented across schools and provinces, PSTs may enter classrooms with limited guidance.[16] This may make it difficult for them to navigate the complexities of science teaching especially with limited opportunities for practice.

In this regard, these persistent gaps justify a SoTL-oriented approach that positions teacher education as a site of evidence-informed innovation, where teaching is deliberately reimagined to be inclusive, inquiry-oriented, and responsive to the real conditions under which teachers work.

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[10] Heather Nadia Phillips and J Condy, "Pedagogical Dilemma in Teacher Education: Bridging the Theory Practice Gap," *South African Journal of Higher Education* 37, no. 2 (2023): 201–17.

[11] Joyce G Poti, Washington T Dudu, and Motlhale J Sebatana, "A South African Beginner Natural Sciences Teacher's Articulated PCK-in-Practice with Respect to Electric Circuits: A Case Study.," *EURASIA Journal of Mathematics, Science and Technology Education* 18, no. 10 (2022).

[12] Linda Darling-Hammond et al., "Educating Teachers to Enact the Science of Learning and Development," *Applied Developmental Science* 28, no. 1 (January 2, 2024): 1–21, https://doi.org/10.1080/10888691.2022.2130506.

[13] Carrier et al., "Teachers as Learners: Outdoor Elementary Science"; Elize C Du Plessis and Mantekana Jacobine Letshwene, "A Reflection on Identified Challenges Facing South African Teachers," *The Independent Journal of Teaching and Learning* 15, no. 2 (2020): 69–91; Kathy Cabe Trundle and Mesut Saçkes, "Teaching and Learning Science during the Early Years," *Journal of Childhood, Education & Society* 2, no. 3 (2021): 217–19.

[14] Daniel Hartmuth et al., "Developing Science Teachers' Enacted Pedagogical Content Knowledge through Integration of Student Feedback into the Refined Consensus Model of Pedagogical Content Knowledge," *Cogent Education* 12, no. 1 (2025): 2470563; Moses Abdullai Abukari et al., "Pedagogical Content Knowledge of Science Tutors and Its Influence on Their Trainees," *Contemporary Mathematics and Science Education* 3, no. 1 (March 3, 2022): ep22008, https://doi.org/10.30935/conmaths/11830.

[15] Maria Tsakeni et al., "Bridging the Gap between Intention and Enactment: A Bayesian Analysis of Pre-Service Teachers' Implementation of Inquiry-Based Practical Work in STEM (Science-Led) Classrooms," in *Frontiers in Education*, vol. 10 (Frontiers Media SA, 2025), 1719693.

[16] Nasaret, Tjirumbi, "Factors improving the beginner teachers' professional identity in induction at schools in Thobo Thabo-Mofutsanyane." *International Journal of studies in Psychology* 4, no. 2 (2024): 22-30; Nasaret, Tjirumbi and Marguerite Muller. "Exploring beginner teachers' experience in their first year of teaching at Thabo Mofutsanyane district: Induction programme approach." *International Journal of studies in Psychology* 3, no. 2 (2023): 83-91.

The marginalisation of science within the FP curriculum is a recurrent concern in both South African and international research. In South Africa, science concepts are integrated into the Life Skills curriculum rather than offered as a standalone subject, leaving PSTs with minimal guidance on how to plan, resource, and teach science meaningfully.[17] Comparable findings emerge elsewhere: in the United States, accountability pressures and crowded timetables have reduced science instructional time, while in the United Kingdom, teachers report prioritising literacy and numeracy over science because of curriculum and assessment demands.[18] Even in systems with progressive curricular reforms, such as Australia and Singapore, studies highlight that PSTs often graduate without sufficient practicum exposure or mentoring to implement inquiry-based science pedagogies effectively.[19] This recurring misalignment between curriculum aspirations and teacher preparation realities points to what scholars describe as the theory–practice divide in science education.[20]

A second body of literature emphasises the professional learning potential of peer collaboration, yet critiques its inconsistent use in teacher education. In South Africa, for example, group work, microteaching, and collaborative lesson planning are common features of Life Skills modules, but these activities are often generic, lacking the science-specific focus or structured feedback needed to strengthen PSTs' PCK. Evidence shows that peer learning communities build confidence and teaching competence when deliberately structured around shared problem-solving, iterative feedback, and disciplinary depth.[21] Without such intentionality, peer collaboration risks becoming superficial, providing emotional support but failing to develop the inquiry-driven, inclusive pedagogies that early childhood science teaching demands.[22] From a SoTL perspective, peer learning must therefore be reimagined as a site of collaborative inquiry, where PSTs co-construct knowledge, trial new strategies, and reflect collectively on their impact.[23]

Institutional support structures, including mentorship, practicum placement, and academic supervision, also feature prominently in the literature as determinants of PSTs' readiness to teach science.[24] In South Africa, many PSTs are placed in schools where science is deprioritised, limiting their opportunities to observe or practise effective science instruction.[25] Similar challenges have been reported in Europe and India, where weak university–school partnerships and limited science-focused mentorship make it difficult for novice teachers to bridge theory and classroom practice. Even in high-performing systems such as Finland, studies show that practicum experiences often lack alignment with university coursework, reducing opportunities for PSTs to develop confidence in inquiry-based methods.[26] This recurring pattern across contexts highlights the need to reimagine institutional arrangements so that coursework, practicum, and mentoring form coherent, feedback-rich systems

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[17] Patrick Mweli and Lerato Mohale, "Foundation Phase Teachers' Experiences in Teaching Physical Education at a Primary School in the COVID-19 Era in the Motheo District, Free State, South Africa," *International Journal of Studies in Inclusive Education* 1, no. 2 (2024): 8–11; Elizabeth Joy Fredericks, "A Framework for Supporting Foundation Phase Novice Teachers' Instruction Competencies in Natural Science" (Cape Peninsula University of Technology, 2024).

[18] Sarah Earle and Jane Turner, "What Has Happened to Teacher Assessment of Science in English Primary Schools? Revisiting Evidence from the Primary Science Quality Mark," *Research in Science & Technological Education* 41, no. (2023): 22–38.

[19] Tonje Tomine Seland Strat, Ellen Karoline Henriksen, and Kirsti Marie Jegstad, "Inquiry-Based Science Education in Science Teacher Education: A Systematic Review," *Studies in Science Education* 60, no. 2 (2024): 191–249.

[20] A Sondlo and U Ramnarain, "The South African Pre-Service Teacher's Physics Pedagogical Orientations.," in *Journal of Physics: Conference Series*, vol. 1512 (IOP Publishing, 2020), 012031.

[21] Michele Stears, Angela A James, and Saritha Beni, "Teaching Science in the Foundation Phase: Where Are the Gaps and How Are They Accounted For?," *South African Journal of Childhood Education* 9, no. 1 (2019): 1–9; Tiffany D. Rowland, "Teacher Learning Communities: A Qualitative Case Study of Professional Development in Special Education" (Liberty University, 2025).

[22] Nina Kolleck et al., "Teachers' Professional Collaboration and Trust Relationships: An Inferential Social Network Analysis of Teacher Teams," *Research in Education* 111, no. 1 (2021): 89–107.

[23] Dilnoza Khasilova et al., "Building SoTL Community Through Collaborative Reflection: A Case of Reflective SoTL Blogs," *Transformative Dialogues: Teaching and Learning Journal* 18, no. 2 (2025): 122–34.

[24] Deborah A. Arasomwan and Nontokozo Mashiya, "Foundation Phase Pre-Service Teachers' Experiences of Teaching Life Skills during Teaching Practice," *South African Journal of Childhood Education* 11, no. 1 (March 11, 2021), https://doi.org/10.4102/sajce.v11i1.700.

[25] Jimmy Ezekiel Kihwele and Jamila Mkomwa, "Promoting Students' Interest and Achievement in Mathematics through 'King and Queen of Mathematics' Initiative," *Journal of Research in Innovative Teaching & Learning* 16, no. 1 (March 30, 2023): 115–33, https://doi.org/10.1108/JRIT-12-2021-0083.

[26] Johannes Sæleset and Patricia Friedrichsen, "Pre-Service Science Teachers' Pedagogical Content Knowledge Integration of Students' Understanding in Science and Instructional Strategies," *Eurasia Journal of Mathematics, Science and Technology Education* 17, no. 5 (2021): em1965.

deliberately focused on science pedagogy.[27] Finally, literature on teacher identity argues that PSTs do not automatically develop the dispositions, confidence, or professional identities required to teach science effectively; these evolve through sustained engagement with peers, mentors, and learners in authentic teaching contexts.[28] When such opportunities are absent, PSTs frequently report anxiety, low self-efficacy,[29] and reluctance to teach science, particularly in under-resourced schools. Conversely, research from the United States of America, Saudi Arabia, and South Africa shows that structured professional development, scaffolded collaboration, and targeted mentorship strengthen PSTs' science identities and equip them to integrate scientific concepts confidently and inclusively into early childhood curricula.[30]

Across these themes, the literature points to three interrelated challenges: the persistent marginalisation of science within early childhood curricula, the fragmentation of peer and institutional support systems, and the misalignment between theoretical coursework and practicum realities. Yet studies also show that when teacher education programmes integrate inquiry-based pedagogy, structured peer learning, and science-focused mentorship into coherent, reflective systems, PSTs develop stronger professional identities, higher self-efficacy, and greater readiness to teach science inclusively. However, limited research within the South African FP context has explored how curriculum structures, professional learning networks, and institutional support systems collectively shape PSTs' preparedness, confidence, and emerging identities as science educators. Insights from this body of literature provide the conceptual foundation for the present study, which draws on PCK, SNT, and the Integrated Pedagogical Network Support (IPNS) framework to reimagine how teacher education in South Africa can prepare PSTs for teaching science *anew and differently* in the FP.[31]

THEORETICAL FRAMEWORK

This study is underpinned by two interrelated theoretical perspectives: PCK and SNT**,** which together inform the Integrated Pedagogical Network Support (IPNS) framework developed through doctoral research. Within this context, these perspectives provide a multidimensional lens for analysing how curriculum design, professional learning networks, and institutional arrangements shape PSTs' preparedness to teach science in the FP.

PCK, as conceptualised by Shulman (1986), emphasises the transformation of subject matter knowledge into pedagogically meaningful and developmentally appropriate learning experiences.[32] In the FP, where science is embedded within Life Skills rather than taught as a discrete subject, this requires inquiry-oriented pedagogical strategies that make abstract scientific concepts accessible to young learners.[33] However, teacher education programmes often privilege theoretical coursework over practice-based learning, limiting PSTs' opportunities to develop and enact inquiry-based science pedagogy. While PCK clarifies the nature of pedagogical knowledge required for effective science teaching, it gives limited attention to the relational and institutional conditions through which such

[27] Zeina Hojeij et al., "Challenges for Practice Teaching in UAE Schools: Supervisors' and Pre-Service Teachers' Perceptions," *Issues in Educational Research* 31, no. 2 (2021): 513–36.

[28] Marcel Graus et al., "Disentangling Aspects of Teacher Identity Learning from Reflective Blogs: The Development of a Category System," *Teaching and Teacher Education* 111 (2022): 103624.

[29] Clever Ndebele and Dagogo William Legg-Jack, "The Impact of Mentoring in the Development of Pre-Service Teachers from a University in South Africa," *International Journal of Learning, Teaching and Educational Research* 21, no. 3 (2022): 88–105.

[30] Clever Ndebele and Dagogo William Legg-Jack, "The Impact of Mentoring in the Development of Pre-Service Teachers from a University in South Africa," *International Journal of Learning, Teaching and Educational Research* 21, no. 3 (2022): 88–105; Patricia Hrusa Williams and Carole K. Lee, "Developing Preservice Elementary Teachers' Professional Identity as Science Teachers through Community-Based Service-Learning," *International Journal of Research on Service-Learning & Community Engagement* 8, no. 1 (2020); Tahani Salman Alrajeh, "Project-Based Learning to Enhance Pre-Service Teachers' Teaching Skills in Science Education," *Universal Journal of Educational Research* 9, no. 2 (2021): 271–79; Sondlo and Ramnarain, "The South African Pre-Service Teacher's Physics Pedagogical Orientations."

[31] Teresa Ribeirinha and Marisa Correia, "Enhancing Pre-Service Teachers' Science Teaching Efficacy Beliefs and Attitudes toward Science Using the Flipped Classroom Model," *Frontiers in Education* 10 (2025): 1512320; Nosisi Percis Dlamini, "Preparing South African Foundation Phase Preservice Teachers to Teach Reading for Meaning," *International Journal of Language and Literary Studies* 4, no. 4 (2022): 158–74.

[32] Lee S. Shulman, "Those Who Understand: Knowledge Growth in Teaching," *Educational Researcher* 15, no. 2 (February 1, 1986): 4–14, https://doi.org/10.3102/0013189X015002004.

[33] Nhase, Zukiswa, and Bekithemba Dube. "Integrating storytelling and inquiry-based approach as pedagogies of developing scientific skills in early childhood classrooms." Childhood 237 (2015): 58, https://doi.org/10.38159/ehass.20234124

knowledge is developed, practised, and sustained.[34] SNT complements this perspective by foregrounding the relational dimension of professional learning, highlighting how networks of peers, mentors, and institutional actors support teachers through feedback, modelling, and emotional affirmation.[35] In contexts such as South Africa, where mentoring and practicum opportunities are often uneven, informal peer relationships and school-based networks frequently become key sources of professional learning and professional identity development.[36] However, SNT alone does not sufficiently address the pedagogical depth of the knowledge circulating within these networks, nor does it address how curriculum and institutional structures shape opportunities for meaningful science teaching practice.

To address these limitations, the IPNS framework is introduced as a synthesising framework developed in this study**.** IPNS emerged from doctoral research to address a persistent gap between curricular intentions and PSTs' opportunities to practise and enact inquiry-based science teaching in the Foundation Phase. Drawing explicitly on PCK and SNT, the framework foregrounds the intentional integration of pedagogical knowledge, structured practice opportunities, and relational support**.** It conceptualises PSTs' preparedness to teach science as developing when theoretical learning is coherently aligned with supported practicum experiences, mentoring, and peer collaboration, rather than positioned as separate or sequential components of teacher education. Within the IPNS framework, PSTs' preparedness is understood as emerging from the interaction of three interdependent dimensions: pedagogical depth, which emphasises inquiry-based and developmentally appropriate science teaching; professional learning networks**,** which embed structured peer collaboration, mentoring, and professional identity development; and institutional alignment, which coordinates coursework, practicum experiences, and professional support systems to ensure coherence between theory and practice.[37] By integrating these dimensions, IPNS provides a conceptual basis for reimagining teacher education as a networked, practice-oriented, and inquiry-driven system rather than a fragmented combination of curricular, pedagogical, and institutional components. Aligned with the principles of the Scholarship of Teaching and Learning, the framework supports evidence-informed and contextually responsive approaches to preparing PSTs to teach science effectively in the FP.

METHODOLOGY

This study adopted a qualitative research approach to explore how PSTs experienced professional learning opportunities that shaped their preparedness to teach science in the FP.[38] The qualitative orientation was chosen because it values participants' voices and the meanings they attach to their experiences rather than seeking generalisable findings. Guided by the principles of the SoTL, the study positioned PSTs as active co-constructors of knowledge whose insights could inform efforts to reimagine teacher preparation for inclusive, inquiry-oriented science pedagogy.[39] An interpretive paradigm framed the study because of its focus on understanding how individuals make sense of their experiences within specific social, cultural, and institutional contexts.[40] This orientation was well-suited to examining how curriculum design, practicum exposure, peer collaboration, and mentorship opportunities collectively influenced PSTs' confidence and professional identities in teaching science anew and differently.

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[34] Saiqa Azam, "Locating Personal Pedagogical Content Knowledge of Science Teachers within Stories of Teaching Force and Motion," *Eurasia Journal of Mathematics, Science and Technology Education* 16, no. 12 (October 21, 2020): em1907, https://doi.org/10.29333/ejmste/8941.

[35] Nina Kolleck, "Motivational Aspects of Teacher Collaboration," *Frontiers in Education* 4 (2019): 122.

[36] Petra Engelbrecht, "Inclusive Education: Developments and Challenges in South Africa," *Prospects* 49, no. 3 (2020): 219–32.

[37] Katlego Mabulana, "Learners' Preparedness for Higher Education in South Africa: Developing a Sense of Academic Belonging through the Selective Learning Approach," *Frontiers in Education* 10 (2025): 1465786.

[38] Ines G. De Almeida and Jan P. Weber, "Pre-Service Teachers' Experiences of Online Microteaching in South Africa," *African Journal of Teacher Education and Development* 4, no. 1 (2025): 90.

[39] Jo-Anne Vorster, "SoTL: A Mechanism for Understanding and Finding Solutions to Teaching and Learning Challenges," *Scholarship of Teaching and Learning in the South* 4, no. 2 (September 28, 2020): 6–21, https://doi.org/10.36615/sotls.v4i2.149.

[40] Nasrin Pervin and Mahani Mokhtar, "The Interpretivist Research Paradigm: A Subjective Notion of a Social Context," *International Journal of Academic Research in Progressive Education and Development* 11, no. 2 (2022): 419–28.

Sampling and Participants

Purposive sampling was employed to invite participants with direct experience in teaching and learning science-related themes embedded within the FP Life Skills curriculum.[41] Such diversity enriched the dataset by providing multiple perspectives on how curriculum design, practicum exposure, and institutional support structures shaped PSTs' professional identities and preparedness to teach science in innovative and inclusive ways.

Data Collection Methods

Two qualitative data collection methods were employed: focus group interviews (FGIs) and group reflections.[42] These methods were selected for their capacity to generate interactive and reflective data aligned with SoTL principles of collaborative inquiry and reflective practice. Together, they enabled the exploration of both shared meaning-making processes and individual sense-making related to PSTs' professional learning experiences in teaching science in the FP.[43] The FGIs were conducted asynchronously within dedicated WhatsApp groups created for each focus group. This approach allowed participants to engage in interview discussions over an extended period rather than at a fixed time and was intentionally responsive to the demanding nature of participants' academic and practicum responsibilities, as several PSTs were concurrently engaged in school-based teaching practice. The WhatsApp-based format enabled flexible participation while minimising logistical and financial barriers associated with synchronous online platforms, such as Microsoft Teams or Zoom, including data costs and connectivity constraints.

Within each WhatsApp group, structured interview prompts were shared by the researcher, and participants responded using text-based messages, with optional voice notes to elaborate on their contributions. Participants were encouraged to engage with one another's responses, supporting dialogic interaction characteristic of focus group interviews. The researcher moderated each group by posting follow-up prompts, seeking clarification where necessary, and encouraging sustained interaction among participants. No live video or audio calls were conducted. The extended asynchronous format allowed participants to reflect on peers' contributions over time, fostering considered and sustained dialogue rather than rapid conversational exchange. The sample consisted of 18 PSTs, purposively selected based on their engagement with science-related themes within the FP Life Skills curriculum. Participants were organised into three focus groups, each comprising six participants, to facilitate manageable interaction and sustained dialogue. Discussions unfolded over a structured period of 90 to 150 minutes per group, allowing participants time to reflect on and respond to prompts related to curriculum engagement, practicum exposure, and access to peer and mentor support. The FGIs focused on how theoretical coursework translated, or failed to translate, into classroom confidence and inclusive, inquiry-based teaching strategies.

Following the completion of the focus group interviews, participants were invited to submit individual written reflections via WhatsApp. These reflections were completed after each focus group discussion and allowed participants to elaborate on, clarify, or critically reconsider issues raised during the group discussions. Although referred to as group reflections, the task was completed individually and served to deepen personal sense-making and articulate perspectives that may not have emerged in the group setting. By combining focus group interviews with individual written reflections, the study captured both collective meaning-making processes and individual interpretive depth. Data collection took place on 18–19 June 2024 via WhatsApp to ensure accessibility for students living both on and off campus. Participation was voluntary, and informed consent was obtained from all participants. While some participants experienced intermittent connectivity challenges, follow-up opportunities were provided to ensure that all voices were adequately represented in the dataset.

[41] Kavitha Rathinam, "Lived Experiences and Perceptions of International Teachers in Implementing US Curriculum: A Qualitative Phenomenological Study" (American College of Education, 2024).

[42] Apurv Chauhan and Surbhi Sehgal, "Interrogating Paradigmatic Commitments of Focus Group Methodology: An Invitation to Context-Sensitive Qualitative Research Methods.," *Qualitative Psychology* 9, no. 2 (June 2022): 127–39, https://doi.org/10.1037/qup0000227.

[43] Lisa S. Ockerman and Sikha Bagui, "Critical Reflection Sessions: Teachers' Perspectives During Professional Development," *International Journal of Changes in Education* , 2024.

Data Analysis

Data were analysed using thematic narrative analysis, which enabled the study to capture both the complexity of participants' professional learning experiences and the theoretical commitments underpinning the research.[44] A combined deductive–inductive coding strategy was employed to ensure systematic integration of theory while remaining responsive to participants' meaning-making.[45] Deductive codes were derived directly from the study's conceptual framework, specifically PCK, SNT, and the IPNS framework. Within the PCK domain, initial deductive codes focused on participants' accounts of science content understanding, pedagogical strategies, learner engagement, and confidence in teaching science-related themes.[46]

Codes informed by SNT captured the nature and function of support structures, including peer collaboration, mentorship relationships, and access to institutional resources. The IPNS framework guided both the deductive coding process and the synthesis of themes by serving as an integrative analytic lens through which curriculum coherence, practicum alignment, and networked support were examined in relation to PSTs' professional identity development and preparedness to teach science. Inductive coding was conducted concurrently to identify patterns and meanings that emerged from the data but were not fully anticipated by the theoretical framework.[47] These inductive codes reflected participants' lived experiences of curriculum engagement, gaps between theory and practice, emotional responses to teaching science, and adaptive strategies developed in response to limited or uneven support.

The analysis proceeded through multiple iterative coding cycles. Transcripts from focus group interviews and written group reflections were first read holistically to preserve narrative coherence and attend to how participants sequenced experiences of coursework, practicum, and support over time, before being coded line by line. Coding was conducted by the researcher, with ongoing refinement of codes and themes to ensure analytic consistency and coherence. Initial codes were refined, merged, and reorganised into broader thematic categories aligned with the study's three research questions on professional learning experiences, support structures, and strategies for reimagining science education in the FP. Themes were compared across data sources to enhance triangulation and strengthen analytic credibility.[48] Through this iterative process, thematic maps were developed to illustrate how curriculum design, practicum exposure, and social support networks interacted to shape PSTs' pedagogical confidence and emerging professional identities. This analytic approach reflects SoTL principles by integrating theory-driven interpretation with careful attention to participants' voices and unanticipated insights arising from the data.

Trustworthiness and Ethics

Credibility was strengthened through triangulation across focus group interviews, group reflections, and curriculum documents.[49] Peer debriefing with academic colleagues helped refine coding decisions, while member checking with selected participants ensured the accuracy of emerging interpretations. Detailed descriptions of the research setting and participant profiles support transferability, enabling readers to assess the applicability of findings to similar contexts. A transparent audit trail was maintained throughout the analysis to enhance dependability, and all coding decisions were carefully documented to ensure confirmability. Ethical clearance was obtained from the University of the Free State (Ref: UFS-HSD2022/2073). Participation was voluntary, informed consent was secured from all

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[44] Philippa Parks, "Story Circles: A New Method of Narrative Research," *American Journal of Qualitative Research* 7, no. 1 (2023): 58–72.

[45] Helen Pearson et al., "The Approach and Application of Analysing Inductive and Deductive Datasets: A Worked Example Using Reflexive Thematic Analysis," *Qualitative Research in Psychology* 22, no. 4 (October 2, 2025): 842–86, https://doi.org/10.1080/14780887.2025.2499265.

[46] Dalia Al-Eisawi, "A Design Framework for Novice Using Grounded Theory Methodology and Coding in Qualitative Research: Organisational Absorptive Capacity and Knowledge Management," *International Journal of Qualitative Methods* 21 (April 20, 2022), https://doi.org/10.1177/16094069221113551.

[47] Courtney McKim, "Meaningful Member-Checking: A Structured Approach to Member-Checking," *American Journal of Qualitative Research* 7, no. 2 (2023): 41–52.

[48] Anita Bans-Akutey and Benjamin Makimilua Tiimub, "Triangulation in Research," *Academia Letters* 2, no. 3392 (2021): 1–7.

[49] McKim, "Meaningful Member-Checking: A Structured Approach to Member-Checking."

participants, and pseudonyms were used to protect identities. Data were stored securely in accordance with institutional ethics protocols.

PRESENTATION OF FINDINGS AND DISCUSSION

This section presents the study's findings through the lens of Inclusive SoTL, focusing on how teacher preparation can foster innovative and inquiry-oriented approaches to science education in the Foundation Phase. Guided by the sub-theme *Teaching anew and differently in SoTL*, the analysis draws on data from focus group interviews and group reflections with third- and fourth-year B.Ed. students. The discussion responds to three interrelated research questions: (1) How do professional learning experiences influence PSTs' teaching identities, confidence, and readiness to teach science in the Foundation Phase? (2) In what ways do peer collaboration, mentorship, and institutional networks enable or constrain inclusive and inquiry-based science pedagogy? and (3) How can teacher education programmes integrate SoTL principles to prepare PSTs to teach science anew and differently? The interpretation is informed by PCK and SNT, integrated through the IPNS framework. Together, these perspectives illuminate the persistent gaps between curricular intentions, practical training, and the professional learning support necessary for developing confident and competent science educators.

Reimagining Curriculum Design for Science Pedagogy

Findings revealed that the B.Ed. curriculum provided only limited opportunities for PSTs to integrate science-related content meaningfully into their FP teaching practice. Across focus group interviews, both third- and fourth-year students expressed that while modules such as Life Skills Teaching and Facilitation included science topics, these were often theoretical, with insufficient opportunities for hands-on practice. As one fourth-year student noted, *"We learned about science themes in lectures, but when it came to teaching practice, we hardly got to use them because schools didn't prioritise Life Skills."* This sentiment was echoed by most third-year participants, who reported that they often taught literacy or numeracy during practicum because mentor teachers allocated minimal time to science themes.

The lack of structured opportunities for integrating theory with classroom practice created a persistent gap between curricular intentions and real teaching experiences. For instance, only a few fourth-year students reported teaching science topics such as *Earth and Beyond* or *Living and Non-Living Things* during practicum, while the majority indicated that science content was either superficially covered or entirely omitted in placement schools. These findings align with previous studies highlighting that without deliberate practicum structures and mentor support, science education in the FP remains marginalised.[50]

Moreover, participants observed that assessment activities within the B.Ed. programme tended to prioritise written assignments and lesson plan designs rather than iterative, feedback-driven teaching opportunities. As one third-year student explained, *"We designed lesson plans for Life Skills, but no one really observed us teaching science to give feedback. It was just about submitting the plan."* This lack of formative assessment limited opportunities for PSTs to develop confidence in translating PCK into inclusive, inquiry-based science teaching practices. Overall, both third- and fourth-year students emphasised the need for curriculum redesign that embeds supervised microteaching, practicum opportunities, and structured feedback loops focused specifically on science pedagogy. These findings suggest that reimagining curriculum design to prioritise practice-based learning would better align teacher preparation with the principles of SoTL, ensuring that PSTs are equipped to teach science anew and differently in the Foundation Phase.

Professional Learning Networks and Mentorship

The study also revealed the critical role of professional learning networks, including peer collaboration, mentor guidance, and institutional support, in shaping PSTs' confidence and professional identities as science educators. Fourth-year students, in particular, highlighted that informal peer networks often became their primary source of lesson planning ideas, emotional encouragement, and teaching

[50] Carrier et al., "Teachers as Learners: Outdoor Elementary Science."

resources. One participant reflected, *"We shared lesson plans and teaching tips among ourselves because sometimes lecturers or mentors were not available to guide us."* This finding resonates with SNT, which emphasises how professional learning frequently emerges through relationships and collaborative networks rather than isolated training activities.[51]

However, while peer collaboration offered emotional and practical support, participants noted its limitations when not formally structured within the programme. Several third-year students observed that without lecturer or mentor input, peer feedback risked reinforcing existing gaps in pedagogical knowledge rather than addressing them. As one participant explained, *"We helped each other, but sometimes we were all unsure about how to teach certain science topics properly."* This suggests that peer networks, though valuable, require institutional scaffolding to ensure alignment with curriculum goals and pedagogical best practices. Mentorship during school placements emerged as an essential yet unevenly experienced support mechanism. Only a minority of participants, mainly fourth-year students, reported receiving sustained guidance from mentor teachers on how to teach science-related themes. One student recalled, *"My mentor actually showed me how to do simple experiments with everyday materials. That gave me confidence because I saw how excited the learners became."* In contrast, most participants indicated that mentor teachers either prioritised other subjects or provided minimal feedback on science lessons, reflecting broader studies highlighting the lack of science-focused mentorship in many teacher education programmes.[52]

Institutional support was similarly inconsistent. Some participants valued workshops and microteaching sessions organised by the university, while others, particularly third-year students, reported that these opportunities were infrequent or poorly integrated into core coursework. Collectively, these findings demonstrate that professional learning networks have significant but underutilised potential to strengthen PSTs' PCK and confidence in teaching science. Embedding structured mentorship, peer collaboration, and practicum feedback into teacher education programmes would align professional learning opportunities with the principles of SoTL and the relational insights of SNT.

Developing Science Teacher Identities through Practice

Across both focus group interviews and group reflections, participants described how their emerging identities as Foundation Phase science educators were shaped through the interplay of curriculum exposure, practicum experiences, and professional learning networks. Fourth-year students, having completed more practicum placements, generally expressed greater confidence in teaching science than third-year students; however, both groups highlighted persistent challenges related to limited opportunities to teach science and ongoing resource constraints. Third-year students, in particular, noted that early teaching experiences frequently prioritised literacy and numeracy, leaving science marginalised within classroom practice. As one participant explained, "*We mostly taught literacy and numeracy. Science was hardly mentioned unless you pushed for it yourself.*" Similarly, a fourth-year student reflected, "*By the time you reach fourth year, you start feeling like a real teacher, but with science, I still feel I haven't taught it enough to be fully confident.*"

Despite these constraints, participants reported that moments of successful science teaching, such as conducting simple experiments or connecting lessons to environmental themes, were pivotal in shaping their emerging professional identities. These experiences contributed to growing pedagogical confidence and a sense of legitimacy as science teachers. One fourth-year student remarked, "*When I finally taught about plants and saw learners asking questions excitedly, I thought, maybe I can actually do this.*" Such accounts highlight the importance of repeated, supported practice opportunities in developing science-related pedagogical content knowledge and professional confidence, reinforcing Veith and Bitzenbauer's argument that science teacher identities are constructed through iterative, experiential learning rather than theoretical instruction alone.[53]

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[51] Christoph Stadtfeld et al., "Integration in Emerging Social Networks Explains Academic Failure and Success," *Proceedings of the National Academy of Sciences* 116, no. 3 (January 15, 2019): 792–97, https://doi.org/10.1073/pnas.1811388115.
[52] Arasomwan and Mashiya, "Foundation Phase Pre-Service Teachers' Experiences of Teaching Life Skills during Teaching Practice."
[53] J M Veith and P Bitzenbauer, "Teacher Identity in Science Education–Results of an Empirical Study on First-and Third-Person Narratives," in *Journal of Physics: Conference Series*, vol. 2297 (IOP Publishing, 2022), 012035.

Participants further emphasised that professional identity development was closely tied to mentorship and feedback. Where mentor teachers or lecturers provided targeted, science-focused guidance, PSTs reported feeling more capable and motivated to teach the subject. In contrast, the absence of such support intensified feelings of uncertainty and reinforced the marginalisation of science within the FP curriculum. These findings underscore the need for teacher education programmes to embed identity-building opportunities, such as supervised practicum, structured mentorship, and reflective practice, within the core design of science teacher preparation. Such opportunities are essential for strengthening PSTs' confidence, inquiry-oriented pedagogies, and emerging identities as capable FP science educators.

Integrating Inclusive and Inquiry-Based Pedagogies

Finally, the findings indicate that while participants valued inclusive and inquiry-based teaching approaches, they often lacked sufficient practical preparation to implement these strategies effectively. Both third- and fourth-year participants expressed strong enthusiasm for hands-on, learner-centred science activities; however, they reported that time constraints, curriculum overload, and limited resources frequently constrained their ability to enact these approaches during teaching practice. As one participant explained, *"We learned about inquiry methods in class, but during teaching practice, there was hardly time or materials to actually use them."* Another participant similarly noted, *"You know the theory of inquiry, but when you are in the classroom, it becomes difficult to apply it because everything is rushed."*

Despite these challenges, several participants described improvising teaching resources, such as using recycled materials or creating simple weather charts, as a means of maintaining learner engagement in science lessons. These accounts reflect both participants' commitment to inclusive, inquiry-based pedagogy and the systemic lack of resource provision in many Foundation Phase classrooms. As one fourth-year participant remarked, *"Sometimes you buy things with your own money because you want the lesson to be exciting,"* while another added, *"Not all schools have resources, so you end up making your own, even if it costs you."*

Participants further emphasised that inclusive pedagogy required responsiveness to learners' diverse linguistic and learning needs, particularly in multilingual and under-resourced contexts. One third-year participant shared, *"Some learners struggled with the terms in English, so I had to explain in their home language, and that helped them participate more."* Another participant echoed this view, noting that *"when you explain in a language learners understand, they become more confident to answer questions."* These experiences align with SoTL principles that advocate for contextually responsive, inclusive teaching strategies that recognise learner diversity.[54] However, participants consistently reported that without structured opportunities to observe, practise, and receive feedback on inclusive and inquiry-based strategies, their capacity to enact these approaches in science teaching remained limited. This gap points to underdeveloped pedagogical enactment knowledge and limited instructional support during practicum experiences. As one fourth-year participant concluded, *"We want to teach science in ways that include everyone and make it fun, but we need more training on how to actually do that in real classrooms."* These findings underscore the need for teacher education programmes to embed inclusive, inquiry-based pedagogy more explicitly within both coursework and practicum experiences in order to prepare pre-service teachers to teach science anew and differently in the FP.

The IPNS Framework: Reimagining Professional Learning for Inclusive and Inquiry-Based Science Education

This subsection presents the IPNS framework as a conceptual synthesis emerging from the study's findings, rather than as a separate set of results. It draws together recurring patterns identified across the data to provide an integrated lens for understanding how curriculum design, practicum experiences, and professional support structures shape PSTs' preparedness to teach science in the FP. The findings

[54] Jessica Versfeld, "A Social Connectedness Intervention as Pathway to Teacher Resilience in Primary Schools in Challenged Spaces" (University of Pretoria (South Africa), 2022).

revealed persistent fragmentation in how PSTs experience science education during their training, particularly in the misalignment between theoretical coursework, practicum opportunities, and professional learning support. While PCK foregrounds the specialised pedagogical and content knowledge required for effective science teaching,[55] it offers limited insight into the relational and institutional conditions that enable or constrain the development of this knowledge. Conversely, SNT highlights the role of social relationships, mentorship, and professional networks in shaping professional learning,[56] yet does not sufficiently address the disciplinary depth or pedagogical focus of the knowledge being shared. When applied in isolation, these frameworks leave critical gaps in explaining the disconnect between curriculum intentions, practicum realities, and support systems evident across participants' accounts.

The IPNS framework is therefore introduced as an integrative analytic response to these gaps, informed directly by participants' experiences reported in the preceding findings sections. The data showed that although PSTs valued collaboration, mentorship, and reflective engagement, these opportunities were often fragmented, informal, and poorly connected to the development of science teaching competence. By bringing together the pedagogical focus of PCK and the relational insights of SNT within a SoTL-informed orientation, the IPNS framework conceptualises professional learning as a deliberately networked and practice-rich process rather than a series of disconnected learning experiences. Central to the IPNS framework is the recognition that preparing FP science teachers requires coherence across curriculum design, practicum experiences, and professional support structures. Curriculum should explicitly integrate inclusive and inquiry-based science pedagogy. Professional learning networks should also provide structured opportunities for peer collaboration, mentorship, and feedback, while institutional arrangements such as the alignment of coursework, assessment tasks, and school-based mentoring should strengthen continuity between university learning and classroom practice. These elements reflect the challenges articulated by participants, including limited practicum exposure, inconsistent mentorship, and the marginalisation of science within the Foundation Phase curriculum.

As illustrated in Figure 1, the IPNS framework positions professional learning as an iterative and interconnected ecosystem in which pedagogical knowledge, social relationships, and institutional support reinforce one another. Rather than proposing a prescriptive model, the framework offers a conceptual roadmap for reimagining science teacher preparation that addresses the theory–practice divide and supports PSTs in teaching science in inclusive, inquiry-oriented, and contextually responsive ways in the FP.

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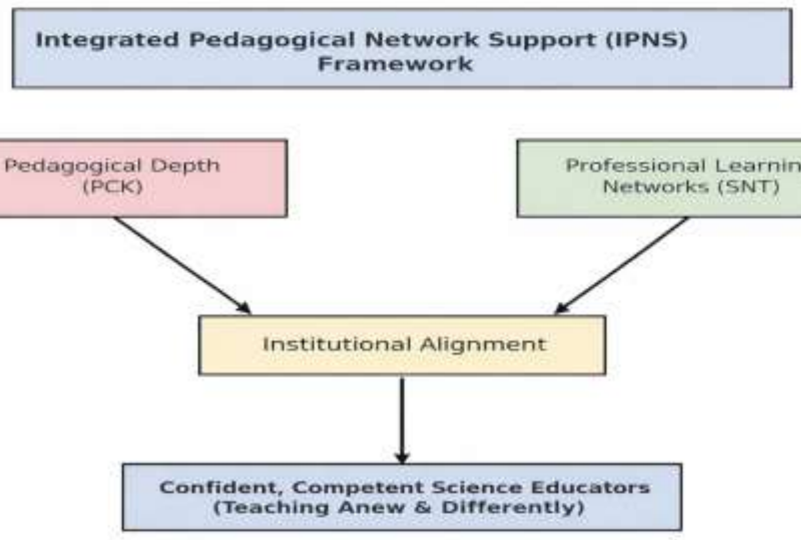

Figure 1: Integrated Pedagogical Network Support (IPNS) Framework for Teaching Science Anew in the Foundation Phase

RECOMMENDATIONS

Drawing from the study's findings, four key recommendations are proposed to strengthen the preparation of Foundation Phase PSTs to teach science effectively and coherently:

- Curriculum innovation: Teacher education programmes should embed supervised microteaching, iterative feedback loops, and practicum experiences that deliberately integrate inquiry-based and inclusive science pedagogy into core coursework. This approach would better support PSTs in translating theoretical knowledge into sustained classroom practice.
- Structured mentorship: Formalised mentorship systems linking university lecturers, school-based mentor teachers, and PSTs should be established to ensure consistent, science-focused guidance during practicum placements.
- Collaborative learning communities: Professional learning networks should be intentionally developed to support peer collaboration, resource sharing, and reflective dialogue centred on science pedagogy, rather than relying on informal or ad hoc interactions.
- Reflective and longitudinal development: Teaching portfolios should be introduced to document PSTs' professional growth over time, alongside longitudinal research that tracks their progression into early career teaching.

These recommendations aim to strengthen coherence between coursework, practicum, and professional support structures, thereby addressing the continued marginalisation of science within the Foundation Phase.

CONCLUSION

This study explored how the B.Ed. curriculum, practicum experiences, and professional learning networks shape PSTs' preparedness, confidence, and emerging identities as FP science educators in South Africa. The findings revealed a persistent gap between the curriculum's emphasis on inclusive and inquiry-based science learning and the realities of school placements, mentorship opportunities, and professional collaboration. Although science concepts were introduced theoretically, PSTs reported limited opportunities to teach science meaningfully during practicum, minimal feedback from mentor teachers, and inconsistently structured peer learning communities. The IPNS framework presented in this study offers a theoretically grounded and contextually responsive lens for addressing these challenges. By synthesising PCK, SNT, and SoTL principles, the framework conceptualises teacher preparation as a deliberately networked, science-focused, and practice-rich process through which PSTs develop pedagogical competence, professional confidence, and emerging identities as FP science educators. These insights contribute to ongoing discussions on early science teacher education by offering a coherent approach to bridging the theory–practice divide and supporting PSTs to teach science in inclusive, inquiry-oriented, and responsive ways in the FP.

Limitations

This study was carried out at a single South African university with a relatively small sample size, which limits the generalisability of the findings. Data were drawn from focus group interviews and group reflections, without classroom observations or multiple institutional comparisons, which could have provided richer triangulation. Future research should therefore include larger, multi-institutional studies, integrate classroom-based data, and assess the longitudinal impact of the IPNS Framework on PSTs' professional identities and science teaching competence.

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