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Exploring the Challenges faced by Pre-service Teachers in Executing Science Lessons during Work Integrated Learning in Rural School Settings

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ABSTRACT

The study explored the challenges faced by pre-service teachers in executing science lessons during work-integrated learning in rural school settings. An exploratory case study methodology was employed, using interviews and an open-ended Google Form questionnaire to collect data from fourth-year primary and high school preservice teachers, training to teach science at a teacher training institution in South Africa. Several key challenges emerged from the data. Firstly, some pre-service teachers reported a lack of access to laboratory facilities, which hindered their ability to conduct practical science lessons. Additionally, the substantial teaching workloads imposed on them during their teaching practicum posed a significant challenge for these pre-service teachers, who found themselves overwhelmed by the demands of the school where they were placed. The absence of effective mentorship further exacerbated difficulties, leaving many pre-service teachers navigating classroom management and instructional practices on their own. Language barriers also played a critical role, as many pre-service teachers struggled to teach and understand scientific concepts due to English not being their native language. Education institutions and policymakers should consider these challenges when developing teacher education curricula and policies. Ensuring that pre-service teachers are well-equipped to handle the unique challenges of rural teaching environments, is essential for improving educational outcomes in these areas. This research underscores the need for targeted support and resources in teacher education programs, especially for those preparing to teach in rural areas. By identifying these challenges, the study offers a foundation for developing more effective teacher education curricula and policies that can better prepare pre-service teachers for the realities of teaching in rural settings, ultimately contributing to improved educational outcomes in these communities.

Keywords: *Challenges, Language Barriers, Management, Preservice Teacher, Resources, Work-Integrated Learning*

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INTRODUCTION

This paper reports on challenges experienced by secondary school pre-service science teachers, in their respective school contexts in South Africa. The study aims to understand the notion of effective teaching practices in these contexts, the beginner teachers' access to these practices and how their contexts influenced how they framed and implemented such practices in their classrooms. If their preservice preparation has been successful, beginner teachers will have a clear vision of effective teaching practices. Ideally, they should possess a diverse array of pedagogical approaches, curriculum and assessment strategies, as well as the disposition to learn in and from practice.[1]Therefore, the primary focus of support at the school level is to facilitate the adaptation of beginner teachers and to employ their skills in consideration of their learners and contexts.[2] A comparison of support mechanisms across schools revealed the challenges of these beginner teachers and their teaching practices are important to inform practices and policy changes within the predominant centralised education system of South Africa.

As understanding of human development and learning continues to advance rapidly, so does the potential to shape more effective educational practices. However, to harness these advancements, a holistic approach that integrates insights from various disciplines, including educational research. This article aims to contribute to this integration by highlighting the implications of challenges in school and classroom practices. Hinojosa and Bonner emphasised the scarcity of literature focusing on on-site coaching and feedback for teacher development.[3] Similarly, research by Barnett and Friedrichsen as well as Wang and Fulton, noted a lack of studies exploring mentors' practices and their impact on pre-service teachers' pedagogical content knowledge (PCK).[4] Moreover, Barnett and Friedrichsen and Bradbury, pointed out that there is limited research specifically addressing day-to-day mentoring in science education, leaving a gap in the understanding of science mentorship.[5] There is an urgent need for studies that investigate how mentoring and field supervision can bolster the professional growth of pre-service teachers during their teaching practice.[6] While pre-service teachers acquire practical knowledge through hands-on teaching experiences, they would benefit greatly from mentors who serve as role models, guiding them through lesson observations and reflective practices.[7] Such mentorship helps bridge the gap between theoretical knowledge and its practical application. Therefore, the modeling of best practices by experienced mentors, coupled with intensive supervision, is crucial for effective professional development.

LITERATURE REVIEW

Darling-Hammond et al. emphasise that effective learning hinges on supportive environments that cultivate emotional connections, belonging, and a clear sense of purpose.[8] Additionally, instructional methods must be designed to engage learners, fostering competence and self-directed learning.[9] These strategies should connect with learners' prior knowledge and with formative assessments serving as tools to gauge the efficacy of teaching approaches.[10]

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[1] K. M. Hammerness, L. Darling-Hammond, and J. et al. Bransford, " How Teachers Learn and Develop," in *Preparing Teachers for a Changing World: What Teachers Should Learn and Be Able to Do*, ed. L. Darling-Hammond and J Bransford (San Francisco, CA: Jossey-Bass, 2005), 358–89.

[2] Hammerness, Darling-Hammond, and Bransford, " How Teachers Learn and Develop."

[3] Denisse M Hinojosa and Emily P Bonner, "The Community Mathematics Project: Using a Parent Tutoring Program to Develop Sense-Making Skills in Novice Mathematics Educators," *Mathematics Education Research Journal* 35, no. 3 (2023): 497–524.

[4] Ellen Barnett and Patricia J Friedrichsen, "Educative Mentoring: How a Mentor Supported a Preservice Biology Teacher's Pedagogical Content Knowledge Development," *Journal of Science Teacher Education* 26 (2015): 647–68; Jian Wang and Lori A Fulton, "Mentor-Novice Relationships and Learning to Teach in Teacher Induction: A Critical Review of Research," *REMIE: Multidisciplinary Journal of Educational Research* 2, no. 1 (2012): 56–104.

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[6] Hinojosa and Bonner, "The Community Mathematics Project: Using a Parent Tutoring Program to Develop Sense-Making Skills in Novice Mathematics Educators."

[7] Dania Comparcini et al., "Developing Mentorship in Clinical Practice: Psychometrics Properties of the Mentors' Competence Instrument," *Nurse Education in Practice* 43 (2020): 102713; Betul Ekiz-Kiran, Yezdan Boz, and Elif Selcan Oztay, "Development of Pre-Service Teachers' Pedagogical Content Knowledge through a PCK-Based School Experience Course," *Chemistry Education Research and Practice* 22, no. 2 (2021): 415–30; Yuval Walter and Igor Verner, "Cross-Age Mentoring to Educate High-School Students in Digital Design and Production," in *Robotics in Education: Current Research and Innovations 10*, ed. M. Merdan et al. (Springer International Publishing, 2020), 367–75, https://doi.org/10.1007/978-3-030-26945-6_33.

[8] Linda Darling-Hammond et al., "Implications for Educational Practice of the Science of Learning and Development," *Applied Developmental Science* 24, no. 2 (2020): 97–140.

[9] Anne Voskamp, Els Kuiper, and Monique Volman, "Teaching Practices for Self-Directed and Self-Regulated Learning: Case Studies in Dutch Innovative Secondary Schools," *Educational Studies* 48, no. 6 (November 2, 2022): 772–89, https://doi.org/10.1080/03055698.2020.1814699.

[10] Marshall Winget and Adam M. Persky, "A Practical Review of Mastery Learning," *American Journal of Pharmaceutical Education* 86, no. 10 (December 2022): ajpe8906, https://doi.org/10.5688/ajpe8906.

Cooperative learning and scaffolding techniques not only promote a positive mindset but also drive academic advancement and constructive behaviour.[11] A teacher's PCK, which includes expertise in teaching processes such as classroom management, assessment, and lesson planning, is crucial.[12]

Challenges in teaching often stem from unfamiliarity with instructional strategies, inadequate classroom management, insufficient professional commitment, time management issues and an unsupportive environment. According to Dilshad and Iqbal, effective teaching hinges on providing adequate physical resources, adopting a student-centered approach, and encouraging self-assessment and reflection.[13]

Furthermore, mentoring plays a pivotal role in developing pedagogical skills among teachers. Given the limited research on mentoring in teaching, there is a pressing need for studies to identify and address potential challenges in mentoring to ensure that student teachers effectively acquire pedagogical skills during their teaching practice.Effective science mentoring should cultivate both theoretical understanding and practical skills in science education. Practical skills include organising activities, preparing chemicals, evaluating practical competencies, and ensuring laboratory safety. Fundamental scientific abilities involve the handling, measurement, observation, design, communication, inference, and prediction of equipment.[14]

The emphasis on science process skills is critical in science education. These skills are crucial not only for mastering scientific concepts but also for solving real-world problems. As such, they play a vital role for both pre-service teachers and learners in understanding science through hands-on experiences.[15] Laboratory activities not only motivate learners but also improve their comprehension of scientific concepts.[16]

However, studies such as those of George in Lesotho, Gudyanga, Gudyanga and Jita in South Africa, and Mudulia in Kenya, highlighted the deficiency of laboratories and resources in schools.[17] Consequently, many learners resort to rote memorisation for exams, missing out on understanding science as an application process.[18] Learners leave high school with limited science process skills, as revealed in Mafugu's study, where university students lack the design skills that are crucial when teaching in under-resourced schools where it is impossible to perform experiments as prescribed in textbooks.[19]

Mentor teachers play a crucial role in nurturing pre-service teachers to impart these science process skills effectively. Bahtiar and Dukomalamo found that students exposed to discovery learning outperformed their peers who followed conventional laboratory practices. However, this approach

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[11] Darling-Hammond et al., "Implications for Educational Practice of the Science of Learning and Development"; Robyn M. Gillies and Michael Boyle, "Teachers' Scaffolding Behaviours during Cooperative Learning," *Asia-Pacific Journal of Teacher Education* 33, no. 3 (November 2005): 243–59, https://doi.org/10.1080/13598660500286242.

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[14] Agatha Asih Nugraheni and Wuri Wuryandani, "The Effect Of Science Technology And Society Models On Science Process Skills," *INFORMASI* 48, no. 2 (December 1, 2018): 213–27, https://doi.org/10.21831/informasi.v48i2.21359.

[15] Antika Yekti Handayani, Mohamad Nur, and Yuni Sri Rahayu, "Pengembangan Perangkat Pembelajaran IPA SMP Dengan Model Inkuiri Untuk Melatihkan Keterampilan Proses Pada Materi Sistem Pencernaan Manusia," *JPPS (Jurnal Penelitian Pendidikan Sains)* 4, no. 2 (2015): 681–92.

[16] H Hermansyah et al., "Guided Inquiry Model with Virtual Labs to Improve Students' Understanding on Heat Concept," in *Journal of Physics: Conference Series*, vol. 1153 (IOP Publishing, 2019), 012116.

[17] Mosotho J George, "Assessing the Level of Laboratory Resources for Teaching and Learning of Chemistry at Advanced Level in Lesotho Secondary Schools," *South African Journal of Chemistry* 70 (2017): 154–62; Remeredzayi Gudyanga, "Probing Physical Sciences Teachers' Chemical Laboratory Safety Awareness in Some South African High Schools," *African Journal of Research in Mathematics, Science and Technology Education* 24, no. 3 (September 1, 2020): 423–34, https://doi.org/10.1080/18117295.2020.1841960; Remeredzayi Gudyanga and Loyiso C Jita, "Teachers' Implementation of Laboratory Practicals in the South African Physical Sciences Curriculum," *Issues in Educational Research* 29, no. 3 (2019): 715–31; Ambogo Mabel Mudulia, "The Relationship between Availability of Teaching/Learning Resources and Performance in Secondary School Science Subjects in Eldoret Municipality, Kenya," *Journal of Emerging Trends in Educational Research and Policy Studies* 3, no. 4 (2012): 530–36.

[18] R Djamahar et al., "Empowering Student's Metacognitive Skill Through Cirsa Learning," *Journal of Physics: Conference Series* 1227, no. 1 (June 1, 2019): 012001, https://doi.org/10.1088/1742-6596/1227/1/012001; Handayani, Nur, and Rahayu, "Pengembangan Perangkat Pembelajaran IPA SMP Dengan Model Inkuiri Untuk Melatihkan Keterampilan Proses Pada Materi Sistem Pencernaan Manusia."

[19] Tafirenyika Mafugu, "Examining the Science Design Skills Competency among Science Preservice Teachers in the Post-COVID-19 Pandemic Period," *Education Sciences* 14, no. 4 (2024): 387.

requires adequate resources.[20] Achinstein and Fogo highlight that mentoring conversations facilitate the development of pre-service teachers' PCK through guided instruction in specific disciplines.[21] Studies suggest that PCK can evolve through reflective practices, observing mentor teachers, participating in discussions, connecting readings, and critically evaluating curricula.[22] For instance, Barnett and Friedrichsen illustrated how mentors promoted topic-specific pedagogical knowledge by sharing strategies, modeling reflection, and engaging in joint discussions about teaching methods.[23] Effective teaching demands rigorous responsiveness from teachers, interpreting classroom observations and interactions effectively.[24] Teachers must learn to attend, analyse, and respond systematically, recognising that teaching is an evolving profession.[25]

Teachers should also foster divergent thinking by posing open-ended questions.[26] Stimulating critical thinking can be achieved through questions of varying cognitive levels.[27] The cultivation of these skills begins with pre-service teachers, who, in turn, promote metacognitive abilities among their learners. Mentor teachers can encourage this by prompting pre-service teachers to articulate instructional choices, methods, and rationales.[28] Research indicates that classroom size and management practices significantly influence teaching outcomes in science.[29] In particular, classroom size impacts low-performing students more than high-achieving ones, and effective classroom management correlates with higher learning engagement.[30]

Despite the recognised importance of mentoring in developing pedagogical skills, literature is scarce on day-to-day science mentoring practices.[31] Based on the foregoing discussion, this study aims to explore how mentor teachers and school environments support pre-service science teachers in bridging the gap between theory and practice in science teaching. This study will use data generated from students teaching in four different provinces of South Africa.

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[21] Betty Achinstein and Bradley Fogo, "Mentoring Novices' Teaching of Historical Reasoning: Opportunities for Pedagogical Content Knowledge Development through Mentor-Facilitated Practice," *Teaching and Teacher Education* 45 (2015): 45–58.
[22] Ekiz-Kiran, Boz, and Oztay, "Development of Pre-Service Teachers' Pedagogical Content Knowledge through a PCK-Based School Experience Course."
[23] Barnett and Friedrichsen, "Educative Mentoring: How a Mentor Supported a Preservice Biology Teacher's Pedagogical Content Knowledge Development."
[24] Tova Michalsky, "Integrating Video Analysis of Teacher and Student Behaviors to Promote Preservice Teachers' Teaching Meta-Strategic Knowledge," *Metacognition and Learning* 16, no. 3 (December 31, 2021): 595–622, https://doi.org/10.1007/s11409-020-09251-7.
[25] Tara Barnhart and Elizabeth van Es, "Studying Teacher Noticing: Examining the Relationship among Pre-Service Science Teachers' Ability to Attend, Analyze and Respond to Student Thinking," *Teaching and Teacher Education* 45 (2015): 83–93; Helena Wessels, "Noticing in Pre-Service Teacher Education: Research Lessons as a Context for Reflection on Learners' Mathematical Reasoning and Sense-Making," in *Invited Lectures from the 13th International Congress on Mathematical Education*, ed. G. Kaiser et al. (Springer., 2018), 731–48, https://doi.org/10.1007/978-3-319-72170-5_41.
[26] Stacey Pylman and Julie Bell, "Levels of Mentor Questioning in Assisted Performance: What Mentors Should Ask Student Teachers While Co-Planning," *Mentoring & Tutoring: Partnership in Learning* 29, no. 5 (October 20, 2021): 522–44, https://doi.org/10.1080/13611267.2021.1986796.
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[28] Eilam, "Probing Teachers' Lesson Planning: Promoting Metacognition."
[29] Peter Blatchford, Paul Bassett, and Penelope Brown, "Examining the Effect of Class Size on Classroom Engagement and Teacher–Pupil Interaction: Differences in Relation to Pupil Prior Attainment and Primary vs. Secondary Schools," *Learning and Instruction* 21, no. 6 (2011): 715–30; Nicholas A. Gage et al., "The Relationship Between Teachers' Implementation of Classroom Management Practices and Student Behavior in Elementary School," *Behavioral Disorders* 43, no. 2 (February 5, 2018): 302–15, https://doi.org/10.1177/0198742917714809; Gracemary Eloheneke Moluayonge and Park Innwoo, "Effect of Challenges with Class Size, Classroom Management and Availability of Instructional Resources on Science Teachers' Teaching Practices in Secondary Schools," *Journal of Science Education* 41, no. 1 (April 2017): 135–51, https://doi.org/10.21796/jse.2017.41.1.135.
[30] Gage et al., "The Relationship Between Teachers' Implementation of Classroom Management Practices and Student Behavior in Elementary School."
[31] Barnett and Friedrichsen, "Educative Mentoring: How a Mentor Supported a Preservice Biology Teacher's Pedagogical Content Knowledge Development"; Bradbury, "Educative Mentoring: Promoting Reform-based Science Teaching through Mentoring Relationships"; Wang and Fulton, "Mentor-Novice Relationships and Learning to Teach in Teacher Induction: A Critical Review of Research."

THEORETICAL FRAMEWORK

This study is anchored in the IDEAL framework, a refined consensus model encompassing PCK, instructional strategies, design, engagement, approximation of practice, and learning.[32] Shulman outlines the multifaceted knowledge required by teachers for effective classroom practice, including content knowledge, pedagogical knowledge, curriculum knowledge, PCK, understanding of learners and their characteristics, and knowledge of educational goals.[33] Particularly in science education, PCK plays a transformative role for pre-service teachers.[34] The PCK in science teaching integrates with four other essential teacher knowledge domains: science curriculum/content knowledge, understanding of learner behaviours, familiarity with instructional strategies in science, and assessment techniques.[35]

The evolution of PCK and related constructs has led to the refined consensus model, which identifies five key pillars: curricular knowledge, assessment knowledge, content knowledge, pedagogical knowledge, and student knowledge.[36] Chan and Hume elaborate on these knowledge bases:

- Assessment knowledge: Designing assessments and using data to enhance instructional strategies.
- Content knowledge: Subject expertise relevant to teaching.
- Curricular knowledge: Understanding the goals, structures, scope, and sequence of the curriculum.
- Knowledge of the students: Awareness of students' intellectual development, learning approaches, and general characteristics.[37]

Pedagogical knowledge: Comprehensive understanding of teaching, learning theories, instructional principles, and classroom management.

Further insights from Carlson et al. categorise PCK into:

- Collective PCK: Shared science knowledge among professionals, including science curriculum, pedagogy, student learning, and assessment.
- Personal PCK: Individual's accumulated science PCK from learning, experiences, and interactions.
- Enacted PCK: Application of an individual's science PCK during planning, teaching, and reflection, shaped by context.[38]

The IDEAL framework bridges the gap between theoretical learning (personal PCK) during pre-service teacher preparation and its application (enacted PCK) in the classroom,[39]

The IDEAL framework also integrates a feedback interaction model.[40] This framework progresses through three iterative stages:

- Design stage: Focuses on teachers' learning needs and offers supportive resources.
- Approximate practice stage: Involves iterative cycles of practice approximations and coaching to implement new instructional strategies.
- Appropriation stage: A cyclic development phase where pre-service teachers implement their strategies through planning, classroom observation, debriefing, and feedback.[41]

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[32] Hinojosa and Bonner, "The Community Mathematics Project: Using a Parent Tutoring Program to Develop Sense-Making Skills in Novice Mathematics Educators"; A. Hume, R. Cooper, and A. Borowski, *Repositioning Pedagogical Content Knowledge in Teachers' Knowledge for Teaching Science*, ed. Anne Hume, Rebecca Cooper, and Andreas Borowski (Singapore: Springer Nature Singapore, 2019), https://doi.org/10.1007/978-981-13-5898-2.

[33] Lee S. Shulman, "Knowledge and Teaching: Foundations of the New Reform.," *Harvard Educaitonal Review*, 1987, 1–22.

[34] Vanessa Kind, "Pedagogical Content Knowledge in Science Education: Perspectives and Potential for Progress," *Studies in Science Education* 45, no. 2 (2009): 169–204.

[35] Shirley Magnusson, Joseph Krajcik, and Hilda Borko, "Nature, Sources, and Development of Pedagogical Content Knowledge for Science Teaching," in *Examining Pedagogical Content Knowledge* (Dordrecht: Kluwer Academic Publishers, 1999), 95–132, https://doi.org/10.1007/0-306-47217-1_4.

[36] Janet Carlson et al., "The Refined Consensus Model of Pedagogical Content Knowledge in Science Education," *Repositioning Pedagogical Content Knowledge in Teachers' Knowledge for Teaching Science*, 2019, 77–94.

[37] Kennedy Kam Ho Chan and Anne Hume, "Towards a Consensus Model: Literature Review of How Science Teachers' Pedagogical Content Knowledge Is Investigated in Empirical Studies," *Repositioning Pedagogical Content Knowledge in Teachers' Knowledge for Teaching Science*, 2019, 3–76.

[38] Carlson et al., "The Refined Consensus Model of Pedagogical Content Knowledge in Science Education."

[39] Hinojosa and Bonner, "The Community Mathematics Project: Using a Parent Tutoring Program to Develop Sense-Making Skills in Novice Mathematics Educators."

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[41] Hinojosa and Bonner, "The Community Mathematics Project: Using a Parent Tutoring Program to Develop Sense-Making Skills in Novice Mathematics Educators."

This study emphasises, in all three stages, shaping well-rounded pre-service teachers.The purpose of this qualitative exploratory study was to shed light on preservice teachers' challenges during work-integrated learning. It also aimed to contribute to the body of research related to the challenges and difficulties preservice teachers encounter and how teacher preparation programs can be tailored to meet the needs of preservice teachers to ensure that there is effective professional development during work-integrated learning. The study is guided by the following research question: "What difficulties and challenges did the preservice teachers face during work-integrated learning?"

METHODOLOGY

To understand the challenges that preservice teachers face during work-integrated learning, a qualitative exploratory case study design was used to gather and analyse data.

Context and Participants

As part of degree fulfilment requirements, preservice teachers are required to take work-integrated learning. This paper involved fourth-year science students who were doing their final-year work with integrated learning. All students were trained to teach science at different levels, from primary to high school. They were all being trained at one university in South Africa and were taught science education courses by one lecturer on one of the three campuses of the institution. To maintain confidentiality, the pseudonyms PST1 to PST70 were adopted. Odd numbers, PST1, PST3, … were assigned to primary school preservice teachers while even numbers, PST2, PST4, PST6, … were assigned to high school preservice teachers.

Design, Procedure and Analysis

Creswell explains that "qualitative research can lead to information that allows individuals to learn about a phenomenon or to an understanding that provides a voice to individuals who may not be heard otherwise".[42] A case study, which included in-depth interviews with PST17, PST14, PST11, and PST10, was selected to address the study's research question. The interview participants were purposively selected based on the students assigned to the researcher for supervision of their work-integrated learning in 2023. The interview featured an open-ended question designed to collect relevant data, encouraging participants to provide detailed responses. The guiding question was: "What are the challenges/difficulties you faced as a beginning teacher? "

To complement the interview data, a Google Form questionnaire was sent to 76 participants, featuring a research question similar to the interview question. Seventy participants responded to the questionnaire. The data from the questionnaire corroborated the interview data, enhancing the validity and reliability of the findings. By including many participants in a qualitative study, data saturation is ensured.

The interview data were transcribed and, along with the questionnaire data, read multiple times to identify themes and sub-themes, which were highlighted using different colour pens and compiled into a table. Four themes emerged:

- Lack of resources
- Unmanageable workload
- Poor management strategies
- Language barriers.

Relevant quotes were selected and presented coherently in the results section. Ethical clearance was obtained from the institution, and informed consent was sought from each participant. The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of the University of the Free State (UFS-HSD2021/0351/22).

[42] John W Creswell, *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research* (Pearson, 2015). 206.

PRESENTATION OF FINDINGS

Table 1: Biographic data

Biographic data of participants, gender, age group, year of study, province of Work Integrated Learning (WIL) and numbers of preservice teacher participants.

		Number of students			**Number of students**
Gender	males	33	Phase of study	High school year 4	35
	females	37		Primary school year 4	35
Age group(years)	15-20	6	Province of WIL	KwaZulu Natal	38
	21-25	53		Free State	28
	26-30	11		Limpopo	2
				Mpumalanga	2

Table 1 reflected that seventy participants participated in teaching practice. There were thirty-three males and thirty-seven females and equal numbers of third- and fourth-year students. Most of the participants (53) were in the 21-25-year age group while only eleven were in the 15-20-year age group and six were in the 26-30-year age group. Most of the participants completed their WIL in the KwaZulu-Natal province (38) and the Free State Province (28) while there were two participants each in the Limpopo and Mpumalanga provinces.

Table 2. Themes and subthemes generated from preservice teacher participants in different schools

Theme	**Sub-theme**	**No. of schools (n = 70)**
Lack of resources	Lack of laboratories	10
	Lack of equipment and/or chemicals	14
	Lack of laboratories and chemicals	15
Unmanageable workload		3
Poor management strategies		11
Language barrier		2

Theme 1: Lack of Laboratory/Laboratory Equipment

Some preservice teachers faced the challenge of not having access to a laboratory facility for their teaching practice. This situation was compounded by the additional setback of unreliable WiFi connectivity, rendering virtual laboratory options ineffective. The absence of a physical laboratory environment posed a significant obstacle in providing hands-on, experiential learning opportunities for students. Despite efforts to utilise virtual resources as an alternative, technical limitations hindered the effectiveness of this approach. As a result, preservice teachers had to grapple with devising creative strategies to engage learners in practical scientific exploration and learning experiences within the constraints of available resources. One of the preservice teachers had this to share:

> *The challenge I encountered during my teaching practice activities was the issue of not having a laboratory to perform practical tasks. The school's WiFi and laptops were quite problematic as I couldn't opt for the virtual laboratory (PST8).*

A considerable proportion of preservice teachers highlighted attention to the scarcity of resources essential for conducting practical activities in educational settings. These resources, vital for hands-on learning experiences, include materials, equipment, and tools required for effective teaching and learning. However, the inadequate availability of these resources poses a significant challenge, hindering the ability of preservice teachers to deliver engaging and meaningful lessons that facilitate experiential learning. Moreover, an additional barrier identified by preservice teachers was the limitation imposed by principals on access to laboratories or specialised facilities within educational institutions. This restriction impeded preservice teachers' opportunities to use these essential spaces for conducting practical demonstrations, experiments, and other hands-on learning activities. Consequently, preservice teachers found themselves constrained in their ability to implement innovative teaching methods to provide learners with first-hand experiences that foster a deeper understanding and mastery of subject matter concepts. One of the participants shared the following sentiments:

> *The school doesn't have resources for practical activities. The lab is not working. The principal is very strict therefore won't allow student teachers to conduct practical activities even under the supervision of mentor teachers. Student teachers are not even allowed to attend staff meetings (PST17).*

Lack of access to essential resources such as computers, projectors, and textbooks significantly hampered the ability of preservice teachers to engage effectively in practical activities and deliver comprehensive lessons. Without computers and projectors, they were unable to use multimedia tools to enhance their teaching methods and simulate real-world scenarios for their learners because these technological tools play a crucial role in creating interactive and engaging learning environments. Furthermore, the absence of textbooks deprives preservice teachers of the foundational materials necessary for curriculum planning and lesson preparation. Textbooks serve as valuable references for educators, providing essential content knowledge, instructional strategies, and assessment tools. Without access to these resources, preservice teachers faced challenges in developing well-rounded lesson plans and providing high-quality instruction. PST29 shared the following sentiments:

> *Again, there is a huge lack of resources, especially textbooks and laboratory equipment. There is a lab, but it is used as a class. It is impossible to do any practical work because there is no equipment. Also, there are no computers or any working projector to compromise and let the learners watch the video instead (PST29).*

The other preservice teacher pointed out that the absence of laboratory facilities impeded the development of science process skills. This suggests that hands-on experimentation and practical application are crucial components for learners to grasp concepts effectively in science education. This is what one of the participants had to share:

> *The challenges I faced during teaching practicals it was difficult for us to do practical work because the school does have a lab and some work was undone. And at the end of the day, students will not have the skill of how science is actually done (PST46).*

Theme 2: Unmanageable Workload

Pre-service teachers, on the brink of their journey into the profession, found themselves grappling with the heavy burden of the substantial teaching workload looming ahead. Amid their collective apprehension, one participant bravely stepped forward to voice their concerns, offering a glimpse into the shared anxieties pulsating within the group:

> *Workload in this school. I am conducting my practices in many classes in such a way that I cannot even get some free periods and most of the periods clash with other classes (PST5).*

The issue of workload resonated strongly with one of the participants, who highlighted that mentor teachers faced challenges in assisting due to their heavy workloads. A participant expressed his perspective on this matter, stating:

> *The teachers have impossible workloads which makes it impossible to impart adequate wisdom, knowledge, or technique to student teachers (PST14).*

Theme 3: Poor Management Strategies

Some preservice teachers found themselves navigating their early teaching experiences without the guidance of mentors, compounding their classroom management challenges. One participant, reflecting on their journey, shared the following insights:

I didn't have a mentor teacher, so it was challenging for me to resolve the level of noise and distraction made by learners. Some would take advantage of me knowing that there won't be harsh penalties against them (PST11).

It seems that the other participants had difficulties in motivating the learners to complete their homework assignments. This challenge likely involved various factors such as lack of learner engagement, distractions, or possibly a disconnect between the homework tasks and the learners' interests or learning needs. Additionally, it might reflect broader issues within the learning environment, such as inadequate support structures or resources for both learners and teachers. One participant shared these sentiments:

Learners perform poorly. They don't do their work. Learners come to school on certain days because of the pandemic. Therefore, I'm unable to give more work to learners, each and every time we meet. As a teacher, I have to go back recap, and redo activities (PST61).

In addition to the noise level being a concern, the other participant raised the issue of a high level of learner absenteeism within the school. This means that not only do the learners regularly miss classes but also do not attend school at all. This absenteeism could have various underlying causes, such as disengagement with the curriculum, personal issues affecting attendance, or systemic challenges within the educational institution.

Other learners make noise during the teaching and learning process and other learners like to be absent from school without reason (PST54).

Theme 4: Language Barrier

Expanding on the participants' comments about language barriers, it becomes evident that many individuals face challenges in understanding concepts due to English not being their native language. This problem is particularly pronounced for those who are only introduced to English instruction from grade 4 onwards. This is what one participant shared:

The barrier I've encountered in the school is the language of instruction. Pupils find it difficult to understand English when you explain the concepts to them especially in grade 4 since they are exposed to English during this year. It is their first time doing English because before this stage they did all languages in IsiZulu which is their home language (PST13).

Supporting the issue of language, PST10 had the following to share:

Transport and language barrier (PST10).

DISCUSSION

Some preservice teachers encountered the challenge of not having access to a laboratory facility for their teaching practice. This situation was exacerbated by the unreliable WiFi connectivity, making virtual laboratory options ineffective. These findings echo similar challenges highlighted in studies by George in Lesotho, and Boakye and Ampiah in Ghana, which underscore the deficiency of laboratories and resources in schools.[43] Consequently, many learners resorted to rote memorisation techniques when preparing for exams, often at the expense of truly understanding science as an application process.[44] The absence of laboratories, chemicals, and equipment, coupled with poor internet connectivity, hampered the professional development of science teachers, limiting their ability to impart practical skills related to science and confining them to teaching theoretical lessons only.[45]

Preservice teachers, poised on the threshold of their journey into the noble profession of education, found themselves entangled in the intricate web of responsibilities that awaited them. As they stood on

[43] George, "Assessing the Level of Laboratory Resources for Teaching and Learning of Chemistry at Advanced Level in Lesotho Secondary Schools"; Cecilia Boakye and Joseph Ghartey Ampiah, "Challenges and Solutions: The Experiences of Newly Qualified Science Teachers," *Sage Open* 7, no. 2 (2017): 2158244017706710.

[44] Djamahar et al., "Empowering Student's Metacognitive Skill Through Cirsa Learning"; Handayani, Nur, and Rahayu, "Pengembangan Perangkat Pembelajaran IPA SMP Dengan Model Inkuiri Untuk Melatihkan Keterampilan Proses Pada Materi Sistem Pencernaan Manusia."

[45] Mafugu, "Examining the Science Design Skills Competency among Science Preservice Teachers in the Post-COVID-19 Pandemic Period."

the precipice of embarking upon their careers, they were confronted with the formidable weight of the substantial teaching workload that was beyond what the training institution expected of the workload allocation to student teachers. This burden, both formidable and heavy, served as a sobering reminder of the profound commitment and dedication required to excel in the field of education. With each passing moment, they felt the gravity of their impending duties pressing upon them, stirring within them a mixture of anticipation, trepidation, and determination. However, amidst the daunting challenges that lay ahead, they also glimpsed endless opportunities to inspire, empower, and shape the minds of future generations, a prospect that fuelled their resolve to embark upon this journey with unwavering passion and purpose.

As preservice teachers embarked on their early teaching journeys, many found themselves thrust into classrooms without the comforting presence of mentors to guide them through the intricate dance of classroom management. The results agree with the findings of Mafugu's quantitative study which offered that this absence of seasoned guidance only served to magnify the already daunting challenges they faced in maintaining order and fostering a conducive learning environment.[46] Drawing parallels to the observations made by Alemdag and Simsek in Turkey, it becomes evident that these classroom management hurdles were not unique to a particular region but echoed across different contexts.[47] Much like their counterparts in Turkey, these preservice teachers grappled with a myriad of issues, from maintaining learner-centred engagement to establishing clear behavioural expectations. Lack of mentorship not only exacerbated the struggles of preservice teachers but also highlighted systemic issues within teacher preparation programs. Without the scaffolding provided by experienced mentors, preservice teachers were left to navigate the complexities of classroom management on their own, often resorting to trial and error. Studies suggest that PCK can evolve through reflective practices, observing mentor teachers, participating in discussions, connecting readings, and critically evaluating curricula.[48]

The participants' comments shed light on the significant hurdles posed by language barriers, revealing a common struggle among individuals grappling with grasping complex concepts due to English is not their first language. This challenge becomes particularly pronounced for those who are first exposed to English instruction at a later stage, such as grade 4 and beyond. The resonance with the insights presented in the study by Yıldırım and Yıldırım is striking, as it underscores the enduring nature of listening comprehension issues faced by second and foreign language learners.[49] The parallels drawn between the participants' experiences and the findings of academic research underscore the pervasive nature of language-related obstacles encountered by learners, emphasising the need for targeted interventions and support mechanisms, to address these challenges effectively.[50]

Discussion Summary

Overall, the combination of resource scarcity and administrative constraints presents formidable obstacles for preservice teachers who seek to deliver high-quality education that nurtures learners' curiosity, critical thinking skills, and practical proficiency. Addressing these challenges requires collaborative efforts among educational stakeholders to enhance resource allocation, promote greater accessibility to facilities, and support preservice teachers in overcoming barriers to effective instructional practices. The lack of computers, projectors, and textbooks poses significant barriers to the professional development and effectiveness of preservice teachers, limiting their ability to provide comprehensive and engaging education to their future learners. Addressing these resource deficiencies is essential to ensure the success and preparedness of aspiring educators. Without access to laboratories, many struggle to fully engage with the scientific method, problem-solving techniques, data analysis, and critical thinking skills that are essential for success in science-related fields. Therefore, addressing the deficiency in laboratory resources becomes imperative in enhancing the quality of science education and preparing students for future

[46] Mafugu, "Examining the Science Design Skills Competency among Science Preservice Teachers in the Post-COVID-19 Pandemic Period."

[47] Ecenaz Alemdag and Pinar Özdemir Simsek, "Pre-Service Teachers' Evaluation of Their Mentor Teachers, School Experiences, and Theory-Practice Relationship.," *International Journal of Progressive Education* 13, no. 2 (2017): 165–79.

[48] Ekiz-Kiran, Boz, and Oztay, "Development of Pre-Service Teachers' Pedagogical Content Knowledge through a PCK-Based School Experience Course."

[49] Ahmet Uysal and Irem Gokce Yildirim, "Self-Determination Theory in Digital Games," in *Gamer Psychology and Behavior* , ed. B. Bostan (Springer International Publishing AG, 2016), 123–35, https://doi.org/10.1007/978-3-319-29904-4_8.

[50] Lulama Mdodana-Zide and Tafirenyika Mafugu, "An Interventive Collaborative Scaffolded Approach with a Writing Center on ESL Students' Academic Writing," *Journal of Culture and Values in Education* 6, no. 2 (2023): 34–50.

academic and professional endeavours in scientific fields. Given the language barriers identified, teacher education programs should incorporate language support initiatives. This could include specialised training in teaching science in a second language, as well as resources to help learners improve their English proficiency. Addressing both the noise level and absenteeism is crucial to creating a conducive learning environment and ensuring that all students can fully engage in their education

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RECOMMENDATIONS

Enhance Resource Allocation

- Targeted Funding for Educational Resources: Allocate specific funds to ensure that essential teaching tools like computers, projectors, textbooks, and laboratory equipment are available in schools, particularly in under-resourced areas.
- Partnerships with the Private Sector and NGOs: Encourage collaborations with private companies, NGOs, and international organizations to donate or fund the provision of these resources, especially in rural or underserved communities.
- Digital Resource Hubs: Develop online platforms where preservice teachers can access digital textbooks, teaching aids, and virtual laboratories. This can mitigate the impact of physical resource scarcity.

Improve Accessibility to Facilities

- Mobile Laboratories: Introduce mobile laboratory units that can travel to different schools, providing students with hands-on science experiences even in areas without permanent laboratory facilities.
- Shared Resource Centers: Establish regional resource centers where schools can borrow equipment or use facilities on a rotating basis, ensuring greater access without needing every school to have a full suite of resources.

Support Preservice Teachers

- Mentorship Programs: Implement mentorship programs in which experienced teachers guide preservice teachers, helping them navigate administrative challenges and share strategies for effective teaching with limited resources.
- Professional Development Workshops: Offer regular workshops focusing on innovative teaching methods that maximize the use of available resources. These can include training on how to integrate low-cost or no-cost educational tools and techniques.

Address Language Barriers

- Language Support Initiatives: Integrate language support modules into teacher education programs, offering specialized training in teaching content in a second language, particularly in science and technical subjects.
- Bilingual Teaching Resources: Develop and distribute bilingual teaching materials that can help both teachers and students improve their proficiency in the language of instruction.
- Collaborative Language Learning: Foster collaborative language learning environments where students and teachers engage in language development activities, enhancing overall communication and comprehension. Create a Conducive Learning Environment
- Noise Control Strategies: Introduce policies and interventions to reduce noise levels in schools, such as soundproofing classrooms, establishing quiet zones, and scheduling activities to minimize disruptions.
- Addressing Absenteeism: Implement programs to tackle absenteeism, such as community outreach to understand and mitigate causes, encourage attendance through recognition and rewards, and provide support to students with chronic attendance issues.

Collaborative Efforts Among Educational Stakeholders

- Stakeholder Engagement Forums: Organize regular forums where teachers, administrators, parents, policymakers, and community leaders can discuss challenges and solutions, ensuring that resource allocation and policy decisions are informed by the realities on the ground.
- Inclusive Policy Development: Involve preservice teachers in policy development processes, ensuring that their insights and experiences directly inform new policies and interventions.

Monitoring and Evaluation

- Regular Assessments: Conduct regular assessments of resource availability, teacher preparedness, and student outcomes to identify gaps and measure the impact of interventions. Use these data to continuously refine strategies.
- Feedback Loops: Create channels for preservice teachers and other stakeholders to provide feedback on implemented changes, ensuring that policies remain responsive and effective.

CONCLUSION

The study highlights the significant challenges that preservice teachers face in providing quality education due to resource scarcity, administrative constraints, and language barriers. These obstacles hinder their ability to nurture critical thinking, practical proficiency, and participation in scientific fields. The study emphasizes the need for collaborative efforts among educational stakeholders to improve resource allocation, improve accessibility to facilities, and support language proficiency initiatives. Addressing these issues is essential to ensure the success and preparedness of aspiring educators, particularly in science education, and to create a conducive learning environment for all students.

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DECLARATION OF INTEREST

The author declares that there is no conflict of interest.

DATA SHARING STATEMENT

Data supporting the findings and conclusions are available on request from the authors.

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