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Science pre-service teachers' experience with mentors during teaching practice

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Abstract

This study aims to explore how mentor teachers and the school environment helped pre-service teachers develop their pedagogical skills, and thereby, closing the gap between theory and practice. The study is based on a survey research design consisting of 75 participants consisting of third and final year students at a research and teaching university in South Africa. The participants completed a Google survey questionnaire where responses were given on a five-point Likert scale from strongly disagree, to strongly agree. The results indicate that although most pre-service teachers received the necessary guidance in theory and practical lessons as well as assessment, a significant proportion of the participants were not adequately assisted. A large proportion of the schools did not have laboratories, laboratory equipment, and chemicals. The study has practical implications for the professional development of teachers of science before service. There is dire need for all science pre-service teachers to be adequately developed by selecting the appropriate context in which the teaching practice is done to develop the knowledge, science specific pedagogical skills, and values necessary for successful entry into a professional career Furthermore, mentor teachers need to be properly oriented about their mentoring roles, and the school management team must assist in monitoring the mentoring process.

Keywords: pre-service teacher, mentor, pedagogical skills, professional development, theory, practice

INTRODUCTION

As part of the developmental process, science pre-service teachers are expected to put into practice the theory-based knowledge acquired through the various courses of the teacher preparation program. Students have to learn to impart various science practical skills, differentiate instruction, manage bad behavior, prepare students for higher-order learning, and reflect on the implications of their teaching practice on students' learning. Hinojosa (2022) highlighted that there is limited literature on on-site coaching and feedback on teacher learning. Furthermore, studies by Barnett and Friedrichsen (2015) and Wang and Fulton (2012) indicated that studies examining the nature of mentors' practice and how mentors influence pre-service teachers' pedagogical content knowledge (PCK), are few. According to Barnett and Friedrichsen (2015) and Bradbury (2010), studies focusing on science-specific day-to-day mentoring are limited, hence, little is known about science mentoring.

There is a dire need for research that focuses on how mentoring and field supervision can support pre-service teachers' professional development during teaching practice (Hinojosa, 2022). Pre-service teachers gain experience-based knowledge when they practice the teaching process. However, as pre-service teachers get experience engaging with learners in the classroom, they need mentors who are role models to guide them through lesson observations and reflections (Comparcini et al., 2020; Ekiz-Kiran et al., 2021; Walter & Verner, 2019). The process reduces the gap experienced by pre-service teachers between theory and practice. Modeling practice by expert mentors and intensive supervision is essential for professional development.

Darling-Hammond et al. (2020) indicate that learning requires supportive environmental conditions that foster emotional connections and a sense of belonging and

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Contribution to the literature

- This study adds to the limited literature on mentor practice in science-specific day-to-day mentoring.
- The study indicated how mentor teachers might assist or hinder the development of science-specific pedagogical knowledge in pre-service teachers.
- The study indicated how the school environment assists or hinders the development of science-specific pedagogical skills among pre-service teachers.

purpose. Furthermore, instructional strategies must be designed to stimulate learning and promote competence and self-directed learning (Voskamp et al., 2020). The instruction strategies should link students' prior knowledge, while formative assessment is used to check the effectiveness of the instructional method (Winget & Persky, 2022). Cooperative learning and scaffolding can create a positive mindset that fosters academic progress and productive behavior (Darling-Hammond et al., 2020; Gillies & Boyle, 2005). A teacher needs the PCK, which encompasses knowledge about the teaching processes, including classroom management, assessment skills, and lesson planning (Park & Steve Oliver, 2008). Poor teacher performance can result from a lack of familiarity with the learning strategy, lack of classroom management skills, low professional commitment, and poor time management. Dilshad and Iqbal (2010) indicate that provision of physical resources, the use of a student-centered approach in teaching and learning, and self-assessment and reflection are essential in ensuring effectiveness in the teaching process. Mentoring is a critical part of teaching practice as it enhances the acquisition of pedagogical skills. The scarcity of research in mentoring, therefore, calls for research that identifies any problems associated with mentoring that might need to be addressed to ensure efficient acquisition of pedagogical skills by student teachers during teaching practice.

Mentoring

In mentoring, the mentor, who is the experienced teacher, and mentee (pre-service teacher), interact in a dialogue, where the mentor provides technical and emotional support, while the pre-service teacher tries to attain new methods and techniques. The pre-service teacher learns the various approaches in teaching different content and imparting science-specific skills. In the dialogue, the mentor and the pre-service teacher discuss authentic tasks of the practice, including lesson planning, student assessment, and evaluating and reflecting on teaching (Smith, 2007). According to Wang and Fulton (2012), mentoring can be classified into three categories: responsive, novice-driven; directive, mentor driven; and interactive, jointly driven. Mentors play multiple roles such as modeling, counseling, observing, and providing feedback within the three conceptions of mentoring (Comparcini et al., 2020; Ekiz-Kiran et al., 2021; Walter & Verner, 2019). When mentors value pre-service teachers' ideas and operate as co-learners, they become more productive than those who operate as expert- and novice (Bradbury, 2010). When they operate as co-thinkers, pre-service teachers will see teaching as a complex process that can be accomplished in a variety of ways. Mentors help pre-service teachers integrate more student-centered approaches, understand the challenges faced by students, and strategize to overcome the challenges (Aydin et al., 2013; Bradbury, 2010). Pre-service teachers should be encouraged to use inquiry-oriented approaches in science teaching.

Science Teaching

Science-specific mentoring should develop the ability to teach theory as well as practical science skills. Practical skills should focus on developing the ability to organize practical activities, prepare chemicals, assess various practical skills, and ensure safety in the laboratory. Basic scientific skills include handling equipment, measurement, observation, designing, communication, inferring, and predicting (Nugraheni & Wuryandani, 2018). In teaching science, the development of science process skills is critical, because the skills are applied later to solve real-life problems. Since science process skills support the mastery of science concepts, they are an important asset for pre-service teachers and science learners in the school system, as they develop science concepts through experiences. Science process skills can be developed through practical laboratory activities (Handayani et al., 2015). Science laboratory activities have the impact of motivating students and improving understanding of science concepts (Hermansyah et al., 2018; Srisawasdi & Panjaburee, 2019). However, several studies like George (2017) in Lesotho, Gudyanga (2020) and Gudyanga and Jita (2019) in South Africa, and Mudulia (2012) in Kenya highlighted the absence of laboratories, laboratory equipment, and chemicals in schools. Students tend to learn science by memorizing concepts in preparation for examinations. Djamahar et al. (2019) and Handayani et al. (2015) observed that learning science as a process that can be applied, is rare in the school system. Mentor teachers must nurture the pre-service teachers so that they can impart the science process skills that can be applied in society. In the study by Bahtiar and Dukomalamo (2019), students exposed to the discovery learning process developed science process skills better than students who used the conventional model of laboratory practice. However, the discovery learning process can only be applied to some groups of learners.

A study by Achinstein and Fogo (2015) shows that mentoring conversations support the development of pre-service teachers' PCK elements by using guided conceptual and practical representations of discipline-specific instruction. Furthermore, studies have shown that pre-service teachers' PCK may develop through reflections on practice, observations of mentor teachers' teaching, discussions sessions to teaching experiences, connecting course readings, and critical examination of curricula content (Beyer & Davis, 2012; Ekiz-Kiran et al., 2021). For example, in one study by Barnett and Friedrichsen (2015), the mentor helped the pre-service teacher develop topic-specific pedagogical knowledge by sharing strategies she used previously, modeling critical reflection and joint discussion about concept sequencing within a topic. Furthermore, the mentor invited the pre-service teacher to critically reflect on their instructional strategies in the classroom. Teachers must enact rigorous and effective responsive instruction by learning how to interpret what they see and hear (Michalsky, 2021). Pre-service teachers should learn to systematically attend, analyze, and respond, because teaching is a learning profession where pre-service teachers learn from their practice over time (Barnhart & van Es, 2015; Michalsky, 2021; Wessels, 2018). In the study by Bahtiar and Dukomalamo (2019), students exposed to the discovery learning process developed science process skills better than students who used the conventional model of laboratory practice. However, the discovery learning approach requires sufficient resources to be available.

Teachers must develop divergent thinking in their students by asking questions that call for divergent thinking (Pylman & Bell, 2021). Stimulating critical thinking can be achieved by asking questions of different cognitive levels (Eilam, 2017). The development of critical thinking skills should begin in pre-service teachers, who in turn, develop metacognitive skills among their learners (Boyd, 2015). Mentor teachers can develop metacognitive habits of mind by probing pre-service teachers to explain when to use a particular instructional approach, how to use the approach, and why the approach is suitable (Eilam, 2017). In the study by Pylman and Bell (2021), pre-service teachers were asked questions of different cognitive levels to promote the development of critical thinking and problem-solving skills. Krathwohl and Anderson (2001) affirm that higher-order questioning and thinking lead to deeper learning.

Studies revealed that class size and student classroom management practices of a science class had significant effects on the success of teaching practices of a science teacher (Blatchford et al., 2011; Gage et al., 2018; Moluayonge & Park, 2017). However, class size had more effect on low-performing learners than on high-achieving learners (Gage et al., 2018). The study also noted that students in classrooms with poor classroom management practices were less engaged in instruction than classrooms with good management practices (Gage et al., 2018).

Mentoring plays an important role in in the development of students' teachers' pedagogical skills. Several authors (Barnett & Friedrichsen, 2015; Bradbury, 2010; Wang & Fulton, 2012) have highlighted the dearth of literature on mentor practice in science-specific day-to-day mentoring practice. Given the dearth of literature on science mentor practice and how mentors influence PCK of pre-service teachers, this study intended to explore how mentor teachers and the school environment helped pre-service science teachers develop their pedagogical skills, in an effort to close the gap between theory and practice.

THEORETICAL FRAMEWORK

This study builds on the refined consensus model of PCK and instructional strategies, design, engagement, approximation of practice, and learning (IDEAL) framework (Hinojosa, 2022; Hinojosa & Bonner, 2021; Hume et al., 2019).

Shulman (1987) describes the kind of knowledge that teachers need for classroom practice. These types of teacher knowledge include "content knowledge, pedagogical knowledge, curriculum knowledge…, PCK, knowledge of learners and their characteristics and knowledge of educational goals" (Shulman, 1987, p. 8). For science teaching, transformative approaches such as PCK are essential for pre-service teachers (Kind, 2009). The PCK for science teaching is anchored in four other types of teacher knowledge: science curriculum/content knowledge, knowledge of how learners learn, knowledge of instructional strategies used to teach science, and the knowledge of assessment techniques in science (Magnusson et al., 1999). It is critical to understand how pre-service teachers facilitate science education in classrooms to determine the science pedagogical skills they develop. Teachers must develop skills of the 21st century, including "critical and creative thinking, problem solving skills, collaboration and argumentation skills, leadership and responsibility, information and literacy skills" (Hadinugrahaningsiha et al., 2017, p. 1). The PCK and related constructs have been redefined, resulting in the refined consensus model of PCK that provides the professional knowledge bases that inform an individual's knowledge of the pedagogical content (Hume et al., 2019). The refined consensus model consists of five pillars: curricular knowledge, assessment knowledge, content knowledge, pedagogical knowledge, and student knowledge (Carlson et al., 2019). Chan and Hume (2019) define each of the professional knowledge bases, as follows:

1. "Assessment knowledge: knowledge about how to design assessments as well as the use of assessment data to improve instructional strategy;"
2. "Content knowledge: subject knowledge that is pertinent to the teaching undertaking;"
3. "Curricular knowledge: knowledge of the goals of a curriculum including its structures, scope, and sequence;"
4. "Knowledge of the students: knowledge of the intellectual development of students and differences in their approaches to learning and general characteristics;" and
5. "Pedagogical knowledge: general knowledge and skills related to teaching, as well as learning theories, instructional principles, and classroom management."

Furthermore, according to Carlson et al. (2019), it further indicates that the refined consensus model of PCK consists of

1. Collective PCK, which is combined science knowledge held by a community of professionals that involves ideas related to the curricular context of science, pedagogy, student learning, and assessment;
2. Personal PCK, which is an individual's cumulative PCK of science acquired through learning, experiences, and interactions with peers and mentors; and
3. Enacted PCK, which refers to the application of an individual's science PCK during planning, teaching, and reflecting. Thus, the PCK of the enacted science is the PCK applied by the individual and is determined by the context.

The IDEAL framework links the theory learned during the pre-service teacher preparation programs (personal PCK) and the enacted PCK in the specific school, which is the teaching practice context (Hinojosa, 2022; Hinojosa & Bonner, 2021). The IDEAL framework draws on the sociocultural theoretical perspective's (Ericsson, 2002; Vygotsky, 1978) and Vygotsky's (1978) notion of zone of proximal development. It also follows the model for feedback interaction (Pendleton et al., 2003). The model consists of three iterative stages:

1. the design stage or the professional development program stage,
2. an approximate practice stage, and
3. the appropriation stage through which the IDEAL views teacher PCK learning as a long-term iterative process that seeks to promote the professional development of pre-service teachers in socially mediated activities using scaffolds, modeling, and feedback (Vygotsky, 1978; Wenger, 1998).

The stage of the professional development program focuses on teachers' learning needs and provides resources to support teacher learning. According to Hinojosa (2022), stage two describes the approximation of the practice cycle. During the iterative cycles of approximations and the representation of practice and coaching, teachers practice the implementation of new instructional strategies in the professional development program (**Figure 1**). The appropriation stage is a cyclic development process in which pre-service teachers execute their instructional strategies. It consists of planning sessions, modeling during classroom observation, debriefing sessions, and feedback on lesson plans (Hinojosa, 2022). This study focuses on stage three, where mentor teachers help in the professional development process by scaffolding in different ways in the unique school environments where pre-service teachers practice teaching.

RESEARCH METHODOLOGY

The study was based on a survey research design. The population consisted of 142 third year and 107 fourth year biology methodology course students. The sample size was determined using the following formulae:

$$n=N/(1+N\times e^2),$$

where n is the number of samples, N is the total population, and e is the error tolerance (level).

I used a 90% confidence level with a population size of 249. $n=N/(1+N\times e^2)=249/(1+249\times 0.1^2)=72$.

Due to the low response expected in online surveys (Arafa et al., 2019; Nayak & Narayan 2019), a larger sample was considered for sampling (125). A sampling interval of two (249/125) was considered after dividing the population size by the sample size (125).

For each of the numbered lists of students in the full grade center of the Blackboard platform, the starting point for selection was determined by generating a random number between the number of the first surname and the number of the last surname, using the calculator "Casio fx 82 ZA plus". From the starting point, every second student was selected from each list of students in the full grade center on the Blackboard platform. A link to the Google form was sent to all selected participants. The participants had to click on the link that opened the form where the participants had to respond by clicking on the appropriate response. After completing the questionnaire, they had to click "submit", to enable feedback to be sent through the Google form. 75 out of the 125 expected participants responded to the questionnaire. The responses were downloaded to an Excel spreadsheet, from which they were copied to statistical package for the social sciences (SPSS) for analysis.

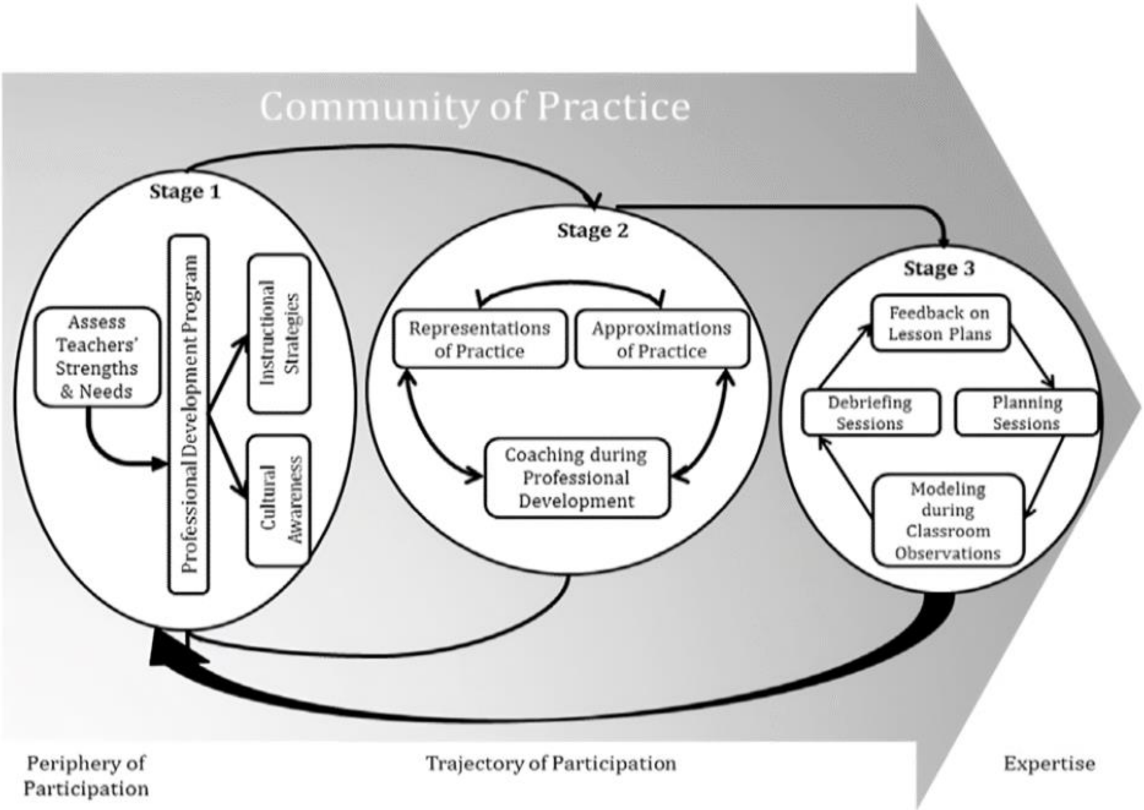

Figure 1. The IDEAL framework (Hinojosa, 2022)

The first part consisted of biographic data eliciting information on gender, study year, age group, and province, while the second part consisted of Likert scale data on the level of teacher agreement on various issues during teaching practice. Participants had to indicate if they strongly disagreed, disagreed, were neutral, agreed, or strongly agreed with each of the various variables. The survey instrument used modified aspects adopted from the theoretical framework. These include the variables, 'the mentor teacher assisted in arranging practical sessions' and 'the mentor teachers assisted in organizing the theory lessons' and 'the mentor teacher provided adequate resources for teaching' which all focus on the planning steps of stage three of the IDEAL framework. Furthermore, debriefing sessions and feedback of stage 3 were represented by the variables, 'The mentor teacher provided appropriate guidance; the mentor teacher focused on various practical skills in guiding teaching practical activities; the mentor teacher assisted in focusing on theory questions of different cognitive levels; the mentor teacher moderated the assessment tasks set to align with lesson objectives.' The other variables were based on the conditions necessary for acquiring science-specific process skills. These were obtained from literature that reflected on effective development of science-specific skills and the researcher and expert experience with science teaching.

The 27th version of the SPSS was used to generate frequencies, means, and standard deviations of teacher responses before service based on data from the Likert scale entered in SPSS. The corrected item-total correlation was used to express the coherence between a variable item and the other variable items in the test. A reliability test was also conducted using Cronbach's alpha to ensure that the questionnaire could be relied upon to secure consistent results upon repeated application in future research studies. According to Malhotra (2007), a Cronbach's alpha value of at least 0.70 indicates that a scale is reliable. From the calculation of the Cronbach's alpha, a significantly high overall reliability test result was observed for the questionnaire, while the alpha statistics for the variables under study were also significantly higher than the minimum threshold of 0.70.

RESULTS

Biographic data reveal that there were 40 women, which was five more than the number of men (**Figure 2**). A 1:1 proportion was observed among the participants in the third year (38) and fourth year (37). Most of the participants (58) were in the 21-25 age group, while eleven were in the 26-30 age group, almost double the number of participants in the 15-20 age group (6).

The overall reliability test score was 0.83, which implies that the research instrument was reliable (**Table 1**).

The reliability score for all items under study was above 0.70 (**Table 2**). High reliability scores (above 0.8) indicate that the research instrument was reliable.

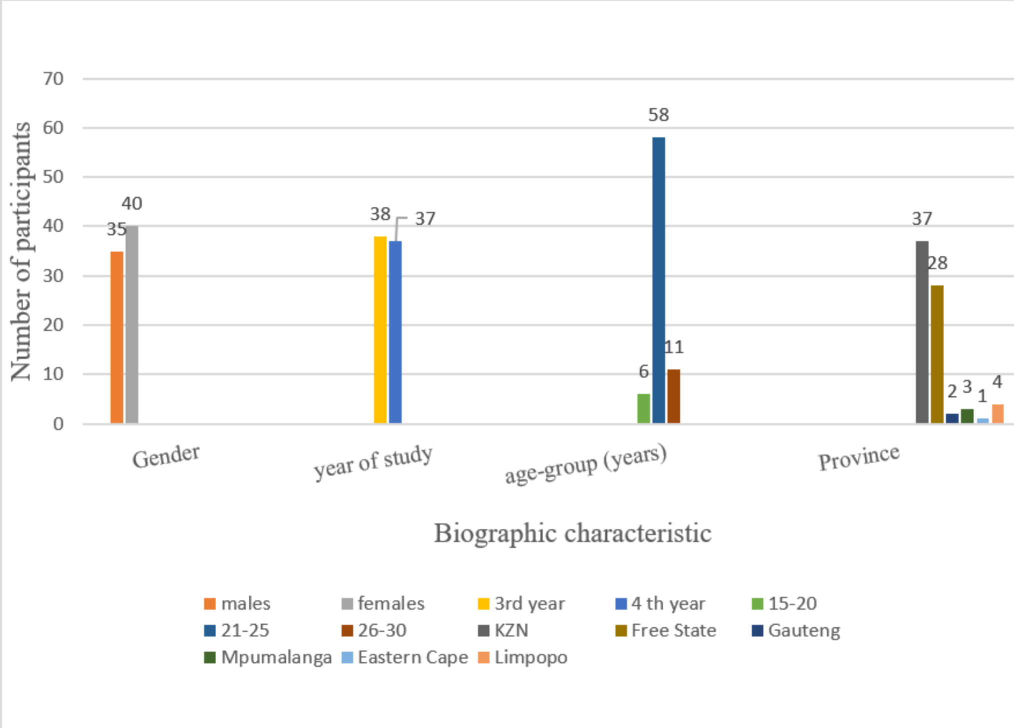

Figure 2. Biographic characteristics of the participants

Table 1. Overall reliability test result

Cronbach's alpha	Cronbach's alpha on standardized items	N
.834	.840	14

Table 2. Item reliability

	SM-ID	SV-ID	CI-TC	SMC	CA-ID
VAR1	40.39	66.511	.574	.561	.815
VAR2	40.23	70.232	.514	.430	.820
VAR3	39.85	68.613	.682	.629	.812
VAR4	40.32	66.977	.619	.550	.813
VAR5	40.37	66.643	.734	.775	.807
VAR6	40.04	69.877	.576	.566	.817
VAR7	40.12	67.729	.683	.747	.810
VAR8	41.76	65.888	.564	.716	.816
VAR9	41.96	68.769	.534	.615	.819
VAR10	41.85	69.208	.518	.750	.820
VAR11	40.73	80.739	-.087	.249	.856
VAR12	41.28	69.826	.440	.526	.825
VAR13	41.39	69.700	.432	.606	.826
VAR14	41.01	79.959	-.055	.225	.857

Note. SM-ID: Scale mean if item deleted; SV-ID: Scale variance if item deleted; CI-TC: Correctional item-total correlation; SMC: Squared multiple correlation; & CA-ID: Cronbach's alpha if item deleted

The Cronbach's alpha if the item was deleted was above 0.8 for all items, indicating that the items measured the same construct. To ensure validity of the research instrument, two experts in both subject matter and questionnaire design reviewed the instrument to evaluate the content, cognitive and usability of the instrument. Pilot testing was then done to identify ambiguous questions which were restructured.

Teachers responded by ticking on a Likert scale: 1 is strongly disagree, 2 is disagree, 3 is neutral, 4 is agree, and 5 is strongly agree. Data were entered into SPSS, which generated frequencies, mean (M) scores, and standard deviations (SDs) for all variables in **Table 3**.

Most of the pre-service teachers affirmed that the mentor teachers provided guidance (**Table 3**), both in organizing practical activities (M=3.56, SD=1.29) and in teaching theory (M=3.72, SD=1.03). Most pre-service teachers were assisted to focus on various practical skills (M=3.63, SD=1.17) as well as in moderation of assessment tasks (M=3.91, SD=0.98). In the moderation process, a significant proportion of the participants indicated that mentor teachers ensured that the assessment tasks consisted of questions of different cognitive levels (M=3.57, SD=1.04).

Despite the assistance provided to pre-service teachers by mentor teachers, most participants disagreed on the presence of laboratories (M=2.19, SD=1.36), laboratory chemicals (M=1.99, SD=1.15) and equipment (M=2.09, SD=1.13) (**Table 3**). Furthermore, most of the participants disagreed that virtual laboratories assisted learners in understanding concepts (M=2.67, SD=1.21). Due to the lack of necessary facilities, a large proportion of participants agreed that it was impossible for learners to perform practical hands-on activities (M=3.21, SD=1.08). A large percentage of the participants disagreed that the science practical skills were able to be imparted because there were no practical activities to reinforce the concepts (M=2.56, SD=1.24).

Table 3. Level of preservice teacher agreement on various issues during teaching *practice* [N (%)]

	SD	D	N	A	SA	Total	Mean	SDev
Mentor teacher assisted in arranging practical sessions.	10 (13.3)	4 (5.3)	13 (17.3)	30 (40.0)	18 (24.0)	75 (100)	3.56	1.287
Mentor teachers assisted in organizing theory lessons.	4 (5.3)	3 (4.0)	20 (26.7)	31 (41.3)	17 (22.7)	75 (100)	3.72	1.034
Mentor teacher provided appropriate guidance.	3 (4.0)	4 (5.3)	00 (0.00)	44 (58.7)	24 (32.0)	75 (100)	4.09	0.947
Mentor teacher focused on various practical skills in guiding teaching practical activities.	6 (8.0)	6 (8.0)	16 (21.3)	29 (38.7)	18 (24.0)	75 (100)	3.63	1.171
Mentor teacher assisted in focusing on theory questions of different cognitive levels.	4 (5.3)	7 (9.3)	18 (24.0)	34 (45.3)	12 (16.0)	75 (100)	3.57	1.042
Mentor teacher moderated assessment tasks set by student teacher.	2 (2.7)	5 (6.7)	12 (16.0)	35 (46.7)	21 (28.0)	75 (100)	3.91	.975
Mentor teacher provided adequate resources for teaching	2 (2.7)	7 (9.3)	13 (17.3)	33 (44.0)	20 (26.7)	75 (100)	3.83	1.018
The school had a laboratory.	34 (45.3)	17 (22.7)	5 (6.3)	14 (18.7)	5 (6.7)	75 (100)	2.19	1.363
The school had laboratory chemicals.	36 (48.0)	16 (21.3)	12 (16.0)	10 (13.3)	1 (1.3)	75 (100)	1.99	1.145
The school had laboratory equipment.	31 (41.3)	18 (24.0)	15 (20.0)	10 (13.3)	1 (1.3)	75 (100)	2.09	1.129
Performing hands-on practical activities by learners was impossible.	3 (4.0)	17 (22.7)	27 (36.0)	17 (22.7)	11 (14.5)	75 (100)	3.21	1.082
Virtual laboratories assisted in understanding concepts	16 (21.3)	19 (25.3)	18 (24.0)	18 (24.0)	4 (5.3)	75 (100)	2.67	1.212
I was able to impart various laboratory skills during teaching practice.	20 (26.7)	17 (22.7)	18 (24.0)	16 (21.3)	4 (5.3)	75 (100)	2.56	1.244
Science classes were overcrowded.	6 (8.0)	26 (34.7)	21 (28.0)	11 (14.7)	11 (14.7)	75 (100)	2.93	1.189

Note. SD: Strongly disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly agree; & SDev: Standard deviation

DISCUSSION

This study adds to the limited literature on mentor practice in science-specific day-to-day mentoring (Barnett & Friedrichsen, 2015; Bradbury, 2010; Wang & Fulton, 2012) by indicating how mentor teachers and the school environment assisted pre-service teachers in developing pedagogical knowledge.

Most of the pre-service teachers affirmed that the mentor teachers provided guidance, both in organizing practical activities and theory lessons. Pendleton et al. (2003) posit that mentoring is a long-term iterative process, which promotes pre-service teachers' professional development through scaffolding and feedback. Additionally, mentors act as role models to guide them through lessons and reflections. The mentors who availed themselves, instilled the required pedagogical knowledge. However, exact pedagogical skills must be explored by further research involving interviews and observations. Although most of the pre-service teachers were assisted, significant proportions of the participants did not receive scaffolding, compromising the intended professional development efforts of the training institution. The appropriation stage of the IDEAL framework, views teachers' PCK learning as a long-term iterative process consisting of planning sessions, modeling during classroom observation, debriefing sessions, scaffolds and feedback on lesson plans and presentations (Hinojosa, 2022). The sessions are likely to build knowledge of instructional strategies used to teach science, and the knowledge of assessment techniques in science (Magnusson et al., 1999). The sessions also promote the development of 21st century skills, including "critical and creative thinking, problem solving skills, collaboration and argumentation skills, leadership and responsibility, information and literacy skills" (Hadinugrahaningsiha et al., 2017, p. 1). Several studies (Comparcini et al., 2020; Ekiz-Kiran et al., 2021; Walter & Verner, 2019) indicate that pre-service teachers get experience through engaging with learners in the classroom. However, to bring about the required development, mentor teachers must provide the necessary support by accompanying pre-service teachers to the classrooms, asking them to reflect on their experience and help to suggest improvements to the lessons delivered. When mentor teachers fail to engage student teachers in the long-term iterative process, the development of the 21st century skills are hindered. Furthermore, science specific skills include handling equipment, measurement, observation, designing, communication, inferring, and predicting are also hindered (Nugraheni & Wuryandani, 2018). Classroom management skills will also be compromised.

Most pre-service teachers were assisted in focusing on various practical skills, as well as moderation of assessment tasks. In the moderation process, a significant proportion of the participants indicated that the mentor teachers ensured that the assessment tasks consisted of questions of different cognitive levels. For the small proportion that were not adequately assisted, as was the case in Kosar's (2021) study on distance teaching practicum, the school management team needs to ensure that mentor teachers accompany pre-service teachers to classrooms (Aderibigbe et al., 2022). The findings of this study where some pre-service teachers were not assisted by mentor teachers could be explained by the results of the study by Phang et al. (2020) on the roles of mentor teachers in mentoring pre-service teachers, where mentor teachers regarded certain roles as unnecessary and unimportant. The fact that some participants point to the fact that they did not get the necessary guidance suggest that some mentor teachers possibly did not value their roles in assisting pre-service teachers, resulting in their failure to assist the mentees according to expectations. Furthermore, constructive discussions are necessary in enhancing the acquisition of knowledge by pre-service teachers. The lack of adequate assistance of some pre-service teachers by mentors calls for universities to provide the necessary guidance to mentor teachers to enable them to perform their roles effectively. Furthermore, mentor teachers should ask to accompany mentees to their classes to ensure that they benefit from their practice through feedback from mentor teachers and discussions between them. According to Wang and Fulton (2012), mentoring can be responsive and novice-driven, where the mentee requests the mentor to observe and provide feedback. Furthermore, the school administration, especially the head of department, must monitor the mentoring process to ensure the professional development of pre-service teachers. According to the IDEAL framework model, teacher PCK learning is viewed as a long-term iterative process that seeks to promote the professional development of pre-service teachers in socially mediated activities using scaffolds, modeling, and feedback (Vygotsky, 1978; Wenger, 1998). The interaction ensures that the gap between the current knowledge of pre-service teachers and their potential is closed, that is, the proximal development zone is achieved within the context of teaching practice.

The absence of laboratories, laboratory equipment, and chemicals coincide with the findings of George (2017) in Lesotho, Gudyanga (2020) and Gudyanga and Jita (2019) in South Africa, and Mudulia (2012) in Kenya. The absence of resources has a significant impact on the enacted PCK in the specific school and limits the pre-service teachers from attaining their maximum potential professional development. The social constructivist theory highlights that learning is context-bound. It is critical to ensure that pre-service teachers' learning environments during practicum experiences are conducive to develop classroom management strategies, rapport with students, skills in dealing with families from different backgrounds, and effective science specific pedagogical approaches.

Implications for the Study

The study has practical implications for pre-service teachers and training institutions in relation to selection of schools that have adequate resources to enhance the optimum professional development in teaching science process skills. Mentor teachers should be trained on how to bring about the required science specific professional development in line with IDEAL framework, which emphasize on lesson planning, delivery, and debriefing sessions. In order to acquire the science specific pedagogical skills, pre-service science teachers need to practice teaching in schools that are adequately equipped. Mentor teachers should develop metacognitive habits of mind by probing pre-service teachers to explain when to use a particular instructional approach, how to use the approach, and why the approach is suitable. The necessary training for mentor teachers and engaging the school management team can assist in bringing about the required professional development among pre-service teachers during teaching practice. The importance of the study to scholars and the public lies in the fact that science is the foundation of industrial, technological, and economic development. Hence, the need for all science pre-service teachers to be adequately developed by selecting the appropriate context in which the teaching practice is done to develop the knowledge, science specific pedagogical skills, and values necessary for successful entry into a professional career and alleviate poor performance which leads to failure of learners when they eventually qualify and teach science in the school system.

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