Leveraging Teacher Educators' Pedagogical Approaches for Biology Terminology Instruction: A South African Case Study

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Abstract: Biology education in South Africa faces challenges, as matric students continue to underperform. Diagnostic reports attribute this issue not only to teacher knowledge but also to students' limited comprehension of biology terminology. This study aimed to investigate the pedagogical approaches used by biology teacher educators in addressing terminology during their content module lectures and to suggest ways to enhance the development of pedagogical scientific language knowledge among pre-service and in-service biology teachers. Four biology teacher educators were observed teaching various topics in their content modules. These observations were transformed into vignettes and analysed inductively to uncover different methods of addressing biology terminology. The findings revealed that educators utilized diverse pedagogical approaches, such as representations, to address terminology effectively. This study emphasizes how these pedagogical approaches in initial teacher education programs can be optimized, offering recommendations for equipping both pre-service and in-service teachers with essential pedagogical scientific language knowledge.

Keywords: Biology Terminology, Initial Teacher Education, Pedagogical Approaches; Pedagogical Scientific Language Knowledge

1. Introduction

The teaching and learning of biology in high schools continues to be a problem not only in South Africa but across the globe (Cimer, 2012; Hadiprayitno et al., 2019). In the South African context, this is seen in the diagnostic reports that show that no more than 55% of matric students get 40% or more in their final biology matric results. Furthermore, the report shows that less than 4% of these learners got 80% in their final results in the past 6 years (Department of Basic Education (DBE), 2022) signaling students' lack of understanding of the subject matter. Amongst other reasons, the prevailing cause of the underperformance in schools is attributed to science language and terminology of biology (De Villiers, 2011; DBE, 2022; Motloung et al., 2021) as learners usually do not understand the meaning of basic terms used in biology classrooms. At times, learners do not know the spelling of different terms. Furthermore, when students answer exam questions where a description of processes is requested, the accuracy in the sequence of steps is usually confused and misunderstood implying that the students are not learning basic biology terminology (DBE, 2022). Yet, the issue of science language and terminology has been extensively researched across different levels of schooling (Kazeni & Maleka, 2020; Oyoo, 2012).

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A lot of what we call subject matter knowledge in science is characterized by terminology (Rector et al., 2013) that hinders students' development of deeper conceptual understanding (Snow, 2010; Zukswert et al., 2019). Therefore, learning science typically means learning its language. This includes not only being aware of the terminology but also how to use the terms in context. Brown et al. (2010) posed a question: "If students are struggling to acquire the language of science, how can science education continue to neglect ... language instruction?" (p. 1490) to challenge science education researchers around issues of language and terminology. This is still an important question to ask given the persistent problems with science language and terminology at the school level. With this problem, Initial Teacher Education (ITE) needs to develop ways of preparing biology teachers in this regard. Particularly, science teachers' pedagogical scientific language knowledge becomes an important knowledge for teachers to deal with language issues in science classrooms (Mönch & Markic, 2022).

Scholars around the world agree that the quality of science teaching and student performance in schools is influenced by the quality of teachers and how they are prepared in ITE (Khoza, 2022; Green et al., 2017; Mincu, 2015). In other words, teachers with sound Pedagogical Content Knowledge (PCK) are likely to teach in a way that learners understand the science concepts. However, according to Mönch & Markic (2022), PCK on its own is not enough to deal with the science terminology in science classrooms. In addition to the PCK, teachers need to acquire pedagogical scientific language knowledge in order to facilitate the learning of scientific terminology in biology classrooms. As such, a starting point to deal with the issue described above is to look into what is done in ITE programs and make suggestions. In this article, I look into some of the approaches used by biology lecturers in their content modules to make suggestions on how these can be translated into equipping both biology pre-service service and in-service teachers' development. This study was guided by the following research questions:

1. What pedagogical approaches do biology teacher educators use to deal with biology terminology in their content modules?
2. In what ways can these pedagogical approaches be leveraged to improve biology teachers' pedagogical scientific language knowledge?

The first question is addressed by revealing the pedagogical approaches that the teacher educators use in their biology content module. The second question is addressed unpacking specific ways in which these can be leveraged to improve biology teachers' practice of dealing with biology terminology. The next section of the article provides an overview of initial teacher education in South Africa to contextualize this study.

2. Literature Review

2.1 Initial teacher education in South Africa

The history of ITE in South Africa is traced back to the apartheid era where teacher preparation was subjected to the racial inequalities that existed at that time. One significant inequality was that Black teachers were often qualified to teach with only a high school certificate, though some obtained a two- to three-year teaching diploma from colleges (Schäfer & Wilmot, 2012). This contributed to a higher number of teachers with limited PCK. Numerous studies have been conducted to address this issue. For example, Teane (2023) investigated the role of partnerships in assisting in-service science teachers deal with difficulties associated with performing practical work. However, no attempts have been made to empower in-service (those prepared during apartheid) teachers on how to deal with biology terminology, yet, there is evidence that that these teachers were disadvantaged. Furthermore, although new teachers are coming from the current ITE programmes, the evidence presented in the introduction of this article reveals that these teachers also lack pedagogical scientific language knowledge. This problem can be attributed to the current pathways of science teacher preparation.

Currently, in South Africa and the world over, pre-service teachers are prepared through two pathways that follow different models. The first pathway uses a consecutive model. In this model, students learn the disciplinary content and graduate with a three-year degree (e.g., Bachelor of Sciences degree). To qualify as science teachers, students do a one- to two-year qualification (e.g., Postgraduate Certificate in Education) covering the professional knowledge of teaching (Musset, 2010). This model is becoming common in most parts of the world especially in the United States (Marinell & Johnson, 2014) and Ireland (Heinz, 2008). Although this model is recognised and perpetuated, particularly in the South African context by the Minimum Requirements for Teacher Education Qualifications (MRTEQ) (Department of Higher Education and Training, 2015), the concurrent model prevails in the universities. In the concurrent model, students qualify with a four-year degree by completing the disciplinary content courses, the professional courses (including methodologies) and the practical components. According to Musset (2010), this model allows the integration of the disciplinary content (biology subject matter knowledge in this case) and the pedagogy (how to teach biology). Hence, when implemented appropriately, the model is assumed to produce teachers with strong knowledge of science teaching pedagogies (Mavhunga & Rollnick, 2017). This study focuses on the development of pedagogical scientific language knowledge. As argued by Love (2010), there is a need for teacher education programmes to equip pre-service teachers with language and literacy PCK defined as the knowledge of teaching the language and terminology of disciplines like science.

There are no consistencies in terms of the implementation of the concurrent model. Literature suggests that there are different versions of this model in South Africa (Nyamupangedengu, 2015). The two most prevalent versions of the concurrent model, perpetuating inconsistencies, are noted by Nyamupangedengu (2015) termed Concurrent model 1 (CM1) and Concurrent model 2 (CM2). In CM1, the students complete the content courses in one faculty, mainly with the main-stream students then the professional knowledge courses in the education faculty. In the CM2, both the content modules and methodology modules are taught by the same faculty (Khoza, 2022). An assumption is that teacher educators would teach the biology content in content modules and then proceed to the methodology modules where the focus is on how to teach that content focusing on problematic areas like dealing with biology terminology. Even though this is the case, anecdotal evidence suggests that some institutions prefer main-stream lecturers to teach content modules while those that have education qualifications teach methodology modules. The reasons for this preference are not yet known. Given the pedagogical issue of terminology that exists in biology teaching and learning, it seems that the ITE programmes are not doing enough regardless of the model of preparing science teachers. Perhaps the issue is the misalignment between the content and methodology modules. For example, in some institutions, science content modules are taught in the science faculty while methodology modules are taught in the education faculty (Khoza, 2022). Pre-service teachers, therefore, tend to see no links between the modules. As such, the question that I am asking in this context is how can we leverage what happens in content modules to better support both pre-service teachers and in-service teachers to deal with certain biology teaching demands like language and terminology? This study is about what can be done both at the ITE level and in the professional development of in-service biology teachers.

2.2 Language and terminology in science classrooms

The role of terminology in learning science is often framed in Vygotsky's statements that there exists a relationship between language and thought (Vygotsky, 1986). In particular, Vygotsky argues that thought processes require language and language also requires an individual's thought processes. His claims cement the argument that since in learning, thought is a necessity, it follows that language is an important resource through which thinking is enacted. While unpacking Vygotsky's (1978) socio-cultural theory, Daniels et al. (2007), suggested that language is a tool through which learning can be fostered in social spaces.

Literature on language in science classrooms is replete. On one end, some scholars focus on how language is used to talk about science concepts (Carlsen, 2007; Kelly, 2010). Such scholars draw from Lemke's (1990) concepts on the use of scientific language by arguing that learning science is like being encultured into a second socialisation with a new language and representations (Bravo & Chion, 2017; Maxwell-Reid, 2020). The debates around this phenomenon are that since science is a language, it becomes challenging for students to learn it, especially in multilingual classrooms that are prevalent in South African and international contexts (Charamba, 2023; Karlsson et al., 2019). On the other end, there is literature focusing on terminology in science classrooms as a component of language. The argument in such studies is that science is a new language in itself. Therefore, science teachers need to possess pedagogical scientific language knowledge (Mönch & Markic, 2022).

There are two categories of terminology used in science classrooms: technical and non-technical vocabulary. Non-technical vocabulary refers to terms that have one or multiple meanings in everyday language but possess a specific and often different meaning within a scientific context. For example, the term cell and inheritance as used in biology has a different meaning from when it is used in everyday life (Cassels & Johnstone, 1985). Technical terms have discipline-specific meaning in the sense that they are not used anywhere except in biology. The terms are at times referred to as 'jargon' and are usually abstract for students to comprehend (Snow, 2010). For example, the terms chromosome and allele in genetics are used only in biology and, therefore, considered technical. Scholars have looked at Contextually, previous research seems to have leaned towards studying school teachers' perceptions about science language and terminology (Semeon & Mutekwe, 2021) and used by teachers to decode science terminology (Kazeni & Maleka, 2020). Zukswert et al. (2019) investigated terminology that may be a barrier to biology students' understanding. However, their study only focused on technical terms and conclusions were based on students' perceived lack of understanding of the terms or their poor performance at defining these terms. In this article, I report on the approaches that teacher educators use to explain biology terminology (both technical and non-technical) in their teacher education classrooms. The contribution of this study is in offering different pathways for leveraging effective approaches that teacher educators use to deal with biology terminology in their content modules. Particularly, I offer suggestions on ways in which language/literacy PCK can be developed in pre-service science teacher education programmes and in-service teachers.

3. Methods

3.1 Research approach

I used a qualitative approach positioned within the interpretivist paradigm (Taylor & Medina, 2011) to study the teacher educators' pedagogical approaches to dealing with biology terminology. Qualitative approach allows the researcher to look at a phenomenon in depth.

3.2 Context and participants

The study involved four teacher educators instructing biology content within a teacher education program at a South African university. In this context, the lecturers are responsible for teaching both the content and methodology modules to the Bachelor of Education students studying to become high school biology teachers. For example, a lecturer would teach a biology content module and its corresponding methodology module. The participants were purposively selected based on their roles as instructors of biology to pre-service teachers and had at least 10 years of experience in teaching biology in the initial teacher education context. The assumption here was that the experience of lecturers would have an impact on the pedagogical practices. As argued by Kini and Podolsky (2016), teaching quality improves with teaching experience. These four teacher educators taught 129 3rd year students and 86 4th year students. Table 1 below shows the details of the teacher educators observed.

Table 1: Details of the TEs observed

Teacher Educator	Number of years teaching in Higher Education	Topic taught	Pre-service teachers taught	Lectures observed
Amy	11	Homeostasis and temperature regulation	3rd years	4 (2 double and 2 single)
		Biochemistry of respiration	3rd years	4 (2 double and 2 single)
Lorraine	10	Nervous system and sense organs	3rd years	8 (4 double and 4 single)
		Genetics	4th years	4 (3 double and 1 single)
Kate	14	Evolution	4rd years	5 (2 double and 3 single)
Gracious	19	Cell Biology	3rd years	4 (3 double and 1 single)

As can be seen in Table 1, the teacher educators taught a variety of topics. A single lecture is 50 minutes long and double lectures are 1 hour 40 minutes long. In practice, the lecturers used 40 minutes during single lectures and 1 hour 10 minutes on average.

3.3. Data collection procedures

Data was collected through classroom observations in three semesters (over 2 years). I observed the four teacher educators in their classrooms teaching the biology topics as shown in Table 1. I would sit at the back of the classroom like one of the students and observe using an observation sheet. The number of lectures observed differs from one teacher educator to another primarily due to the time allocated for that topic and the practical activities offered in that module. The observation tool with a date, focus of the lecture and lecturer's name was used to record the pedagogical approaches of the teacher educators in terms of what they do in dealing with the biology terminology. Table 2 shows an example of how the observation tool would be filled during the observation.

Table 2: An example of a filled observation schedule

Teacher Educator	Lorraine
Lecture	1
Focus	Overview of genetics
Terminology	Observed lecturer approaches
Chromosome	Lorraine holds strings of different shapes (ball-shaped string and straight string). She writes the term 'chromosome' on the board and then asks students what they see. She also asks students the how the strings are arranged.
DNA	Lorraine asks students what the term 'DNA' stands for. She then breaks down the term into its derivatives – *De-oxy-ribo-nucleic*. After that, she explains what each term in the acronym DNA stands for. During her explanation, she also refers to a model of DNA that she had brought to the lecture.
Sugar	Lorraine asks students what the term 'sugar' means. This then leads to a discussion amongst students. She then engages students in a discussion about the term 'sugar' as it is used in the term 'DNA'. During the discussion, she refers to a diagram that is projected on the screen from her PowerPoint presentation.
Chromatin	Lorraine holds the ball-shaped string again and refers students to it. She then asks them how it is arranged again. She asks students the question "if this is a chromosome, as a chromatin, how would it be arranged and why?"

Since I was not using a video or audio recorder to record the classroom events, the observation schedule helped me to focus on the use of terminology. The act of sitting down immediately after the observations to produce narratives helped me to describe in detail what happened in the lectures. To ensure credibility during the data collection phase, I discussed the observations with the participants for member-checking.

3.4 Data analysis

Data analysis ran concurrently with data collection and it involved a series of steps. Step 1 took place immediately after every lecture. I sat down and produced vignettes from the observation schedule. The purpose of the vignettes was to produce a detailed description of the pedagogical practices of dealing with the biology terminology observed from each lecture and to support the observation schedule. Table 3 below shows examples of the vignettes produced from some of the filled observation tools.

Table 3: Examples of the vignettes produced

TE	Portion of vignette
TE3's lecture 2 of evolution	In Lillian's second lecture, she was direct with the students, acknowledging the difficulty of understanding evolutionary terminology. She consistently asked students to write down terms as she spoke them aloud (e.g., Australopithecus). For terms with structural or functional derivatives, she began by explaining the structural and functional derivative first, then worked backward to introduce the scientific term.
TE2's lecture 4 of nervous systems	In lecture 4, Betty used a pool noodle, cut lengthwise, to demonstrate the transmission of a nerve impulse. She placed differently coloured pins on the surface to aid her explanation. While discussing the topic, she wrote essential terms on the board and later incorporated them into sentences to outline key processes.
TE1's first lecture on homeostasis	During the introduction of the topic of homeostasis, Alice asked the students for their understanding of the term, but no one responded. She then broke the word down into "homeo-" and "-stasis." At this point, a student suggested that "-stasis" might mean static.

Step 2 of data analysis involved coding the observation tables and the vignettes. Inductive coding was used - The codes emerged from the data to explain certain portions that capture the teacher educators' pedagogical practices of dealing with biology terminology. Some of the codes that emerged from the data included repetition of a term, giving students time to think about the term, breaking the term into its constituents, etc. Another researcher was invited to code and we met to discuss the codes and reached a consensus.

Step 3 of the data analysis involved reducing the codes by categorising them into what we call pedagogical practices. We are using the term pedagogical practices to mean grouped specific practices that are coded as ways of dealing with biology terminology.

4. Result and discussion

4.1 The pedagogical approaches used by TEs to deal with biology terminology: Research methods and results

Analysis of data showed that the teacher educators used a variety of approaches to deal with the biology terminology. Table 4 shows these approaches and some examples of terms.

Table 4: The teacher educators' approaches to dealing with biology terminology

Approaches	Examples of terms
1. Explicitly mentioning the origin of the term and/or breaking down the term into its constituents	Prokaryotic, eukaryotic, phylogenetic, autotroph, heterotroph, aerobic, melanocytes, Glycoprotein, homeostasis, phagocytosis, endosymbiont, pseudopodia, adenosine diphosphate (triphosphate), deamination, bipedalism, hydrophobic, australopithecine, Golgi apparatus, microfilament, Australopithecus, catabolic, anabolic, glycolysis, Phosphorylation
2. Moving from everyday use of the term to the scientific use and/or beginning with a common term then a scientific term	Cell, membrane, cell fractionation, plasma, inheritance, variation, energy, aerobic, fit, chain, transcription, translation, sugar, Channel, trait, hammer (or malleus), the anvil (or incus), and the stirrup (or stapes), amplify
3. Using representations and concrete materials	Gene, genetic information, chromosome, allele, neuron, channel
4. Explicitly differentiating between singular and plural	Bacterium (Bacteria), mitochondrion (mitochondria), nucleus (nuclei)

Although I have categorised the approaches in Table 4, the approaches are interrelated in terms of how they were used in the lectures. I, therefore, present these in a narrative manner below.

The first approach has to do with mentioning the origin of the term from the Greek and/or Latin languages. For example, Lorraine first mentioned how the term 'pseudopodia' is derived from the Greek language. She also used the same procedure with the terms 'cytokinesis' and 'eukaryote'. Amy also used the same approach when teaching the concept of autotroph and heterotroph in the biochemistry of photosynthesis. A significant challenge for students in learning biology is their inability to correctly spell terms, which can alter the meaning of the entire concept (Zukswert et al., 2019). For instance, confusing "stroma" with "stoma" can change the intended meaning within the context, as noted by Amy in one of her lectures.

Another major issue for students when handling terminology is their difficulty in accurately writing and describing terms, which is essential for understanding key concepts in biology (Ali et al., 2022). I, therefore, also advocate for requesting students to vocalise the terms. Asking students to vocalise problematic biology terms is also supported by Ali et al. (2022) as an effective approach to help students with pronunciation which can lead to writing the term correctly.

Other teacher educators emphasised the functions as derived from the term. In order words, the way a term is constructed stems from how the term is used. For example, Carlos first explained what the term apparatus means before introducing the origin of the term in terms of who discovered the Golgi apparatus. When he mentioned phagocytosis, he then went back to its origin in the Greek language and broke down the term. In addition to explaining the origin of the term, some teacher educators involved their students in breaking down the term into two and then began to explain each separately before the actual definition of the whole term. Breaking down the term into its constituents is explained by Bowers et al., (2010) as a morphological instruction. In this framework for dealing with biology terminology, students get involved in understanding how the term is structured. This, in turn, helps them to pronounce and spell complex biology terms that they learn. According to Goodwin and Ahn (2010), this kind of approach is an effective way to improve students' vocabulary skills. Several strategies can be used in this approach (Zoski et al., 2018). The morphological strategy seen in the teacher educators' classrooms is described by Zoski et al. (2018) as deriving words by combining morphemes. However, the teacher educators also began with the full term and then dissected it to define each part. I argue that awareness of such strategies is important for teachers to help their students understand biology terminology. Berninger et al. (2003) also advocated for this approach, seeing that students who realise morphemic patterns in terms can easily access meaning even though they may not pronounce the terms successfully.

Some terms are used in everyday life as well as in science. However, in science, their meaning is different from the everyday meaning. These are called non-technical terms (Cassels & Johnstone, 1985). For many of such terms, the teacher educators used representations like diagrams presented on the screen and asked students to describe if the diagrams/pictures were the same or different. For example, when teaching cell biology, Gracious asked the students what they think a cell is. In the slide, he had put a picture of a cell phone, a prison cell, and a biological cell. Diagrams are regarded as important in biology instruction as they help students to visualise abstract concepts (Kottmeyer et al., 2020). Therefore, this finding supports Rosen et al.'s (2012) findings that teaching abstract science terminology while using diagrams/images resulted in better student learning compared to when the term was used without a diagram/image. Furthermore, Fisher et al. (2002) argued that extensive use of metaphors and analogies as representations can aid students in understanding science terminology, thus, increasing the comprehension of scientific concepts.

Some terms in biology are used across science disciplines. An example is when he also drew from the mathematics discipline to explain cell fractionation. While doing this, he differentiated that fraction in mathematics is an 'object' whereas cell fractionation is a mechanism. This differentiation was important to help students remember and describe cell fractionation from the perspective of what fractions are in the mathematics context. The assumption here was that students would be familiar with the term fraction. Terms like plasma are used in students' everyday lives to mean a flat-screen television. Carlos made this distinction by verbally telling students that he is not talking about the fancy TV that they watch at home. Amy also explained the term energy from how it is used in everyday life and used an example of an energy drink. She further mentioned that the term is borrowed from Physics. Bryce and Blown (2016) highlighted that transitioning from everyday language usage to scientific terminology re-establishes everyday intuitive concepts as the bedrock of subsequent scientific comprehension. This approach has been widely acknowledged by scholars as effective for students to retain an understanding of scientific terms (Oyoo & Semeon, 2015). As Semeon and Mutekwe (2021) found that many science teachers were not proficient in the meanings of some terms in everyday use and scientific use, this finding has implications for the professional development of science teachers.

Some teacher educators started with the common term before going to the scientific term, students seemed to dwell much on the common word than the actual biological term. However, what seemed to be beneficial with this strategy was that as the common word was used, the students got an opportunity to grasp the broad description of the term. Again, students were involved in the process drawing from what they could have been exposed to in their everyday lives. Carlos asked what a filament is and why it is used in many manufacturing companies for students to understand its durability and strength. The idea of involving students in co-construction has been noted by other scholars as a key approach in science classrooms (Nawani et al., 2018). Through this process, students get encultured in the new culture of a science classroom. Research indicates that a major factor contributing to students' difficulties in learning biology is their ability to spell terms correctly, ensuring that the meaning of the entire concept remains intact (May et al., 2013). As such, helping students to learn the biology terminology involves doing it both verbally and in written form.

Apart from representations supporting scaffolding of non-technical biology terms that seem to exist at the microscopic level, Lorraine used models to help students understand technical terms while vocalising if the term refers to a structure, a process or a mechanism. For example, when teaching genetics, Lorraine would say; "This is the structure of a chromosome…can you describe it?" while using a concrete material to illustrate what the chromosome looks like. This would allow students to recognise how a chromosome looks like when they see the structure. A study conducted by Khoza and Nyamupangedengu (2018) showed that the use of concrete materials allows students to engage cognitively and socially. Through these engagements, students are able to make sense of the biology terms. Many biology technical terms are difficult for students to relate to. Seeing the expression of meanings of these terms can help students understand the vocabulary. Furthermore, when teaching about the communication of neurons, she would refer to protein channels as a process. The students get to understand how to communicate using the science language to maintain a shared understanding of the science knowledge. This supports Thörne and Gericke's (2014) argument that merely mentioning terminology is insufficient. Facilitation through making links and how these terms are used in explanations is important because a term may be presented as signifying a 'structure' whereas it should be used as a process. As Lorraine used representations like concrete models, she would also request the students to highlight the term in their notes, write it down or even say it loudly before it can further be explained served as a way of fostering students' familiarisation with some of these terms. Furthermore, rather than just asking the students to memorise the term, it is important to also illustrate how it is used in context (e.g., a sentence) and how it relates to other terms.

Lorraine did this by exposing students to concept mapping as a representation, thus allowing students to understand how different terms relate to each other and how these terms can be used in context.

4.2 How can these effective approaches be leveraged to improve how Life Sciences can deal with terminology?

In section 4.1, I have shared and discussed how experienced teacher educators deal with terminology when teaching biology to pre-service teachers. Below, I discuss the departure point in terms of leveraging on these approaches gleaned from the teacher educators' practices. I discuss three pathways to doing this.

4.2.2 Pathway 1: Explicit inclusion of how to deal with biology terminology as a topic in methodology modules

As stated above, the knowledge of how to teach science in ITE is usually taught in methodology modules, making these modules a central point for pre-service teachers' development of PCK (Bailie, 2017). There is evidence that when methodology courses are designed to equip pre-service teachers with specific pedagogical aspects, changes are seen. For example, Karisan et al. (2019) looked at the methods courses designed for STEM education. The pre-service teachers showed awareness and intentions to teach Science Technology Engineering and Mathematics (STEM) subjects after participating in the course. Given the contextual nature of language issues (Karlsson et al., 2019), I argue that explicit inclusion of how to deal with biology terminology in methods modules can be a way forward to solve the pedagogical problems that exist in schools. Pre-service teachers need to be afforded opportunities to first understand science as a new language and how to deal with the terminology. In these methods modules, teacher educators need to explicitly highlight problems associated with biology language in schools. However, the explicit teaching of these approaches would not necessarily result in the pre-service teachers using these approaches or developing their pedagogical scientific language knowledge.

Just like Zhou et al. (2016) who found that micro-teaching lesson study helped pre-service teachers to understand the dynamics of teaching with technology, I also suggest that pre-service teachers should be allowed to practice how to enact these approaches in their methods modules. An advantage of micro-teaching using a lesson study approach is that pre-service teachers plan and reflect together while getting instant feedback from the lesson planning and presentation phases. Since pre-service teachers are prepared to teach a variety of contexts, the lesson planning and presentations may be tailored in such a way that they define and imagine their future teaching contexts since issues of language in science teaching are contextual (Kirby, 2017).

4.2.1 Pathway 2: Modelling in content modules

Loughran and Berry (2005) defined modelling as "doing in our practice that which we expect our students to do in their teaching" (p. 194). In the past, scholars have seen modelling as a practice that should happen in methods modules. Recently, studies have shown that teacher educators can model pedagogical approaches in content modules (Khoza, 2022; Nyamupangedengu & Lelliott, 2016). How teacher educators facilitate the learning of pre-service teachers should model best practices for teaching science. Loughran and Berry (2005, p.197) conceded that when teacher educators model the "thoughts and actions" supporting their ideologies about education, this transforms into "more powerful teaching and learning about teaching". Lunenberg et al. (2007) suggest four ways of modelling practice. The first is implicit modelling where the teacher educators reveal best teaching practices without telling students about them. This kind of modelling has limitations as the pre-service teachers may not be able to understand how what the teacher educator is doing will assist them as school teachers. This is because their primary agenda in content modules is to learn the content (Loughran, 2006). It is, therefore, important that the teacher educators explicitly model these pedagogical approaches with what Lunenberg et al. (2007) call metacommentary or thinking aloud. Not only do I suggest explicit modelling as a way of facilitating the pre-service teachers' internalisation of different ways of dealing with biology terminology. I also suggest that the teacher educators need to facilitate the translation to the pre-service teachers' practices. This facilitation can be through mentioning pre-service teachers' confusion of different terms or even highlighting how what terms confuse the pre-service teachers would also confuse the learners. Smith (2005) argues that simply explaining what constitutes good teaching to student teachers is insufficient. Pre-service teachers must be shown, through the teacher educator's instruction, how they can implement various teaching strategies. In this way, the pre-service teachers would start thinking of their future teaching contexts, thus facilitating their learning agenda of learning about teaching specifically on dealing with scientific language. As Kazeni and Maleka (2020) found that science teachers seem to use teacher-centred approaches to decode scientific terms, I argue that pre-service teachers should be exposed to strategies that involve learners so that they can decode the terminology for themselves to gain a deeper understanding of science concepts. There are still studies in the international context reporting that teachers use and explain science terminology more than their learners (Dorfner et al., 2020). As such, in modelling these approaches, teacher educators should also explicitly model how to involve learners in the teaching and learning process in the usage of terms and encourage students to use the correct scientific terminology in context.

4.2.3 Pathway 3: Professional development of in-service teachers

The South African education system still has teachers who have joined the system for a while. Regardless of when these teachers joined the system. Many teachers may not have been exposed to how to deal with biology terminology as seen from the diagnostic reports and literature (Semeon & Mutekwe, 2021). This means the problem of dealing with biology terminology extends beyond the ITE context as many in-service teachers lack pedagogical scientific language knowledge (Mönch & Markic, 2022) . Many studies that investigate biology in-service teachers' teaching practices usually recommend the professional development of these teachers. Other scholars go further to provide evidence of these professional development initiatives. I maintain these recommendations that these in-service teachers need to be developed to deal with biology terminology. Many studies utilise the refined PCK consensus model to develop pre-service and in-service science teachers' PCK (Bheling et al., 2022; Carpendale & Hume, 2022). However, the language element or how to deal with science terminology is often neglected. There is, therefore a need for a stronger focus on pedagogical scientific language knowledge during professional development programmes. In this way, in-service science teachers will not only be equipped with the PCK but also specific ways of dealing with biology terminology.

Although studies indicate that once-off-teacher professional development initiates are likely to impact teachers' practice (Timperley et al., 2007), just like Howard-Jones et al. (2020), prolonged professional development programs can help teachers attain a greater depth of knowledge and skills for dealing with biology terminology especially if the teachers may have certain beliefs about science language. Furthermore, the nature of these professional development initiatives should involve the co-construction of knowledge with the teachers. Models like a lesson study (Mapulanga et al., 2023) with expert advice seem to be working when it comes to professional development initiatives. As such, the focus of these initiatives should take this approach. Another approach that can be used is having expert teacher educators modelling how to deal with biology terminology in a school context followed by reflection exercises with these teachers to harness the skills for dealing with biology terminology. These approaches are in line with teacher professional development practices identified in the literature (Germuth, 2018).

5. Conclusion

The main aim of this study was to look at the approaches that teacher educators use to deal with biology terminology in their content modules and then make suggestions in terms of how we can leverage these practices to solve the issue of science language that continues to contribute to underperformance of biology learners in matric. I have shared three pathways as suggestions for the development of not only biology pre-service teachers but also in-service teachers. These suggestions are not specific to biology teachers but to science teachers in general (including physics and chemistry). I, therefore, call on teacher educators to implement the first two suggestions in their initial science teacher education programs. In this regard, an explicit inclusion of a section where pre-service teachers are taught how to deal with biology terminology is needed to support the development of pedagogical scientific language knowledge. This can be done in methodology modules in such a way that the design of these modules affords pre-service science teachers the knowledge and skills of how to deal with biology terminology. With regards to the third pathway, there is a need to come up with professional development programs for in-service science teachers in order to equip them with the skills and knowledge of how to deal with biology terminology.

Given these suggestions and once enacted, further research can look into the evaluation and impact assessment to determine the effectiveness of the proposed interventions. This could involve conducting longitudinal studies to track the retention and application of the pedagogical scientific language knowledge and skills gained through teacher education programs and professional development initiatives.

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