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THE IMPACT OF SCIENTIFIC LANGUAGE ON THE TEACHING AND LEARNING OF GRADE 7 NATURAL SCIENCES

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Abstract

Questions have been asked about whether science is more special than any other subject in being less culture bound, and less subject to the usual differences between languages. At so many angles scientific language has been viewed as difficult because of its academic, authoritative and impersonal nature which makes it difficult for both teachers and learners to understand. This is an unfortunate reality because learners ought to develop a strong foundational understanding of scientific concepts in order to comprehend scientific knowledge and processes. Previous studies have shown how language acts as a possible barrier to scientific concept formation. Consequently, the current paper reports on a study to determine how the nature of scientific language impact on the teaching of grade 7 Natural Sciences. Guided by the socio-cultural theory as a framework the study adopted a qualitative case-study research approach. From two different schools in Johannesburg, four Natural Sciences teachers and their grade 7 Natural Sciences learners were purposefully selected to participate in the study. Each teacher was observed twice while teaching Natural Sciences to grade 7 learners and the observations were captured using Reformed Teaching Observation Protocol (RTOP). Each lesson observation was followed by semi-structured interviews to accord the teachers an opportunity to explain some of the episodes observed in the lessons. Data collected was subjected to constant comparative analysis. The results showed that both teachers and learners struggled with writing, pronouncing and spelling scientific terminologies regardless of their proficiency in the language of teaching and learning. The teachers indicated that their learners failed to understand the scientific concepts and processes when they explain to them in English. The lack of fluency in English reduced the participation of learners during the teaching and learning process particularly where teachers had zero tolerance for learners' use of home languages to answer questions. What came out strongly from the lesson observations was that whether learners were first or second English language speakers, the teachers' abilities to scaffold learning was essential to ensure science concepts were comprehensible to the learners. Concepts were more accessible to the learners in classrooms where the teachers utilised different ICT tools which lowered the impact of scientific language. The findings have implications for both pre-service and in-service teacher professional development programmes to equip teachers with the knowledge and skills for making science more comprehensible to the learners.

Keywords: *Natural sciences, nature of scientific language, language of instruction, English second language speakers.*

1. Introduction

In an attempt to overcome the challenges brought by the nature of scientific language and the language of teaching and learning in South African schools, teachers apply different pedagogical and intervention approaches, amongst other strategies. Ng and Cheung (2018) proposed that teachers should use scaffolding to assist learners to overcome the language barrier. The implications of learning science in a home language, a language that is more accessible to a learner, may seem as an ideal solution, however the nature of scientific language itself poses a huge challenge. Talking, writing and reasoning scientifically is fundamental in science learning.

Historically, human progress and advancement is attached to scientific improvement and innovation. A nations' development and economic prosperity is linked to its investment in scientific research and education (Brown, 1996). Miller (2006) asserts that language challenge is the most experienced one internationally amongst all the challenges. Ridge (1997) further dissects this assertion and narrows it down when he laments that learners at secondary school level in South Africa have limited academic success in science subjects, part of which is attributed to the language of instruction. However, recent research has established that the complexity of scientific language also plays a huge role in this. In support of this view, Mavuru and Ramnarain (2020) posited that not only is English as a language of

instruction impeding learners' understanding of scientific concepts, but the complex nature of the science language, play a huge role in blocking learners' scientific concept formation.

Scientific language contrasts with common everyday language which leads to considerable confusions in classroom settings where learners are introduced to scientific terms that have a different meaning in their everyday use. Previous researchers (e.g. Derewianka, 2014; Mavuru & Ramnarain, 2020) have also indicated that the way science language is written, designed to be concise, precise, and authoritative, tends to isolate learners from meaningfully engaging with the science content. This scientific language complexity tends to be difficult for learners to comprehend and hence blocks learning. There are however learners who display good proficiency in English but still struggle with scientific concepts and processes, which therefore highlights the assertion made by Derewianka (2014) that the problem of understanding science cannot not solely be placed on the language of instruction, but also the nature of science as an entity of knowledge, and the linguistic puzzle of science text. It is against this background that the current study sought to address the following research questions: 1. What are the challenges posed by the nature of scientific language that hinder effective learning of Natural Sciences at grade 7 level?; and 2. How do teachers mitigate the challenges caused by the impact of the nature of scientific language in teaching grade 7 Natural Sciences?

2. Literature review

Apart from the language of teaching and learning, the complex nature of the scientific language makes learning science difficult for learners' (Msimanga, Denley & Gumede, 2017). This is evident where even learners with good English language proficiency struggle to write and speak scientifically. Almost two decades ago Schleppegrell (2004) pointed that science has a language of its own that is distinct; abstract, objective and information oriented. Examples of complex scientific words that learners struggle with range from being technical (specific to science discipline) and non-technical (words that attain new meaning when they are used in science) for example when the word 'diversity' is brought into the biology branch of science it assumes a different meaning than it would in daily use. This makes the scientific words ambiguous and confusing, e.g. words like 'power' may mean something else in the learners' daily use which is totally different from the scientific meaning of the word (Mavuru & Ramnarain, 2020). Teachers should be well equipped with pedagogical strategies to mitigate these language conflicts. To this Ng and Cheung (2018) suggested that teachers should provide more scaffolding to facilitate learners' understanding of scientific concepts. The National Research Council (2004) suggested modelling which clearly defines task outcomes by giving learners partial solutions, hints and clues and by asking them leading-on questions to guide their learning.

Words in science can be difficult to pronounce and unfamiliar because some scientific words originate from Greek and Latin languages (Steffanides, 1965). Scientific terms learners struggle to pronounce and write at grade 7 level are often long words, for example 'monocotyledonous' and 'dicotyledonous'. Queigly (2019) proposes that words should be broken down into prefix, root and suffix when teaching. Zoski, Nellenbach and Erikson (2018) termed this approach as *'morphological strategies of teaching science'.* This makes the word easy to pronounce and write.

3. Methodology

The current study followed a qualitative case-study research design. Creswell (2016) defines qualitative research as an enquiry that seeks to understand social or human phenomena. This design allowed the researcher to observe and interact with the different research participants to formulate an understanding of their relationship with scientific language and the impact it has on teaching and learning of grade 7 Natural Sciences. Four grade 7 Natural Sciences teachers from two different schools were purposefully selected as a sample. In South African schools, grade 7 is a first step in transitioning from an intermediate phase (grade 4-6) where Natural sciences is offered as Natural Sciences and Technology. This comes with a shift in the structure of the curriculum with the technology component removed and the new features of the subject entail parts of Biology (Life Sciences), Physics and Chemistry. This is a critical level in science education upon which foundational scientific principles and core strands are laid out.

Data was collected through non-participant classroom lesson observations, which were followed by semi-structured interviews with the teachers. Each teacher was observed whilst teaching two Natural Sciences lessons and the Reformed Teaching Observation Protocol (RTOP) (MacIsaac, D., Sawada, D, & Falconer, 2001) was use to observe the classroom interactions. The interviews and lessons observed were audio and video recorded respectively with permission from the participants. The qualitative data was subjected to constant comparative analysis (Merriam & Simpson, 2000).

4. Research findings

Through a careful analysis of the data amassed through classroom observations and the interviews that followed, this study was able to formulate three themes in response to the research questions. Theme 1 highlights the challenges teachers and learners face with regards to scientific language, theme 2 explores the different pedagogical strategies and tools teachers and learners use to combat the scientific language challenges.

4.1. Theme 1: Teachers and learners struggled with pronouncing, spelling and writing scientific terminology

The four teachers acknowledged the difficulty of writing, spelling and pronouncing scientific terminology despite having a good command of English, the language of instruction at their respective schools. The teachers had to go an extra-mile when preparing for lessons to identify scientific terminology which they anticipated could be challenging for themselves and the learners. Jizal, one of the teachers said, "During first term there are physiology terminologies which my learners and myself struggle to spell." Barry, another participant who teaches in an affluent private school also said:

Barry: With online teaching due to COVID-19 pandemic, you need your preparation to be on point because the parents are tuned in with their children, and you can't be pronouncing wrongly in front of the parents who are paying a lot of money for school fees.

The way in which one pronounces is embedded on the dialects, laws and structure of one's home language, which however has the ability to create confusions especially in multilingual classroom settings. An example is one of the lessons observed where a learner read from her workbook in response to a question asked by the teacher. The learner came across the word 'convection' and she incorrectly pronounced it as 'conviction', which has a completely different meaning. As such Nikelo, the teacher pointed out during interviews that because of the interjections from her classmates who laughed and corrected her, the learner's confidence was affected thereafter. The teachers indicated that failure to read or pronounce scientific terminologies correctly results in poor learner participation in class discussions or answering questions. In another observed lesson the researcher also noticed how learners avoided using scientific terms, instead they replaced them with a longer explanation of the scientific term or process or by simply giving an example instead. This was evident when the teacher, Busi asked the learners to explain the different types of heat transfers. Instead the terms radiation, convection and conduction, the following are the learners' responses where learners avoided stating the actual scientific terms:

Learner 1: It's like when water turns to steam *ma'am*.
Learner 2: When warm air rises over the ocean cool air replaces it.
Learner 2: Ma'am, or when you touch a hot pan on the stove and it burns your hand.

4.2. Theme 2: Teachers used different strategies and tools to facilitate conceptual understanding

During the interviews, the teachers in public schools expressed how they lacked support and resources to aid their teaching. However, they still used different strategies to facilitate conceptual understanding amongst their learners. The teachers started their lessons by asking learners to write down in their workbooks all the key scientific terms in the particular topic and their meanings. One of the teacher had this to say about the strategy:

Nileko: It opens ways to easily integrate the scientific terms later on in the lessons because by then learners know what they mean, or they can use it to refer back to their word bank to check the meaning of the words if they get confused whilst you are teaching. Writing down the words also helps teach them to learn how to spell these words.

The school where Nikelo was teaching did not have circuit boards and electric instruments to connect and demonstrate to the learners, instead he wrote notes and sketched the circuit diagram on the chalkboard while explaining the roles of the different components of an electric circuit and how current flows. This strategy enabled learners to visualize the different components and their roles in an electric circuit. When asked how that particular approach helped to eliminate or reduce scientific language barriers, he responded:

Nikelo: For this lesson we were supposed to use certain materials, like circuit boards so that learners could see, but those things don't exist here, so we end up using only theory just to illustrate, so that they can remember.

These limiting factors did not dissuade the teachers from creating a learning environment and pursuing conceptual understanding for their learners. In her classes, Busiswa continuously repeated the

scientific terms with the learners as she was writing them on the board. She would spell the term as she wrote it down and the learners would repeat after her while copying down. When she introduced a new concept or long scientific word she would either break it down or initially use a more common name for it and then continue to use the more scientific term gradually as they progressed with the lesson. She also broke down long scientific terms into syllables and sang it with the learners in class. This is what Busiswa said "It helps, not only the learners, but I also get to practise spelling and pronunciation, because some of these science words can be very difficult."

Barry and Jizal had plenty of support and materials at their respective schools to help learners understand scientific concepts better. They had a good Wi-Fi connection in their classes, speakers, projectors, laptops, and they also received PowerPoints with relevant info-graphics and revision worksheets from their curriculum department. The books Barry's learners used were compiled internally every term. They had a glossary with simplified definitions for scientific terms. In one of his lessons, Barry started by displaying a video of himself from the previous year explaining how circuits work and named the different components. After that the learners were given all the materials to connect their own circuit, the teacher deliberately gave them one faulty component per group so that it would not be easy for them. As learners were working in their small groups, they used the correct scientific names for the different apparatus and all of them were successful in figuring out what was wrong with their circuits and fixed it. Acknowledging the value of hands-on approach and using videos in class, Barry said:

Barry: It is not easy keeping these learners interested, but with videos, they learn better because when they see how an object or instrument looks like, they are able to remember its name. Same thing with connecting circuits, keeping them hands on helps them and encourages those who are shy to take part in class discussions a chance to interact physically with a circuit board.

The two teachers in public schools acknowledged the role of code switching in facilitating conceptual understanding in Natural Sciences lessons. However, Jizal, who teaches in a private school did not share a similar sentiment because most of her learners were English home language speakers. Barry, had a few learners that spoke isiZulu as their home language, even though he did not fully understand the language he allowed learners to discuss in isiZulu. The researcher observed how those learners communicated in a mixture of isiZulu and English when discussing work amongst themselves but fully transitioned to English when talking to the teacher or the rest of their classmates. In one incident where learners were working in groups to connect an electrical circuit, these were the notable exchanges that came from their discussions:

Learner 1: [isiZulu] Pho why ingakhanyisi? (Why is it not lighting up?)
Learner 2: [isiZulu] Enye intambo mele ithinte ku positive. (The other wire must be connected to the positive side.)
Learner 3: [isiZulu] Still ayikhanyisi *dog*, maybe le light lishile. (It still does not light up, maybe the light bulb is burnt out)
Learner 1: [isiZulu] Or maybe le battery lifile, let's ask sir for a new one. (Or maybe the batteries have ran out of power, let's ask sir for a new one)

When the teacher eventually came in to assist, learners immediately switched to conversing in English and asked for batteries and a new light bulb. Learners were comfortable discussing in their home language amongst themselves and that helped them to collaboratively find a solution to a scientific problem and facilitated conceptual understanding.

The teachers showed knowledge of the challenges language imposes on the teaching and learning of grade 7 Natural Sciences. They also displayed pedagogical expertise which made learning meaningful through the use of strategies that made scientific terminology and concepts accessible to their learners.

5. Discussion

The findings of this study showed that both teachers and learners face challenges with regards to writing, spelling, and pronouncing scientific terminologies. The teachers gave insight on how this affects the teaching and learning process in grade 7 Natural Sciences classrooms. The research findings revealed that learners struggle to understand scientific language even though they have good proficiency of English, the language of instruction. These findings confirms Msimanga et al.'s (2017) and Schleppegrell's (2004) assertions that science has a language of its own that is distinct, abstract, objective and information oriented. Therefore, good English language proficiency does not automatically lead to correctly writing and speaking scientifically hence Derewianka's (2014) suggestions that teachers need to scaffold learning as learners who are proficient in English language still experience problems in the science classrooms. Three out of the four teachers who participated in this study applied code switching

in their classes, and also recommended using the learners' home languages to facilitate conceptual understanding. The researchers found this strategy effective in closing the gap in scientific language challenges in grade 7 Natural Sciences. This is in line with the outcomes of the study done by Mavuru and Ramnarian (2020) in grade 9 Natural Sciences, which found that teachers' acknowledgement and drawing on learners' home languages are helpful in elevating linguistic challenges in learning Natural Sciences. The study by Msimanga and Lelliot (2014) also alludes to the use of learners' home languages in a class discussion as an effective strategy in facilitating constructive scientific conceptual development.

6. Conclusion

Important findings from the study showed that scientific language problems are experienced by both teachers and learners regardless of whether they are proficient in English or not which is the language of teaching and learning. It was evident from the findings that during planning teachers ought to anticipate and recognise language challenges learners are likely to experience. Important strategies were used to assist learners transcend across everyday language use to scientific terminologies in the science classrooms which prepared learners to communicate, spell and pronounce those terms and ultimately understanding the concepts. These strategies include: teachers helping learners prepare a glossary of scientific terminologies per chapter; engaging learners in hands-on activities in the classroom, which could be in the form of practical/ inquiry-based activities; use of multimedia; and code switching. Whilst these strategies have been identified previously, in the current study, the manner in which the teachers used each of the strategies made a difference as it was context dependent. These findings have implications for both pre-service and in-service teacher professional development providers to consider teacher input when planning and implementing any development as they have the practical experiences of such issues in the science classrooms.

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