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Investigating the classroom teaching practices of life sciences teachers in Gauteng

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ABSTRACT

In the analysis of the South African NSC diagnostic reports, the Department of Education prepared areas of learners' struggle have proved to repeat themselves from 2017 to 2020. The classroom practices of Life Sciences teachers, focusing on teacher knowledge, were observed in a sample of schools in the province of Gauteng, South Africa. The investigation aimed to investigate these practices of Life Sciences teachers and consequently diagnose teaching difficulties. Data was collected through interviews and observations in a multi-case study approach and analyzed using Mudau's (2016) Classroom Practice Diagnostic Framework. This study reveals that teachers' classroom practices contribute to the teaching difficulties they experience when considering teachers' knowledge of the Life Sciences content, the teaching context, and learner understanding.

Introduction

Life Sciences National Senior Certificate examinations in South Africa showed poor performance from 2017-2020. However, it was found that there were commonalities in examination problem areas over these four years, alongside a progressive decline in student performance.

Life Sciences is a subject that requires scientific inquiry skills to create scientific knowledge (DBE, 2011). Scientific investigations, a fundamental area of Life Sciences, mainly cover poorly understood things- a constant debate about what is genuine. Teachers are fundamental in the teaching and learning of science, and only with teachers' contributions will there be science education progress (Kola, 2013). A good Life Sciences teacher will include the debates and arguments surrounding specific topics, such as evolution. By employing specialized and qualified teachers in science education, we can ensure content accuracy, suitable instructional strategies, and more motivated learners (Ntuli, 2019).

In South Africa, many current teachers were trained in the former colleges of education, which indicates limits in content knowledge (Rollnick et al., 2008). When topics are taught, teachers should understand them much more profoundly than their students are meant to achieve (McDermott et al., 2000). Mudau (2013) found that even though teachers had been provided training on a science topic, they still needed help to teach. This indicates that content knowledge needs to be improved and that difficulties in teaching a topic could be better understood when observing classroom practices. In Science education, difficulties in achieving enhanced learning frequently occur (Mudau, Fhatuwani, & Thomas, 2013). The classroom practice diagnostic framework (CPDF) (Mudau, 2013) can be used to diagnose teaching practices and, consequently, diagnose teaching difficulties (Mudau, Fhatuwani, & Thomas, 2013).

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With the downward trend of achievement, it is imperative to identify the challenges in life sciences' teaching and, consequently, learning. In the analysis of the South African NSC diagnostic reports, areas of learners' struggle proved to repeat themselves from 2017 to 2020. Teachers face challenges in how to teach some aspects of the subject content (Ajani, 2019), which inadvertently affects learner performance. Poor subject knowledge cannot be the exclusive reason teachers face struggles in teaching (Mudau A., 2016); diagnosing all the prevalent challenges that teachers may face may provide a foundation for understanding the NSC results for Life Sciences.

With the patterned recurrence of the same concepts of struggle across four years for all Life Sciences students in South Africa, diagnosing the challenges leading up to this struggle is imperative to devise a way forward in Life Sciences Education.

This paper will outline the qualitative case study that took part in 4 schools in the Gauteng province of South Africa, aimed at identifying the content knowledge, context knowledge, and learner understanding to understand teaching difficulties better.

A discussion of relevant literature will follow the introduction, the methodology employed and a discussion of findings.

Literature Review

The literature reviewed will provide insight into what informs teaching practices and the reason behind the challenges in teaching Life Sciences.

The NSC examination results of 2017-2020

Annually, the Department of Basic Education in South Africa releases a diagnostic report, which provides an analyses of learner performance in the National Senior Certificate (NSC) examinations. These diagnostic reports can be used to identify strengths and weaknesses in the skills and knowledge of the candidates (DBE, National Senior Certificate Diagnostic report Part 1, 2017).

Table 1: Summary of student registered to write the Life Sciences NSC examinations, as well as the levels of achievements, for the years 2017-2020

	No. of students registered to write the Life Sciences NSC examinations	**Students that achieved 30% or higher**		**Students that achieved 40% or higher**	
		Number	**Percentage**	**Number**	**Percentage**
2017	318 474	236 809	74.4%	166 071	52.1%
2018	310 041	236 584	76,3%	160 208	51.7%
2019	301 037	217 729	72.3%	147 436	49%
2020	319 228	226 700	71%	153 028	47.9%

The curriculum of Life Sciences in South Africa

Curriculum and Policy Statement (CAPS) documents provide information regarding the subjects offered in South Africa. The CAPS document for Life Sciences provides detailed information on the subject.

Life Sciences is a Further Education and Training subject, offered from Grade 10 to Grade 12 and is part of the elective subjects. Students are required to register for a minimum of three subjects above the four compulsory subjects comprising Home Language, First Additional Language, Life Orientation and Mathematics/Mathematical Literacy. A student with Life Sciences as a subject will be taught the subject for a minimum of 4 hours per week. The Grade 10 and 11 curricula are designed to be completed in 32 weeks, and the grade 12 curriculum in 27 ½ weeks (DBE, 2011, p. 19).

Life Sciences is the scientific study of the molecular level of living organisms and the relationships between living organisms and how these living organisms interact with the environments they live in (DBE, 2011, p. 9).

Learners who study Life Sciences will develop knowledge of concepts, processes, systems, and biologically key theories. Furthermore, a Life Sciences student will be equipped with the ability to critically evaluate scientific processes and issues and be made aware of the contributions made by South African scientists in the field. Other developments include scientific literacy, appreciation of the diversity of South African biomes, understanding of the values of biotechnology for humankind and the extent of human impact on the environment (DBE, 2011, p. 9).

Life Sciences comprises many sub-disciplines such as Biochemistry, Botany, Zoology, and Environmental studies. Learners will therefore be exposed to various possibilities of specialization.

Teaching practices

Teaching effectively is at the center of meaningful learning (Anderson, 2004), and in order to do so, teachers must have effective methods of instruction (Roehrig & Luft, 2004). The most commonly used approach to teaching is the lecture method (Ayele et al., 2019) which relies heavily on teacher instruction and has very little learner involvement. There is a need for South African teaching practice programmes to adequately prepare education students for the 21st century (Jansen et al, 2015).

Teacher education and training

Through the lens of graduate education, interactive teaching and active learning have resulted in high levels of student achievement (Freeman , et al., 2014). Research has identified that the lack of faculty training is a major obstacle in teaching and pedagogy (Fiore et al., 2009) since it is not common for university professors to use interactive teaching approaches (Fairweather, 2008) and often the faculty members do not have the time, resources or skills needed for implementation of interactive teaching (Suchman, 2014). When the necessary efforts are made to improve science education, only a select few of the faculty members are involved (Owens, et al., 2018). In a study conducted in San Francisco, faculty members selected for participation in the active learning course reported incorporating interactive practices into their teaching practices (Owens, et al., 2018).

Content knowledge

Traditionally, for a person to *know* the content, the expectation was for them to have a degree in the subject, however, meaningful content knowledge is linked to the ability to make the uses of the content meaningful to learners (Loewenberg Ball et al., 2007). Content knowledge refers to the knowledge held by teachers about the subject matter (Ball et al., 2008). McDermott (2006) emphasises that a teacher requires an in-depth understanding of the content that they plan to teach.

In 1986, Shulman identified a special domain of knowledge for teachers and termed it *pedagogical content knowledge (PCK), which involves unifying knowledge of content and teaching* it (Shulman, 1986).

The integration of Pedagogical Content knowledge (PCK) and Content Knowledge (CK) is an indication of how knowledgeable teachers are about the content they are teaching and how to teach it, and the lack thereof contributes to teaching difficulties (Kleickmann, et al., 2012). Mudau and Nkopodi (2015) found that the less content knowledge a teacher has, the less confidence they have in teaching science which makes it a challenge to teach science.

Muwanga-Zake's work (1998) attributed the lack of content knowledge to poor teacher training in tertiary education. The DBE introduced professional training programmes for these struggling teachers (National Staff Development Council NSDC; 2007). These once-off topic-based programmes are ineffective in improving learner performance (Ono & Ferreira, 2010), especially since these programmes do not prepare teachers for the entire syllabus. They are often only aimed at senior teachers at each school and not all teachers.

A contributing factor to weak content knowledge is the insufficient training received by teachers at teacher training institutions, leading to teachers having limited knowledge of what they are expected to teach in-depth (Rollnick, Bennet, Dharsey, & Ndlovu, 2008). Although workshops are often offered to teachers in South Africa, they often occur once a year and are only offered to certain teachers (such as those teaching Grade 12).

There have been studies indicating poor teacher content knowledge in South Africa, such as the study by Stols, Olivier and Grayson in 2007 and Taylor and Moyana in 2005. In order for a teacher to represent content to their learners in an effective manner, sufficient content knowledge is critical. Having good pedagogical skills alone is not enough to mask poor content knowledge (Baumert, et al., 2010). Quality content knowledge is aquired through professional training at tertiary level and is not mere general knowledge (Howey & Grossman, 1989). The fusion of in-depth content knowledge and knowledge of strategies to make the content understandable, leads to pedagogical content knowledge (Shulman, 1986).

It is also expected for a teacher to be consistently reflective in their approach to teaching, hence, adapting their approach by making use of metaphors, analogies and activities that addresses the various cognitive levels of learners (Cochran et al., 1993).

The knowledge of using technology in teaching subject content to achieve learning goals has been termed Technological, Pedagogical and Content Knowledge (TPACK) (Donnelly et al., 2019) and is widely used.

According to a recent study, and supported by previous studies, the use of Technology in education assists with active learning, an enriched teaching approach and more permanent learning for students (Tafli, 2019). The teacher participants attributed the advantages of using technology to: saving time, providing fast access to updated information, and making the learning process easier, more fun and generally, more effective (Tafli, 2019). Furthermore, the findings of the aforementioned study revealed that half of the participants struggle when integrating technology in teaching and this could arise from poor undergraduate education regarding integration.

When attempting to understand how an individual learns, the *theory of connectivism* directly refers to construction of knowledge in the digital age (Siemens, 2008), an addition to the existing theories of Behaviourism, Cognitivism and Constructivism. However, connectivism does not disregard the lessons of constructivism, as the need to construct knowledge individually by each learner is imperative (Kerr, 2007).

In a study conducted in Greece, with 32 science teacher participants, it was revealed that 52% of the teachers had inadequate or weak use of technologies in their teaching practices with less than 19% of teachers making exceptional use of technology in their practice (Sofianidis & Kallery, 2021). University graduates within the teaching profession, do not have digital competencies nor the technical

experiences to develop their students' technological skills using ICT (information and communications technology) (Pérez-Navío et al., 2021).

Blackwell et al. (2014**),** Karaca et al. (2013) and Shiboko (2015) revealed that teachers with more years of teaching experience tend to have negative attitudes towards implementing technology in their classrooms, as opposed to teachers who have recently entered the profession. This is due to the likeliness that recently qualified teachers are better skilled with the use of technologies due to their teacher training taking place in an era of modern technology (Turugare et al., 2020).

Context knowledge

Context knowledge can be understood as the teacher's understanding he/she has of the classroom as they practice their teaching skills, including all the contextual factors that may influence the delivery of their lessons (Mudau A., 2016), such as the availability of resources, the curriculum they are expected to teach and the socio-economic climate in which the learners are living.

A study conducted in government-aided schools in India revealed that science teachers showed significant difficulties comprehending Biology concepts (Chavan, 2016). The findings revealed that the teachers at this school typically used a textbook as an instructional tool when teaching Biology (Kuechle, 1995), and that many of the teachers cited "insufficient content in the science textbook" as the reason for finding difficulty with some concepts.

In the same study, in addition to teachers having difficulty imparting content because of the lack of scientific knowledge, there was a lack of resources to accomplish the task (Chavan, 2016).

Considering the previous study, the reliance on textbooks as the only teaching tool used by teachers (Chavan, 2016) reveals a poor understanding of content. This leads to the need to question the depth of teacher training and perhaps the debate of whether universities are training competent professionals or merely producing mass quantities of graduates who lack confidence in their qualification (Edessa, 2017).

In South Africa, the CAPS document (DBE, 2011) indicates that every learner has the right to access learning materials such as textbooks, but this is not always a reality in third world countries. As previously mentioned, access to a textbook is not sufficient and in South Africa, this basic criterion is not even met and having no access to textbooks negatively affects student performance (van der Berg, 2008).

Learning by *inquiry* refers to a way of learning which enables learners to investigate the natural world, and through gathering evidence, justify scientific assertions (Hofstein et al., 2004). Laboratories create an environment in which a learner can *inquir*e i.e., to investigate phenomena and solve problems (Hodson, 1993). Laboratory activities allow learners to learn with understanding and, concurrently, construct their own knowledge (Tobin K. G., 1990). However, meaningful learning in the laboratory is the amalgamation of practical activities as well as sufficient time to interact with and reflect on these activities (Gunstone et al., 1990).

Based on a 2012 Mudulia study, the availability of textbooks, chemicals, and lab equipment directly correlates with high student performance, while among schools that perform poorly are those without or ill-equipped laboratories. (Mudulia, 2012). The *constructivist* approach could serve as a model for science educators attempting to understand the cognition of science (Lunetta, 1998). Cognition of science is the idea that learners construct their own knowledge through personal experiences. A laboratory would provide opportunities to learners in a science classroom to be involved with activities which allow for investigation, inquiry and, consequently, constructivism.

There is a worldwide shortage of resources in schools (Ngema, 2016). In 1986, a study conducted in Kenya, evidently attributed poor performance in science subjects mainly to poor teaching (Kizito, 1986). Kenya, another African country, struggles with poverty.

Many schools in South Africa, especially in the rural townships, lack even the most basic of resources such as textbooks to support learning (Garcia et al., 2019). It has been reported by Adeniran (2020) that in order to achieve effective teaching and learning of science, all necessary resources and facilities need to be accessible.

The lack of these resources, including the physical infrastructure that is conducive to learning, hinders both the interest and academic performance of learners (Adeniran, 2020).

Another contextual factor that often effects the teaching of science, is the time available to teach it. With the curriculum as packed as it is in South Africa, teaching is moving too slowly (Mbatha, 2016). It has been suggested that more time should be allocated in the school curriculum to teach science (Mtsi et al., 2016). Simple acts such as teachers and learners being on time for classes, having equipment ready to use and being well-prepared in general may assist in allowing optimal time for teaching.

Teacher understanding of learners

Understanding the language in which learners learn and think is essential to showing that you understand them. In South Africa, the population is very diverse. With the country having 11 official languages, the linguistic abilities of learners plays a huge role in their experience of learning. Many South African learners are taught through the medium of an additional language and the learners may not be proficient in the language in which they are taught (Kaiser, 2017) or expected to be examined on . Learners are usually only

taught in their mother tongue from Grades 1-3, and thereafter most teaching takes place in English or Afrikaans (Ferreira, 2011). This means that the learning of Life Sciences involves learning the subject matter and, for some learners, attempting to cope with the comprehension of language. The majority of South African teachers work in a classroom where English is the medium of instruction, but often not the first language of the learners or even the teachers (Selati et al., 2002).This means that there is a two-fold challenge faced by teachers of having to teach learner content while the learner is still learning the language (Ferreira, 2011).

The learning of science involves the challenge of learning the language of science (Wellington, & Osborne, 2001). It is crucial to pay attention to language for improved quality of science education, and therefore every lesson is a language lesson (Schaffer, 2007).

Language is a further problem when teachers themselves are not well-versed in the language of instruction, let alone using the language to convey scientific knowledge, which has its own vocabulary. The understanding of a learner includes the understanding of the existing knowledge that the learner has about the topic that is to be taught (Magnusson at al., 1999) as well as knowledge of the skills the learner is still to acquire. Learners often have misconceptions about content they are expected to know, and these misconceptions often relate to the fact that students have not experienced the phenomena in their real-world context. Studies have shown that misconceptions that occur in high school are often reproduced at university level (Coll et al., 2003). Effective science teaching involves being aware of student misconceptions and as a result, finding ways to reduce these misconceptions (Galvin et al, 2015).

In order to ensure a learner is interested in what is being taught, consideration of how the learner prefers to learn may prove fruitful. Fleming's VARK inventory describes that there are 4 learning styles: visual, aural, read/write and kinaesthetic learning (Marcy, 2001). There are many theories which include various understandings of learning styles: Honey and Munford's learning styles model (Honey et al, 1992) informed by the earlier Kolb's learning styles model (Kolb, 1971), and the aforementioned VARK model, to mention a few. The existence and recognition of various learning styles highlights the importance of including various stimuli in teaching to cater for learner needs (Dantas et al., 2020) and consequently, leads to higher levels of interest and motivation to learn.

Theoretical Background

The classroom practice diagnostic framework

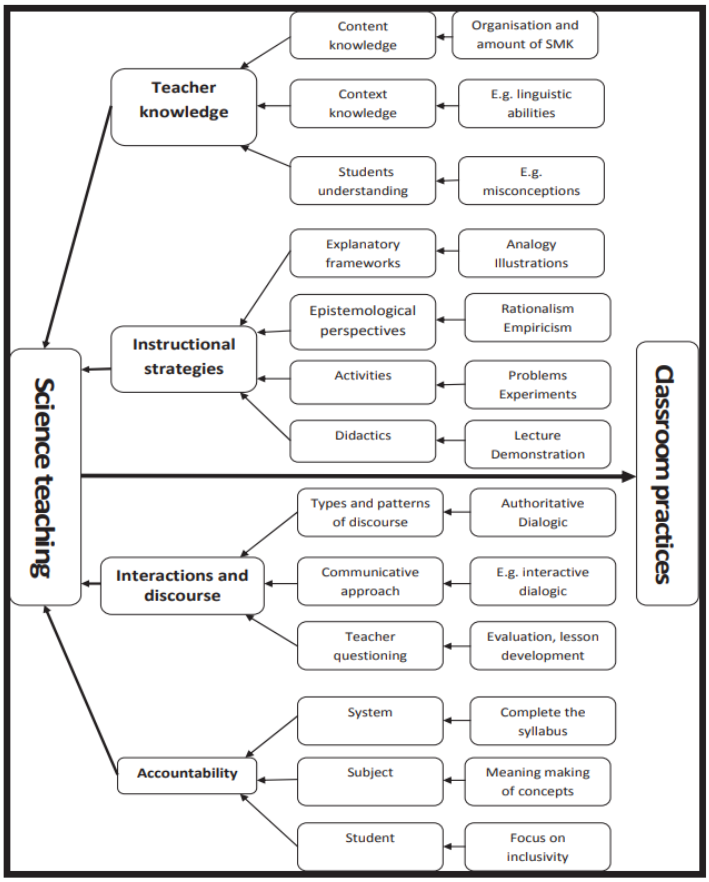

Figure 1: The Classroom Practice Diagnostic Framework (Mudau, 2013)

The classroom practice diagnostic framework (CPDF) developed by Mudau in 2013, is a framework that can be used to diagnose a teacher's classroom practice and furthermore reveal the reasons for their teaching difficulties. The classroom practices used by teachers influences the meaningful learning and level of achievement of learners (Mudau, 2016).

The CPDF combines the following criteria: Teacher Knowledge; Instructional Strategies; Interactions and Discourse and Accountability. This may ensure the diagnosis of a teacher's classroom practice to be more thorough.

Teacher understanding of learners

For the purpose of this study, the domain of Teacher Knowledge in the CPDF will be inform data collection and analysis.

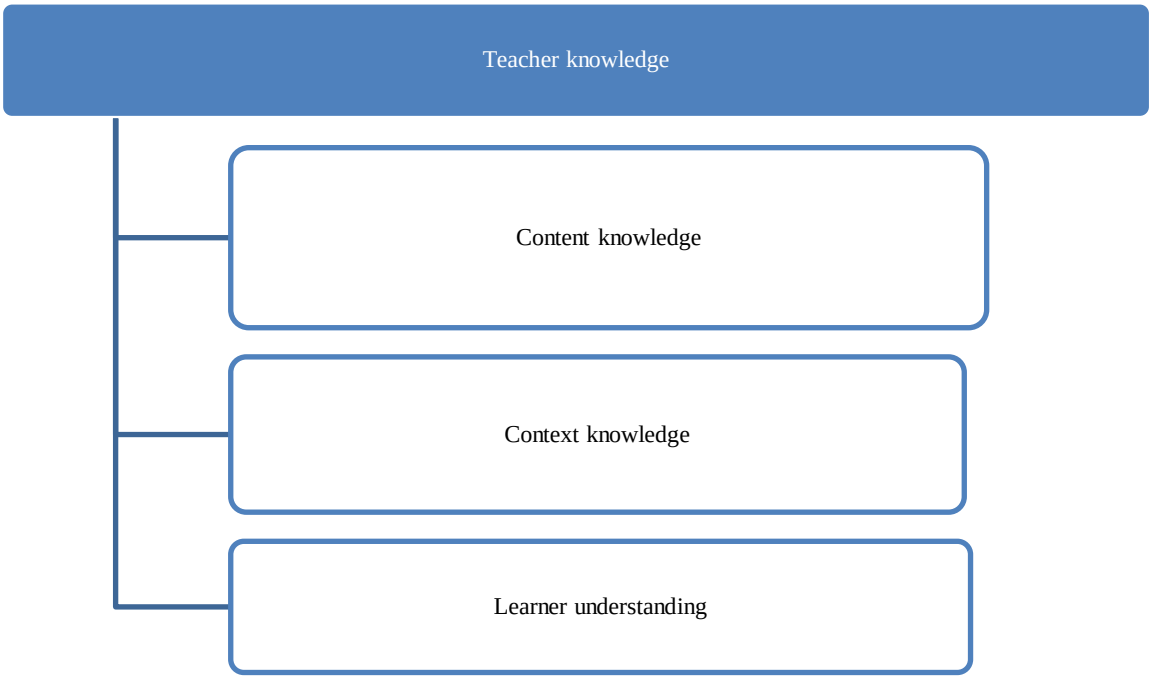

Figure 2: A schematic representation of the adapted theoretical framework

When attempting to understand the applications of the theoretical framework in answering the research question, the links between the various themes must be understood. When content knowledge is poor, a teacher may have difficulty teaching the topic (Mudau et al., 2015), rely more on textbooks (Chavan, 2016), or include fewer scientific investigations due to lack of confidence (Edessa, 2017).

Additionally, with the poor availability of resources in South Africa (Garcia et al., 2019), there will be limited variation in instructional strategies which leads to a decline in learner interest and motivation to learn (Adeniran, 2020).

Understanding the language in which a learner thinks and learns most efficiently is fundamental to achieving meaningful learning (Kaiser, 2017), and understanding the prior knowledge and misconceptions of learners, whether or not they are a result of linguistic differences, can assist teachers in minimizing the difficulties of teaching new material (Galvin, et al., 2015). The CPDF can be used to diagnose a teaching difficulty focusing on one aspect (Mudau A. V., 2016), or linking individual aspects which may describe most of the teaching practices of a teacher.

Research & Methodology

A qualitative approach was employed in this study, which produces work that is naturalistic in nature, which examines social settings and the behaviour of those in them (Berg, 2007), in this case existing in a Life Sciences classroom.

The research design was exploratory and descriptive in nature, as a descriptive study aims to answer "what" questions (Maree et al., 2007) such as "what are the classroom practices of the teachers?"

A detailed description of the classroom situation and interview responses are given in this study, which is both descriptive and interpretive in nature. This study has followed inductive reasoning, detecting patterns and then developing conclusions underpinned by an interpretivist paradigm. Assumptions made included the teacher being cognizant of CAPS requirements due to their experience in the teaching profession.

Data was collected in a multi-case study approach since the primary aim was to understand teachers' classroom practices. Yin (2003) states that a case study involves the investigation of a phenomenon within a real-life context. The level of interaction between

researcher and participant (the teacher) allowed for observation and understanding of these teachers within the context of their classroom (Cohen et al., 2013).

In this study, the population comprised 4 Life Sciences teachers from different Gauteng high schools whose students write the National Senior Certificate examinations. The choice of schools was random, as the researcher sent out email communication to various public schools in Gauteng, and the first 4 schools to respond were included. These four schools are in no way related.

The sampling technique was homogenous purposive sampling involving teacher participants who all shared the same characteristics. These teachers were currently teaching Life Sciences and have a professional and academic qualification

The data was sourced from the observations made by the researcher in the classroom as well as deduced from the responses to the semi-structured interview questions.

The study makes use of a multi-method data collection approach. Participant interviews were used to corroborate participant observations. This has allowed for triangulation of data collected.

In the structured observation, the researcher aimed to observe predetermined categories of behavior (Ebersohn, et al., 2016) such as the methods in which teachers use the basic scientific terminology when teaching or how they approached a lesson which requires scientific investigation.

At the point of observation, the criteria of field notes taken was informed by the themes of the theoretical framework: Teacher content knowledge, teacher context knowledge and teachers understanding of learners.

In all four cases, the classroom observations were video recorded, as the research was collected amid the COVID-19 pandemic, and the participants were given the option to have the researcher in their class or rather have a video recorder only. The use of a video also allowed the researcher the opportunity to replay and revisit the video multiple times to analyse the data. Even in the cases where the researcher was present, the video was still taken to ensure the same level of data analysis across all four cases.

The observations were made in an effort to draw conclusions from the concurrences and conflicts of the interviews and observations. The observations were also done first, in order to ensure authentic situations to avoid the participants being aware of the areas of interest and altering their teaching accordingly.

The interview schedule contained predetermined questions based on the criteria to investigate the classroom practices although further probing was indefinitely required. Further lines of inquiry emerged based on the answers given. Probing was therefore used for elaboration as well as for clarification to ensure the data collected was accurate and valid. These interviews were designed in a way that was reproducible (Ebersohn, et al., 2016) to ensure the research can be collected to gather similar information by someone other than the current researcher.

The interview schedule was informed by consulting Patton (2002) and outlined by the theoretical framework, separated into four sections:

i. Section A: Getting to know the teacher
ii. Section B: Content knowledge
iii. Section C: Context knowledge
iv. Section D: Learner understanding

The use of a semi-structured interview allowed the researcher the opportunity to modify questions, relying on the responses of the participants (Punch et al., 2014).

Apart from the reliability and validity of the questions, the validity of the researcher is also applicable. The research has been conducted by a qualified Life Science teacher with experience in both high school and university teaching and research.

Findings

Content knowledge

Case A: Ms Blue

Ms Blue has topic difficulties with Evolution, which was covered in her tertiary education. Evolution is an area of poor performance in the Life Sciences examinations in the years observed (2017-2020). This is an example of a link between teaching difficulties and poor learner performance. The teacher does, however, attend professional development workshops which mainly focuses on Grade 12 assessments which could potentially assist with overcoming the difficulty.

Her content knowledge is fair due to topic difficulties and the absence of an action plan to eradicate these difficulties. Ms Blue teaches Evolution as a theory that does not need to be believed, which insinuates that scientific theories are not completely valid.

When Ms Blue was asked an inquiry question, Ms Blue was not entirely sure of the answer, starting her answer with " I guess…". This type of response quickly ended the inquiry from the learner as it became apparent that the teacher did not know work above the scope of the curriculum nor did she offer to assist the learner in answering this question.

The lack of accommodation for inquiry and critical thinking limits the construction of new knowledge, as the learners then were limited to the information supplied in the textbook and the limited answers Ms Blue was able to provide to her learners.

If Ms Blue had greater content knowledge, the learners may have been more motivated and enthusiastic, feeling as if the teacher herself could serve as a learning resource rather than the few resources they had access to.

Case B: Ms Green

Ms Green had good teacher content knowledge and frequently attended professional development workshops. Despite not having any further academic qualifications beyond her bachelor's degree, she did major in Life Sciences as part of an education degree and was very knowledgeable about the content learners were expected to understand as well as often made reference to how the learners may be assessed on these topics.

A major concern is that Ms Green had never taught Grade 10 Life Sciences before and in Grade 10, many basic skills are taught and scientific investigation skills are well explored. If Ms Green had perhaps had the experience in Grade 10 teaching, she may have been able to correctly identify learner's prior knowledge and build on it as a result.

The teacher indicated that scientific investigation was a topic of difficulty for her to teach which is evidently an area of poor performance in the Life Sciences NSC examinations. Ms Green does not incorporate inquiry in her teaching approach to aid in the development of scientific investigation skills.

Case C: Ms Yellow

Ms Yellow has poor content knowledge due to Life Sciences not being the teacher's specialization and she does not attend any Life Sciences specific professional development courses. Ms Yellow also avoids the use of scientific investigations which is indicative of lack of confidence, possibly due to not being trained in this manner.

Ms Yellow was the most easily observable case of how poor content knowledge translates to teacher difficulties, as Ms Yellow displayed many instances of lacking confidence and also not knowing the answers to students' questions when they asked questions beyond the scope of the curriculum.

Not only does Ms Yellow lack the teacher education and training, but she does not seek out professional development to eradicate these challenges, and therefore reproduces her teaching techniques, resulting in limited learner-teacher interaction and low levels of motivation among her students. Ms Yellow is unqualified and underdeveloped in the area of Life Sciences content knowledge.

Case D: Ms Red

Ms Red's has good content knowledge, based on the observed lesson. She teaches beyond the curriculum and takes a holistic approach to her teaching. She makes it very clear to her learners how different topics are related to one another and how the content learned in previous grades informs new knowledge.

The most enjoyable part of her lesson, which enhanced learner participation, was her use of colloquial terms that invited humour and a sense of real-life application. When asked, Ms Red confirmed that inquiry is a very important element of her approach to teaching. In her lesson, her instruction was clear and inviting. The learner's voices were equally important, and she made every effort to answer their questions and guide their thoughts away from misconceptions.

In the interview, Ms Red referred to many exciting lessons she did with students, such as taking them out to the garden and showing the effect that soil pH has on the colour of flowers. This, for example, is above what is expected to be taught and understood.

Ms Red has 3 qualifications, all aiding her in her understanding of the content and how it should be taught. She had an informative answer to each and every question that was asked.

Ms Red mentioned that she does not teach Grade 12, but attends professional development opportunities that provide her with the necessary skills and knowledge to be able to not only teach Grade 12, but also to teach the lower grades in such a way to prepare them for the content yet to come. She encourages learners to ask questions and allows them to get involved in her lessons.

Ms Red was also the only teacher that did not rely on a textbook, and drew diagrams and explained concepts in such a way that she made it obvious to the learners and the researcher that she was confident and passionate about the content of Life Sciences.

In examining the data collected from the teachers, it is evident that the levels of content knowledge of the teachers vary. This could possibly be attributed to the differing years of experience of teaching Life Sciences. Ms Blue and Ms Yellow had fair and poor content knowledge respectively, which influenced the ways in which they taught the subject. The use of scientific investigations was limited and consequently the types of teaching techniques adopted, which resulted in limited interaction between the teachers and the learners and low levels of learner motivation.

Understanding of learners

Case A: Ms Blue

The study revealed that Ms Blue had a fair understanding of her learners through identifying prior knowledge and misconceptions by using a question and answering technique. Her questioning technique accommodated various cognitive levels and Ms Blue kept all her learners engaged in this process by calling on each individual learner to answer questions.

Ms Blue's teaching approach disregarded consideration for a learner that may prefer to learn kinaesthetically, as she catered mainly for visual and aural learners and provided notes to her learners which may serve adequately for a learner who prefers to learn through reading and writing. The lack of accommodation for the kinaesthetic learning style and cognitive abilities related to this style, resulted in limited inclusive education and may further contribute to learning difficulties

Ms Blue revealed having a general understanding of her learners' background, but brought no indigenous knowledge or real-life references into the class.

Case B: Ms Green

Ms Green's learner understanding was fair. She allowed for a limited engagement in her classroom, although her teaching caters for various learning styles and questioning accommodates various cognitive abilities. She does not stimulate learner critical thinking, and therefore limits learner enthusiasm in her classroom

The teacher made use of technology in her classroom and various visual aids, but there is no accommodation for learner inquiry or kinaesthetic learning in her class. Stimulating higher order thinking allows the learners to construct knowledge beyond recalling facts and repeating the content found in the textbook.

Ms Green quite evidently knew all her students names and intentionally involved all the learners in answering questions by calling them by name and directing their thinking. It was not observed that the learners were enthusiastic due to limited open discussion.

Case C: Ms Yellow

Ms Yellow has a fair understanding of her learners based on prior knowledge identification. The teacher incorporated most learning styles, however, does not cater for kinaesthetic learners. She has limited knowledge on what a cognitive ability and learning style is and many of her learners may not be proficient in the language of instruction.

With Ms Yellow having a poor conceptual understanding of what a learning style is, she neglects to cater for all learning styles and therefore does not successfully adapt her teaching to cater for all cognitive levels. Due to the exclusion of the kinaesthetic learning style, these learners may lack cognitive stimulation and consequently not learn the content effectively.

Ms Yellow's inability to answer all her learner's questions is not only indicative of poor content knowledge, but poor understanding of her learners needs for cognitive stimulation. There was also an observable difference between Ms Yellow's home language and the language of her learners which contributes to the difficulty in understanding her learners and difficulty ensuring positive communication patterns.

Case D: Ms Red

Ms Red had great learner understanding with a thorough diagnosis of prior knowledge, accommodation of learning styles and cognitive abilities.

Ms Red exhibits positive rapport with her learners. She made efforts to understand her learners, identify misconceptions and cater for all learning styles and cognitive abilities by adapting her teaching method. The sense of personal connection between the teacher and her learner's revealed positive relations where the students displayed elements of feeling understood and heard.

Her learners were very interested in the knowledge the teacher had to share that could not be found in their notes, and relied heavily on her answers. Ms Red also confirmed in the interview that she was very conscious of the various abilities of her students, and made reference of her ability to read their expressions and adapt her teachings according to student responses.

She is also aware of and incorporates various learning activities to ensure that all her learners are stimulated and encourages collaboration.

Ms Red confirms that there is a language barrier between her and many of her students, but to overcome this, she facilitates discussions among students, enabling them to support each other, and cover any gaps that may be created by the language barriers.

Three of the four teachers were observed to have only a fair understanding of their learners whereas Ms Red's understanding of her learners was good. This what not due to the absence of misconceptions, language barriers or differing cognitive abilities, but rather due to the planned accommodation for these aspects in Ms Red's teaching approaches to overcome the difficulties that were present. Ms Blue, Ms Green and Ms Yellow limited the discussions between teacher and student and did not adequately address

misconceptions and different styles of learning. In majority of these classrooms, kinaesthetic learners were not accommodated for, leading to them possibly feeling excluded and under stimulated.

Context knowledge

Case A: Ms Blue

Ms Blue had poor context knowledge due to poor resource use despite the availability of resources in her class.

It was observed that Ms Blue was significantly reliant on the textbook as a teaching and learning resource, while her classroom is equipped with technology and 3-D models relevant to the topic. This is indicative of poor content knowledge, time restriction and poor technological knowledge-all already observed as contributing factors of teaching difficulties.

Ms Blue also taught at a school which is well-resourced, however, she lacks a laboratory to conduct scientific investigations. Without proper exposure to scientific investigations, beyond reading about them in textbooks or watching videos, the topic becomes difficult for learners.

Academic performance in Life Sciences is declining in the school, and teacher struggles with time constraints as her timetable does not afford her enough time according to CAPS.

Case B: Ms Green

Ms Green has good teacher context knowledge with inclusion of various resources to aid teaching. Teacher has a well-resourced classroom with laboratory equipment and available technology.

Ms Green mentioned that the school management system made sure that all learners had access to online platforms at the beginning of the year, although circumstances throughout the year may change for individual learners. Additionally, despite the confirmation from Ms Green about all her learners having access to online learning platforms, there was no use of or even reference to any online platform during the lesson which means, perhaps online learning platforms were not used to their full capability.

The school academic trend was vaguely identified by Ms Green and indicated no trend.

Case C: Ms Yellow

Ms Yellow had fair context knowledge due to the lack of a laboratory and her lack of innovation to still teach the skills that a laboratory may lead to. She ensured the inclusion of technology in the classroom which is helpful to cater for quick and efficient learning.

She displayed a lack of knowledge of the learning trend in the school which is evidence that the teacher does not teach Grade 12. Ms Yellow seems very reliant on the security that her classroom offers, not encouraging or incorporating thinking or activities that may take place outside of the classroom.

Case D: Ms Red

Ms Red had good context knowledge with varied use of resources and knowledge of school performance. This became evident when she answered the interview questions by clearly outlining prior years' performances. The trend of performance in Life Sciences is increasing in the school which is evidence of good teaching practice.

The teachers classroom has extensive resources to aid her teaching, however, lacks laboratory equipment. Ms Red mentions that there is an available laboratory which she uses often, however, she is resilient enough to overcome the challenges of not having access to these resources.

For example, during the COVID-19 pandemic, she carried out practical's under a visualizer for her students to observe, and did not allow the situation to hinder her teaching approaches.

Additionally, she does not limit her teaching to the confines of her classroom, has she takes the learners outside for learner experiences. Ms Red portrays the determination and willingness to make good use of her resources and overcome any barriers caused by the context that she teaches in.

The teachers with good context knowledge (Ms Red and Ms Green) made good use of the resources available in their classroom. Both of these teachers had availability of laboratory equipment and prioritized scientific investigations. Similarly, these two teachers also had good content knowledge and amalgamated the content and context knowledge to teach lessons that involved improvisation, use of everyday objects to teach which engaged learners. The teachers with poor context knowledge (Ms Blue and Ms Yellow) had access to various resources that could have been improvised, however, they both lacked the ability or creativity to use these resources to enhance learning to its best. Rather than improvising, these teachers indicated that their context attributed to struggles in teaching certain topics, indicating that poor context knowledge leads to teaching difficulties.

Conclusion

Poor teacher content knowledge, context knowledge, and learner understanding significantly contribute to difficulties in teaching. The teachers with poor content knowledge had fewer years of experience teaching Life Sciences, did not attend professional development training and relied heavily on textbooks or notes as references. The lack of incorporation of scientific investigations is also the trend among these teachers with poorly motivated learners. Poor learner understanding prevents a teacher from identifying misconceptions and teaching beyond learning barriers, limiting their teaching methods and being unable to cater to various cognitive abilities. Instead, barriers to learning contributed to teaching difficulties due to a lack of knowledge or motivation to overcome them. Coupled with poor context knowledge, teachers must incorporate resources meaningfully to encourage active participation. They instead allow the lack of resources or skills to use these resources to become an excuse. The teaching difficulties are therefore attributed to the poor levels of knowledge in these three areas.

Good content knowledge is characterized by teachers who frequently attend professional development and can adapt their teaching styles without restriction—possessing a good understanding of learners results in more open discussions between teachers and learners where learners become motivated to learn, and their various learning styles are catered for. The presence of learning barriers created more opportunities to learn in different ways. Having sound knowledge of the context of teaching also empowers teachers to make use of resources in such a way as to make teaching more interesting and improve the levels of interest of the learners. A teacher with good knowledge in the three areas had little difficulties in teaching and desired to overcome and improve on these difficulties.

Limitations of the study

To understand this study's limitations, contextualizing it is essential. This study was limited to only four schools in Gauteng, with hundreds of schools. Therefore, it is not easy to generalize the findings as the sample represented a tiny part of the province. The schools were also all state schools, disregarding the contrasts that may occur in a private school due to the availability of resources and class sizes.

The data was also collected amid the COVID-19 pandemic, and access to schools and classrooms was restricted. For that reason, many schools declined participation in this study, and observations were done using recorded lessons in 3 of the 4 cases. In addition, class sizes and time allocations were also different due to the pandemic and social distancing. The movement of learners and touching of learning resources that were to be shared could have been much higher.

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