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Analysis of teaching and learning of natural sciences and technology in selected Eastern Cape province primary schools, South Africa

Bongani Bantwini

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Abstract

Great consensus exists that high-quality natural science teaching and learning at primary school level is fundamental for learner success and advancement in life. This paper discusses how natural science is taught and learnt in selected primary schools in the Eastern Cape Province, South Africa. Data was collected through 22 classroom observations during a science lesson and 55 responses to a questionnaire. Findings reveal that: teaching in most classrooms used non-stimulating pedagogical approaches that lacked practical activities that promote deeper learning of science content and develop learner's inquiry abilities; the classroom environment was impoverished for science teaching and learning. I argue and conclude that science teaching and learning in these schools requires attention as it hardly aligns with the Curriculum Assessment Policy Statement requirements in South Africa. Moreover, there is a need for stimulating classroom approaches that attract and inspire young learners to pursue science learning at high school and tertiary level.

Introduction

There is great consensus that high-quality science[1] education teaching and learning at primary school level is fundamental for learner success and advancement in life (Halverson, 2007; National Research Council, 2012). The early science learning can help learners develop curiosity, appreciation and understanding of the natural world, which are fundamental for learning progression (Eshach & Fried, 2005; Halverson, 2007; Trundle, 2009). According to the International Council for Science (2011), stimulating of

[1] In this paper science education and natural science are used interchangeably.

science education is fundamental for both the future of science and the ongoing development of our global knowledge society. However, despite the above consensus, James and Pollard (2006) posit that teaching and learning are what ultimately make a difference in the mind of the learner and thus affect knowledge, skills, attitudes and the capacity of young people to contribute to contemporary societies. Teaching becomes the centre stage of science learning and learner achievement. In developed countries, the issues and complexity of teaching and learning of science education has received considerable attention due to the envisaged returns (Glenn, 2000; Goodrum, Hackling & Rennie, 2001; Osborne & Dillon, 2008; Teaching and Learning Research Programme, 2006). In the US for example, the National Commission on Mathematics and Science Teaching for the 21st Century headed by John Glenn (2000) argued that the future well-being of their nation and people depends not just on how well they educate their children generally, but on how well they educate them in mathematics and science specifically. Also underscoring the significance of teaching and learning of science education, Diamond (Teaching and Learning Research Programme [TLRP] 2006) in the United Kingdom report on science education in schools asserted that the ability to generate new knowledge and use it innovatively depends upon having a scientifically literate population and therefore good science education in schools is a vital preparation for scientific literacy in later life. Undoubtedly, effective science teaching assist in developing learner motivation and self-confidence necessary and crucial to increase their academic performance (Chalufour, 2010).

Despite the various countries' attention to science education, in South Africa such attention has not been much, especially in the natural sciences and technology at the Intermediate phase level (Grades 4–6). Research on the teaching and learning of natural sciences and technology is still fledgling (Set, Hadman & Ashipala, 2017), leaving us with knowledge gaps regarding the various issues that may be impeding or enhancing successful results in the learning area at that particular level. Nevertheless, snippets of research do indicate that: natural science teaching hardly support the conceptual development of primary school learners (Set, Hadman & Ashipala, 2017); there is lack of requisite infrastructure which renders teaching and learning in rural schools nearly impossible (Mtsi, Maphosa & Moyo, 2016); some educators lack proper foundation in natural sciences teaching methods and content knowledge (Mtsi, Maphosa & Moyo, 2016; Mpanza, 2013; Ngubane, 2014); and there is neglect and insufficient support of primary school natural sciences and technology teachers by their school districts (Bantwini, 2012;

Ngubane, 2014). The less attention on natural sciences and technology is also visible from the omission of the learning area in the Annual National Assessment, a key instrument currently used to measure learner performance at General Education and Training Band (primary school level). This is despite the concerning results from the Trends in International Mathematics and Science Study (1995, 1999, 2002, & 2011), the only standardised international test that includes natural sciences and technology in which South Africa participates.

In this paper I intend to add to the existing scholarly knowledge on teaching and learning by focusing on the intermediate phase (Grade 46) natural sciences (NS) in selected public primary schools in the Eastern Cape. The following questions guided the inquiry: (1) how is natural science taught in some public primary schools? (2) what are teachers' perception regarding how learners learn natural science in their classrooms? Hoadley (2012) asserts that gaining deeper and more robust understandings of instructional practice is critical to understanding why and in what ways schooling in South African primary schools continues to fail the vast majority of learners. This is also aligned with the Minister of Basic Education's (2010) concern that the levels and quality of educational outcomes achieved by learners are far below the national targets. Moreover, the National Development Plan Vision 2030 views foundational skills in science as an essential component of a good education system (The Presidency, 2011). A sound foundation in science education can arguably increase learner interest and continuity in studying science, thereby increase the pool of learners who can pursue science at tertiary level, which may ultimately reduce the country's skills shortage. Thus, by improving teaching and learning (natural science in this case), as the Department of Basic Education [DBE] (2011) asserts, learners will benefit from a higher quality of education and the nation as a whole will also benefit as school graduates with better skills and knowledge levels enter further and higher education and the workplace. However, as DBE (2011) argues, without substantial improvements in the learning outcomes, the future development of the country will be seriously compromised. In this paper attention is drawn to some of the teaching and learning issues that potentially contribute to learner understanding of and achievement in natural sciences and technology.

Teaching and learning of natural science

This paper is premised on the Curriculum and Assessment Policy Statement (CAPS) Grades 4–6 Natural Sciences and Technology (DBE, 2011) aims that, effective teaching and learning of natural sciences and technology should develop learner's ability to: (1) complete investigations, analyse problems and use practical processes and skills in designing and evaluating solutions; (2) grasp scientific, technological and environmental knowledge and apply it in new contexts; (3) understand the practical uses of natural sciences and technology in society and the environment and have values that make them caring and creative citizens. The paper further draws on James and Pollard's (2006) principles of teaching and learning (in general), which advocate that teaching and learning should: equip learners for life in its broadest sense; engage with valued forms of knowledge; recognise the importance of prior experience and learning; require the teacher to scaffold learning and ensure that needs assessment is congruent with learning and promote the active engagement of the learner. Additionally, the paper subscribes with the notion that effective science teachers should also know and understand how learners learn science as well as the theories related to effective learning, how the content is represented, the scope and sequence of the subject matter as well as the level and appropriateness of the language of instruction (Luneta, 2012).

The significance of teaching and learning of natural sciences and technology is crucial and forms a critical part of the discussion for several reasons. Naude (2015) argues that when children in the South African schools enter the intermediate phase, they engage with a demanding science curriculum, which requires a higher level of depth and detail different from the foundation phase curriculum. As a result of this gap between the phases, children are largely left to the development of their spontaneous development, based on some *ad hoc* instruction. Complicating the matter, Magano (2009) highlights that some teachers have an attitude towards the teaching of certain knowledge areas, which has a negative impact on the teaching of natural sciences as these concepts are also critical in establishing learner's basic scientific skills. From the international perspective, Fraser-Abder (2011) argues that existing evidence indicate that only a small amount of the students[2] who go through the school system develop any useful scientific literacy. She further contends

[2] The term 'student' is used interchangeably with learners, as the international literature mainly uses 'student' while in South Africa we use 'learners'.

that schools keep on producing graduates who lack even a basic understanding of science and technology, with negative attitude towards science and with no fully developed critical thinking skills capability. Thus, effective teaching and learning of natural sciences and technology becomes vital to develop a stronger foundation required in the next levels.

The goal of science education, Osborne and Dillon (2008) argue, is to develop students' understanding both of the canon of scientific knowledge and of how science functions. Thus, effective and quality science teaching can help to develop the necessary inquiry abilities and a sound learning foundation for science concepts, leading to the desired learner performance and outcomes. Chalufour (2010) asserts that cognitive stimulation in the early years is critical for brain development and that young children have cognitive capacities far beyond what was previously believed. Learning, according to James and Pollard (2006) should aim to help individuals and groups to develop the intellectual, personal and social resources that will enable them to participate as active citizens, contribute to economic development and flourish as individuals in a diverse and changing society. The National Center on Time and Learning (2011) argues that science education should build on children's innate curiosity, expanding their scientific knowledge and engagement over time as they examine objects, design and analyse investigations, collect data and discuss and defend their ideas. Chalufour (2010) believes that effective science teaching needs to embrace knowledge and science processes and practices, as well as provide multiple opportunities for students to use these processes and apply them across many experiences. However, she argues that many early childhood teachers are unprepared to promote science inquiry and learning in their classrooms due to the way science was presented to them as students, a static collection of facts to be transmitted by their teachers and memorised by students. The American Association for the Advancement of Science (AAAS, 1990) state that science teaching that attempts solely to impart to students the accumulated knowledge of a field leads to very little understanding and certainly not to the development of intellectual independence and facility. With the critical and scarce skills shortage in SA, quality natural sciences and technology teaching and learning at primary school level can be a good investment.

Research design and methodology

The reported study used a mixed methods approach with the aim of obtaining breadth and depth of understanding and corroboration of findings while offsetting the weaknesses inherent in using either a quantitative or qualitative method alone. In Hoadley's (2012) view, mixed methods are increasingly regarded as crucial in obtaining valid and reliable understandings of classroom knowledge and processes of its transmission. A mixed method design allows for triangulation, which requires careful analysis of the type of information provided by each method, including its strengths and weaknesses. The participants for both the quantitative and the qualitative stages were natural sciences teachers in the Intermediate Phase (Grades 4–6) from public rural, township, urban and farm schools spread across eight school districts in the Eastern Cape Province, a large and predominantly rural province in South Africa. Permission to conduct the study was requested and granted by the Provincial Department of Education Superintendent, as per their research policy requirement. Data was collected using classroom observation during the teaching of a science lesson and a questionnaire.

Classroom observations

According to Cohen, Manion and Morrison (2011), observation as a research process affords the researcher an opportunity to collect live data from natural occurring social situation. An observation tool informed by literature review and questions from other previously used observation instruments was used (*see appendix 1*). The tool comprised the following foci: classroom management; instructional learning; teacher pedagogical content knowledge and planning; and general comments. The classroom management section focused on classroom description, seating arrangements (gender, language, race and special needs), learner interaction and access to materials and strengths and weaknesses of the classroom environment. Instructional learning was divided into three sections: lesson delivery, conceptual focus of the lesson and assessment during the lesson. For each of these sections several observational guiding questions were posed. The last section on teacher pedagogical content knowledge and planning also comprised many guiding questions. These areas of focus were developed based on key attributes for successful science teaching.

A purposive sampling technique focusing on natural sciences and technology teachers in Grades 4–6 and willingness to be observed teaching was applied. Twenty two primary school science teachers, 20 females and two males, were observed teaching a science lesson. Table 1 below summarises the characteristics of the observed classrooms. Of the 22 classroom observations, six 4th grade classes were observed, seven 5th grade and nine 6th grade classrooms. In 4th grade the number of learners varied from 27 to 57 in one classroom, in 5th grade from 26 to 99 learners in a classroom and 6th grade from 4 learners to 82 learners in one classroom. The coding and analysis of the classroom observation data followed the iterative process as suggested by Miles and Huberman (1984). The observation forms were reviewed to determine common trends and emerging issues. This led to the identification of common themes and issues presented and discussed in the findings section.

Table 1: Characteristics of 22 observed classrooms

				School Types			
Grade	**# of observed teachers**	**Male**	**Female**	**Rural**	**Township**	**Farm**	**Urban**
4	6	0	6 (100%)	2 (33%)	1 (17%)	1 (17%)	2 (33%)
5	7	1 (14%)	6 (86%)	1 (14%)	4 (57%)	1 (14%)	1 (14%)
6	9	1 (11%)	8 (89%)	5 (56%)	1 (11%)	1 (11%)	2 (22%)
Total	**22**	**2**	**20**	**8**	**6**	**3**	**4**

Questionnaire

A questionnaire comprising Likert scale and open-ended questions was used to elicit teachers' opinions regarding: teaching of science in their respective grades; how learners learn science in their classrooms; and their general beliefs and philosophy about science teaching (*see appendix 2*). One hundred and eight natural sciences and technology teachers were asked to complete a questionnaire. The use of a questionnaire also intended to afford teachers who were not observed teaching an opportunity to participate in the study. Of the 108 questionnaires distributed, 55 (51%) responded. The completed questionnaires were imported into the Statistical Package for the Social Sciences (SPSS) for frequency distribution analysis.

The respondents were from 32 schools spread across eight districts (4 from each district), purposively sampled. The sampling focused on science teachers in Grades 4–6, ensured that each grade level was represented, and that each teacher was willing to participate in the research. They were from rural (54%), township (29%), and urban public (15%) and farm schools (2%) spread out across the districts. The 55 teachers who completed the questionnaire were 26% males and 74% females. They were all South Africans and the racial distribution was as follows: blacks (89%), whites (6%) and coloureds (6%). About 17% of the participants' age range between 25–34yrs, 47% were between 35–44yrs, 24% were between 45–54yrs, 13% were between 55–59 and above. The majority of the respondents had taught for more than 10 years. Also, all the teachers taught more than two learning areas at different grade levels.

Findings

A brief description of the infrastructure of classrooms is presented, followed by findings from the questionnaire. Thereafter, the themes emerging from the classroom observation are presented and finally, a discussion of the qualitative and the quantitative findings.

Brief description of the observed classrooms (n=22)

Findings from classroom observations show that the lack of proper school buildings, classroom environments conducive to learning, teaching and learning resources, and proper sanitation facilities were common in many of the visited schools. In rural schools (65%) the infrastructure was dilapidated, whereas most township and urban schools had recognisable physical infrastructure. Over 50% of the classrooms were overcrowded with learners seated on a very few old desks and broken chairs arranged one behind another while in some classrooms learners were seated in groups. There was a clear lack of space for both learners and the teacher to freely move around. In 83% of the classrooms teachers stood in front of the classroom with limited movement and learners walked on top of the desks to reach the other end of the classroom. Nevertheless, a few of the observed classrooms (17%) did have enough space for both the teacher and learners to move around. These classes were usually located in a big hall or church building where there was a multi-grade classroom teaching. The cement floor in some classrooms had cracks and dust, not healthy for breathing, whereas others had old dirty wooden floors or mud floors. Despite these conditions, tidiness was noted as one of the positive things in the observed classrooms.

The classrooms were also characterised by walls bare of posters or illustrations. Eby, Herrell and Jordan (2009) assert that drab, undecorated spaces lead to expectations of dullness and boredom. These authors argue the necessity for creating a therapeutic environment that will allow all the students to succeed. The physical environment hardly supported science learning; a conclusion based on the lack of space for learners to move around and resources to engage in the inquiry-based science activities. In some classroom (though not many) learners were seated in groups of seven. However, the arrangement of groups raises questions regarding their formulation, as some learners had their backs towards the blackboard, the main teaching aid.

The teaching and learning environment, especially of science, plays a fundamental role in the learners' success. The Organisation for Economic Cooperation and Development (OECD, 2009) highlights that the quality of the learning environment is the factor affecting student learning and outcomes that is most readily modified. The findings reported in this study indicate that the observed classroom environment did not support effective teaching and learning. This is despite the research that indicates that young learners develop science understanding best when given multiple opportunities to engage in science exploration and experiences through inquiry (Bosse, Jacobs, & Anderson, 2009; Gelman, Brenneman, Macdonald & Roman, 2010). The physical structure of a classroom is a critical variable that affects student morale and learning (Phillips, 2014) and therefore should be inviting to make students enthusiastic about learning. A science classroom should inspire learners and not depress them and make the subject seem difficult, especially learners from disadvantaged backgrounds. According to Marcinek (2011), the physical space and environment, the lighting, the colour of the walls and the arrangement of tables and chairs affect our overall mood, our ability to learn and productivity. Teachers should therefore ensure that the classroom environment is conducive for learners to progress well.

Classroom teaching and assessment approaches

In the questionnaire, teachers were asked about their classroom teaching and assessment approaches. Their response rate to the questions is shown in Table 2 below.

Table 2: Teachers' responses to questions on the questionnaire (n= 55 responses)

Statement	Never	Sometimes	Mostly	Always
Begin a session by determining prior knowledge on the topic and their expectations for the training session	10%	8%	45%	37%
Do you set appropriately challenging expectation for learners		17%	51%	32%
Learners listen to lecture style presentations	28%	30%	32%	11%
Use teaching strategies that promote learner enquiry		10%	54%	37%
Choose different teaching strategies for different instructional purposes		20%	33%	46%
Maintain an orderly, purposeful learning environment for science learning	4%	17%	35%	44%
Use variety of assessment methods		4%	28%	69%

Evident from the data is that the majority of teachers (82%) begin a session by determining prior knowledge on the topic; set appropriately challenging expectation for learners (83%); use teaching strategies that promote learner enquiry (91%); employ different instructional approaches and maintain conducive learning environment for science learning (79%); and employ a variety of assessment methods (97%).

Teachers were also asked to reflect their beliefs in regard to their teaching philosophy, their responses are shown below:

Table 3: Teaching and learning of natural science

Statement	Frequencies	Percentage
When teaching I usually • Deal with facts and real life situations • Deal with ideas and theories	467	8713
It is more imortant to me to • Lay out the material in clear sequential steps • Give an overall picture and relate the material to other	3021	5941

Though 87% of the teachers indicated that they deal with facts and real life situations as shown above, findings from the 22 observed classrooms show that 88% of the teachers facilitated connections between prior knowledge and new learning while 12% did not. In several classrooms teachers began their lesson by asking a few questions related to the previous lesson. In some classrooms teachers introduced the new lesson by writing the topic on the board and then asked questions about it. The paraphrased interchange below illustrates this point.

Teacher: *Today we are going to talk about electricity. Does anyone of you know what electricity is?*

Learner: *Electricity is what we use at homes to light or cook*

Teacher: *Yes, electricity is what we use at home.*

Teacher: *Yes, what else can you say about electricity?*

During classroom observations about 59% of the teachers did not express their expectations of the learners and the learning goals. While, the other 41% of teachers only communicated the learning goals, with some teachers even writing the goals on the chalkboard.

In all the classrooms teachers used a lecture style, telling method and textbook reading approach. The teaching mainly focused on the imparting of science facts that were not integrated in the learners' real world. For example, in one classroom the topic was about plants. However, instead of taking the learners outside to observe and explore the surrounding vegetation, learners were kept in the classroom to observe two dead plants. The entire lesson was based on transmission of facts with the assumption that learners knew about plants from their community. Based on observations, in 45% of the classrooms there were opportunities to make learning meaningful by making deeper connections that will facilitate knowledge construction. For example, the teacher could have drawn examples from the learners context to clarify the topic under discussion. However, in 55% of the observed classrooms teachers did not provide opportunities to make learning meaningful. Additional to the employment of the above instructional approaches was that very little visual material was used to provide clarity or emphasise the point under discussion. Ironically, in almost all the classrooms, opportunities were available to employ materials that could easily be found around the community.

Based on the classroom observations 80% of the teachers did not provide challenging learning tasks to the learners. This means that the activities did not require learners to make any analysis, prediction, synthesis or drawing of conclusions. The remaining 20% of teachers only required learners to analyse and draw conclusions on the assigned learning activities. Also of interest from the data was that the questionnaire finding indicating that most teachers use teaching strategies that promote learner inquiry did not resonate with the classroom observations as the inquiry learning process was not used in the classrooms. Furthermore, in about 68% of the classrooms the differentiated instruction and assignments were lacking and the content and resources seemed not matched to the expected learner's level. Additionally, during lesson instruction 75% of the teachers hardly gave clear instructions or modelling before students began an assigned activity.

In about 94% of the classrooms learner engagement during instruction was through question and answer method intended to check their level of understanding. The observation data analysis shows that in 67% of the classrooms teachers did not pose a range of questions/tasks that required different levels of learner response. However, most teachers appeared to be impatient when learners were silent or gave responses that were considered incorrect. In most classes (72%) learners were not encouraged to explain what and why they were learning and to reflect on their thoughts, processing and strategies. Rather, the learners who gave incorrect responses were not challenged or probed as to how they reached their conclusions. Commonly, teachers would tell the learner, "*Let's hear from other people*" or "*What do others think*?". Control was seldom delegated to the learners to self-initiate and reflect on their learning.

Encouraging from the observed classrooms was that 95% of the teachers did not struggle with natural science content knowledge. However, the remaining 5% of teachers demonstrated some science misconceptions, lack of clarity and incomplete teaching of the topic or concept. For example, in a lesson on electricity a teacher referred to a dry cell as a battery. The learners were not taught the components of a dry cell nor did the teacher explain the difference between a dry cell, wet cell and battery. Further, the teacher did not bring the dry cell to class so that learners could explore it. Throughout the lesson the teacher read from the textbook. Based on observation, it was in only a third of the classrooms where the teaching approach/method matched the lesson topic.

Common in most of the observed classrooms was that at the end of the lesson teachers would give learners some questions (three at most) or a problem to work on in groups. These groups were usually gender mixed. Evident during the group work was that not much attention was given by the teacher to ensure that all learners benefitted from the group work. In 67% of the classrooms the teachers dominated the instruction and in only 33% there was equal involvement of teacher and learners. In 55% of classrooms, the teacher did not appear to have rapport with the learners. The relationship was professional but not warm and a power relationship was visible between the teachers and learners. Research indicates that the best teachers are able to inspire a love of learning in their students, to build a positive relationship with their students, to get to know them and to show interest in their overall development and progress (O'Neill, 2007).

Table 4: Summary data from classroom observation instrument

STATEMENT	YES	%	NO	%
Learning tasks that are challenging to learners, requiring them to analyse, predict, synthesise and draw conclusion.	N=20 4	20%	16	80%
Opportunities to make learning meaningful or available.	N=20 9	45%	11	55%
Evidence is differentiated instruction and assignment is apparent. Content and resources are matched to learner level.	N=19 6	32%	13	68%
Providing clear instructions and modeling before learners begin an activity.	N=16 4	25%	12	75%
Posing range of questions/task during instruction that require different levels of learner response	N=18 6	33%	12	67%
Learners are encouraged to explain what they are learning and why, and to think about their thoughts, processing, and strategies.	N=18 5	28%	13	72%
Assessment criteria are clear, explicit, and aligned to task and curriculum.	N=15 10	67%	5	33%
Control is delegated to the learners to self-initiate and reflect on their learning.	N=18 6	33%	12	67%
Is there any evidence during the lesson observed that the teacher struggles with Natural science content knowledge?	N=19 1	5%	18	95%
Is the teaching approach/method used appropriate for teaching the topic of the lesson? Does it allow effective transmission of knowledge?	N=18 6	33%	12	67%

Teachers' perceptions regarding how learners learn natural science in the observed classrooms

In the questionnaire, teachers were also asked about how learners learn natural sciences and technology in their classrooms. The used questions and responses are represented in the table below:

Table 5: Summary data on how learners learn natural science in the questionnaire

Statement	Never	Sometimes	Mostly	Always
Encourage learners to share their science ideas with the class		6%	44%	50%
Learners solve science problems on their own	6%	38%	38%	19%
Learners show active participation during the lesson	2%	13%	35%	50%
You ask learners to explain reasoning behind an idea		15%	59%	26%
Learners work on science investigation		22%	42%	36%
Use group work as a teaching approach		24%	34%	42%
You link the importance of science to career choices	2%	13%	38%	47%

From the above table, the questionnaire results show that 94% of the teachers claim to encourage learners to share their science ideas with the class, a finding that did not resonate with classroom observations. In almost all the observed classrooms learners learnt through verbal instruction, with hardly any visual and practical activities. Learners were only given time to discuss questions developed by the teacher in groups and were never given an opportunity to develop their own questions or conduct an investigation. However, observation of the group dynamics indicated that learners do not share ideas; groups were dominated by the more talented learners. The TLRP (2006) states that teaching and learning should engage learners with the big ideas, key processes, modes of discourse and narratives of subjects so that they understand what constitutes quality and standards in particular domains. This engagement was missing in 72% of visited and observed classrooms. About 80% of the observed teachers did not seem to grasp their learners' preferred learning styles, which should inform the selection of their pedagogical approaches. Also, it was evident that teaching was routine and without critical reflection.

Discussion

The teaching and learning of science in the observed classrooms hardly aligns with the DBE (2011) CAPS teaching aims for natural sciences and technology, the cognitive and practical process and design skills that learners should develop. According to the CAPS (DBE, 2011), the teaching and learning should promote understanding of science as activities that sustain enjoyment and curiosity about the world and natural phenomena. Learners should be able to raise questions, identify problems and issues, predict, plan and conduct investigations, communicate results, to mention a few. However, teaching in the observed classes hardly promoted these goals and objectives. Some incongruence emerged between the findings from the completed questionnaire and classroom observations. For example, the questionnaire revealed that 81% of teachers claim to begin a session by determining a learner's prior knowledge; a finding not borne out by observation. In most cases preliminary questions were raised to remind learners about previous lessons and not to diagnose their comprehension level. In most classrooms, the teacher's questioning skills focused on comprehension and never moved to application, analysis or synthesis as suggested by Blooms Taxonomy. Considering the learner performance in South Africa (DBE, 2013 & 2014), questioning can be used as an effective tool whereby one determines learners' thinking, experiences and shortfalls regarding the topic under discussion. Hence, a teacher should plan and reflect on the type of questions to be asked, something that was missing in most classrooms. Sound teaching, according to the AAAS (1990), usually begins with questions and phenomena that are interesting and familiar to students, not with abstractions or phenomena outside their range of perception, understanding, or knowledge. Moreover, effective questioning is essential to developing scientific habits of mind (National Research Council, 2012). Based on data from the questionnaire and classroom observation, there was an evident mismatch or conflict of ideas. This mismatch indicates a possible flaw in self-reporting, which finds that teachers respond in a manner that will please the researcher, rather than an honest reflection on their own practice. This indicates a potential methodological flaw when collecting data by questionnaires alone and hence the need for the use of various data collection instruments.

The questionnaire data shows that most natural science teachers (62%) used a lecture style to teach their learners. These findings concur with the classroom observation data. In all the classrooms, the dominant teaching approach was the lecture style and telling method. There was a lack of differentiated instructional approach to accommodate learners with various abilities and learning styles. This raises questions as to whether teachers have access to a reservoir of pedagogical approaches that they can use in their classrooms for a diverse group of learners. To accommodate every learner, teachers should explore various teaching approaches that can benefit the different learners. Schleicher (2012) argues that the kind of teaching needed today requires teachers to be high-level knowledge workers who constantly advance their own professional knowledge as well as that of their profession. In most classrooms, teachers appeared to hardly understand or know their learner's preferred learning style. This knowledge can help in choosing the appropriate teaching method that will accommodate diverse learners in their classrooms. Davidoff and Berg (1990) suggest that learning is more effective if the teaching methods used match students' preferred learning styles. In addition, effective learning occurs when the conditions for learning are maximised through the deliberate use of instructional design principles that consider learning differences and increase the possibilities of success for all learners; which is also the foundation of the DBE (2011) CAPS. Thus, effective teachers personalise (supposed to) learning for their learners, as they recognise that they develop at different rates and have different abilities. That being said, the challenges associated with the implementation or use of learner centred education approach are widely noted (Vavrus, Thomas & Barlett, 2011: Schweisfurth, 2011). Schweisfurth (2011) identifies the challenges as having been labelled a 'paradigm shift' and the failure metaphorically described as 'tissue rejection'. However, Schweisfurth (2011) argues that some successful implementation seems most likely in contexts where teachers are supported in a multi-stranded, sustained, joined-up manner, and are 'scaffolded'. Hence, I argue that for teachers to succeed in using learner centred approaches in their classroom they require some support from their colleagues, districts and the department of education. Obviously, the nature of support will vary as it will include coaching and mentoring, material resources, infrastructure and more.

To vary teaching strategies, science teachers should constantly reflect on their practice to determine if learners are still benefiting from their lessons. Evidently, most teachers were not familiar with reflective teaching practice. Reflective teaching practice is viewed as a means by which practitioners can develop a greater level of self-awareness about the nature and impact of their performance, an awareness that creates opportunities for professional growth and development (Osterman & Kottkamp, 1993). I argue that an effective and a caring teacher comprehends the significance of making sure that every learner is involved in the learning process, and that they benefit from every lesson taught in the classroom. Thus, it is critical that teachers are reflective in their teaching, as this alerts them to struggling learners as well as their weaknesses or strengths in a particular lesson or topic. Teaching and learning, as James & Pollard (2006) contend, should equip learners for life and engage them with valued forms of knowledge.

Findings also indicate that the natural science teaching hardly promoted inquiry abilities in learners, as they learnt through transmission of established knowledge. The majority of classes lacked practical exercises which promote deeper learning of science content knowledge and critical thinking. In her study, Ngubane (2014) found that educators did not grant learners an opportunity to assimilate and make sense of new knowledge as they were expected to respond to many close-ended questions. Young learners, as Halverson (2007) argues, are naturally curious and constantly explore the world around them. Therefore, science teaching should provide the opportunity for learners to expand their natural curiosity and building of theories. This is particularly important in South Africa given the low numbers of learners who pursue science at FET level and eventually at tertiary level. The use of an inquiry teaching approach at the primary level can cultivate learner inquisitiveness and interest in science. The OECD (2009) argues that even excellent pre-service training for teachers cannot be expected to prepare them for all the challenges they will face throughout their careers. Thus, use of inquiry based teaching and learning has implications for teacher continuous professional development provided by school districts in South Africa. Furthermore, it has implications for school facilities such as laboratory, libraries as well as the number of learners in each classroom.

Learner assessment and their learning, as DBE (2011) states, is integral to the teaching and learning process. However, the assessment approach, mostly the question and answer approach, common in many classrooms was less effective for science learning. Effective assessment should be carefully, thoughtfully and intentionally planned to achieve its goal. This does not mean, I argue, that teachers should not pose spontaneous questions to learners, but the lesson assessment process should not be entirely based on unplanned questions. Learners should be provided with projects that require them to develop a question, predict, formulate a hypothesis, conduct an investigation, collect and analyse data, draw conclusions, develop reports and make presentations to their peers. This approach will help to address learner diversity in classrooms and ensure cognitive domain gains suggested by Bloom's taxonomy. Furthermore, it will help the teacher with more insight regarding his/her teaching practice or facilitation of a particular science lesson.

Conclusion

This paper reveals how natural sciences and technology is taught in some schools in the EC province. It is concluded that the teaching approaches used are not likely to attract and inspire young learners to continue studying science at higher school and tertiary level. The teaching approaches are intellectually non-stimulating, making science boring and confusing, as they treat the subject as isolated from learner's daily lives. South Africa needs active and stimulating classrooms that will inspire the young ones to continue studying sciences despite the existing myths about it. It is therefore critical that we pay close attention to how we train and support both new and experienced teachers. To change the status quo of the classroom results, Intermediate phase science teachers should be imbued with knowledge of various pedagogical approaches that will cater for their diverse learners. The teaching of science should promote deeper learning that sets a foundation for the next grade level and later learner success and advancement in life.

It is also concluded that the poor quality of science teaching that some learners receive, especially those from previously disadvantaged backgrounds, can be one of the contributing factors towards poor learner performance, if not attended to soon. Also, many teachers lack the ability to reflect on their own practice. Effective teachers are reflective in their practice. They are constantly aware of what is going on, continuously make changes and adapt their teaching practice to ensure learner success. They are creative and do not fear to take risks and make decisions to improve their performance and that of their learners. These teachers can creatively adapt and teach any group of learners with any learning styles. Based on the findings, Intermediate phase natural sciences teaching in the Eastern Cape requires urgent attention as it hardly aligns with most of the CAPS principles of teaching and learning.

Also critical is the physical environment where the teaching and learning process takes place. The environment hardly corresponds with the classroom objectives in terms of learner interaction and teaching approach. It is concluded that teachers can improve the state of their classrooms by ensuring that furniture, walls and floors are well maintained. This will increase their learners' sense of well-being and motivation. Every teacher should ensure that the learning environment is conducive for teaching and learning. Similarly, the Department of Education has a responsibility to ensure that all the classrooms are provided with useable furniture and that broken chairs and tables are fixed or replaced with new ones. Finally, more research focusing on teaching and learning of science at public primary schools should be undertaken in order to gain views and more knowledge regarding challenges in various contexts.

References

American Association for the Advancement of Science (1990). *Effective teaching and learning. Principles of learning teaching science, mathematics and technology*. Viewed 23 October 2014, from http://www.project2061.org/publications/sfaa/online/Chap13.htm#1. Author, 2012.

Bantwini, B.D. (2012). Primary school science teachers' perspectives regarding their professional development: Implications for school districts in South Africa. *Professional Development in Education Journal*, *38*(4), 517–532.

Bosse, S., Jacobs, G., & Anderson, T.L. (2009). Science in the air. *Young Children*, 10–15, reprinted and retrieved at www.naeyc.org/files/yc/file/200911/BosseWeb1109.pdf

Chalufour, I. (2010). *Learning to teach science: Strategies that support teacher practice*. SEED papers collected from the SEM in Early Education and Development conference at the UNI. Viewed 19 November 2012, from http://ecrp.uiuc.edu/beyond/seed/chalufour.html.

Cohen, L., Manion, L., & Morrison K. (2011). *Research methods in education* (7th ed.). London and New York: Routledge. Taylor &Francis Group.

Davidoff, S., & Van den Berg, O. (1990). *Changing your teaching. The challenge of the classroom*. Pietermaritzburg: Centaur Publications

Department of Basic Education. (2010). *The SACMEQ 111 project in South Africa: A study of the conditions of schooling and the quality of education*. South Africa Country Report. Pretoria, South Africa.

Department of Basic Education (DBE). (2011). National Curriculum Statement (NCS). Curriculum Assessment Policy Statement. Republic of South Africa.

Department of Basic Education (DBE). (2011). Action plan to 2014: Towards the realization of schooling 2025. Republic of South Africa.

Department of Basic Education (2013). *Report on the Annual National Assessment of 2013: Grade 1 to 6 & 9*. Republic of South Africa. Retrieved from: http://www.education.gov.za/Portals/0/Documents/Reports/ANA%20Report%202013.pdf?ver=2014-02-07-112211-420

Department of Basic Education (2014). *Report on the Annual National Assessment of 2014: Grade 1 to 6 & 9*. Republic of South Africa. Retrieved from: http://www.education.gov.za/Portals/0/Documents/Reports/REPORT%20ON%20THE%20ANA%20OF%202014.pdf?ver=2014-12-04-104938-000

Department: The Presidency. National Planning Commission. (2011). National Development Plan 2030: Our future-make it works. Executive Summary. Republic of South Africa.

Eby, J.W., Herrell, A.L, & Jordan, M. (2009). *Teaching in the elementary schools: A reflective action approach* (5th ed.). Upper Saddle River, New Jersey: Pearson Education, Inc.

Eshach, H., & Fried, M.N. (2005). Should science be taught in early childhood? *Journal of Science Education and Technology 14*(3), 315–336.

Fraser-Abder, P. (2011). *Teaching budding scientists: Fostering scientific inquiry with diverse learners in grades 3–5*. Upper Saddle River: Pearson.

Gelman, R., Brenneman,K., Macdonald,G. & Roman, M. (2010). *Preschool pathways to science: Ways of doing, thinking, communicating and knowing about science*. Baltimore, MD: Brookes Publishing.

Glenn Commission. (2000). *Before it's too late: A report to the nation from the National Commission on Mathematics and Science Teaching for the 21st Century*. U.S. Department of Education.

Goodrum, D., Hackling, M. & Rennie, L. (2001). *The status and quality of teaching and learning of science in Australian schools*. A Research Report prepared for the Department of Education, Training and Youth Affairs.

International Council for Science. (2011). *Report of the ICSU Ad-hoc Review Panel on Science Education*. International Council for Science, Paris.

Halverson, K. (2007). Why teach science in early childhood? Viewed 21 September 2013, from http://wenku.baidu.com/view/b2449c78a26925c52dc5bf04.html.

Hoadley, U. (2012). What do we know about teaching and learning in South African primary schools? *Education As Change 16*(2), 187–202.

James, M. & Pollard, A. (2006). Principles for teaching and learning. In Improving teaching and learning in schools. A commentary by the Teaching and Learning Research Programme. Viewed 19 January 2014, from www.tlrp.org.

Luneta, K. (2012). Designing continuous professional development programmes for teachers: A literature review. *Africa Education Review 9*(2), 360–379.

Marcinek, A. (2011). Classroom environment: Does space make a difference? Viewed 17 September 2015, from http://www.edutopia.org/blog/classroom-environments-make-difference-andrew-marcinek.

Magano, L. (2009). *How natural sciences teachers plan and enact their lessons in Outcomes-Based Education*. Submitted in partial fulfilment of the requirements for the Masters in Education, University of Pretoria.

Viewed 10 January 2017, from: http://repository.up.ac.za/bitstream/handle/2263/26163/dissertation.pdf?sequence=1

Mpanza, N.M. (2013). *A case study of teachers' implementation of the grade four Natural Science curriculum.* A dissertation submitted to the School of Education, University of KwaZulu Natal in partial fulfilment of the requirement for the Masters of Education Degree. Retrieved from: http://researchspace.ukzn.ac.za/xmlui/bitstream/handle/10413/11441/Mpanza_Mavis_Nokuthula_2013.pdf;sequence=1

Miles, M.B., & Huberman, M.A. (1984). *Qualitative data analysis: A sourcebook of new methods*. Newbury Park, California: Sage Publications.

Mtsi, N., Maphosa, C. & Moyo, G. (2016). Exploring educators' preparedness to teach Natural Sciences at the senior phase of South African secondary schools. *Journal of Educational Studies 15*(2), 108–135.

National Center on Time and Learning. (2011). Strengthening science education: The power of more time to deepen inquiry and engagement. Viewed 01 January 2015, from http://www.timeandlearning.org/sites/default/files/resources/strengthening_science_education_full_report_.pdf.

National Research Council (NRC). (2012). *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: National Academies Press.

Naude, F. (2015). Foundation Phase children's causal reasoning in astronomy, biology, chemistry and physics. *South African Journal of Childhood Education*, 5(3), 1–9.

Ngubane, H.M. (2014). Teaching matter and materials in grade 4 natural sciences: a case study in the Camperdown circuit of KwaZulu-Natal. Dissertation for a Masters Degree (Science and Technology Education). Retrieved from: http://researchspace.ukzn.ac.za/bitstream/handle/10413/11472/Ngubane_Hlengiwe_M._2014.pdf?sequence=1&isAllowed=y. Retrieval date: 3/3/2016.

O'Neill, S. (2007). Director General First Classroom Strategy. Department of Education and Training. The Government of Western Australia.

Organisation for Economic Cooperation and Development (OECD). (2009). Creating Effective Teaching and Learning Environment: First results from TALIS, OECD.

Osborne, J. & Dillon, J. (2008). Science education in Europe: Critical reflections. A report to the Nuffield Foundation. Viewed 09 December 2015, from http://www.nuffieldfoundation.org/sites/default/files/Sci_Ed_in_Europe_Report_Final.pdf.

Osterman, K.F., & Kottkamp, R.B. (1993). *Reflective practice for educators: Improving schools through professional development*. Newbury Park, CA: Corwin Press.

Phillips, M. (2014). A place for learning: The physical environment of classroom. Available online: http://www.edutopia.org/blog/the-physical-environment-of-classrooms-mark-phillips.

Schleicher, A. (Ed.). (2012). *Preparing teachers and developing school leaders for the 21st Century: Lessons from around the World.* OECD Publishing. Viewed 28 May 2015, from http://dx.doi.org/10.1787/9789264xxxxxx-en

Schweisfurth, M. (2011). Learner-centred education in developing country contexts: From solution to problem? *International Journal of Educational Development 31*, 425–432.

Set, B., Hadman, J., & Ashipala, D.O. (2017). An investigation into how grade 5 teachers teach natural science concepts in three western cape primary schools. *World Journal of Education 7*(1), 33–43

Teaching and Learning Research Programme (TLRP). (2006). *Science education in schools: Issues, evidence and proposals*. Viewed 10 March 2015, from www.tlrp.org

Trundle, K.C. (2009). Teaching Science during the Early Childhood Years. Viewed 29 March 2014, from http://ngl.cengage.com/assets/downloads/ngsci_pro0000000028/am_trundle_teach_sci_early_child_scl22-0429a.pdf

Vavrus, F., Thomas, M., & Barlett, L. (2011). *Ensuring quality by attending to inquiry: Learner-centred pedagogy in sub-Saharan Africa*. Addis-Ababa: UNESCO.

Bongani Bantwini
School of Natural Sciences and Technology for Education
North West University

bongani.bantwini@gmail.com