TEACHING DIFFICULTIES OF NATURAL SCIENCES EDUCATORS IN THE PLANET, EARTH AND BEYOND STRAND IN THE SEKGOSESE EAST CIRCUIT OF LIMPOPO

BY

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DECLARATION

STUDENT NUMBER: 44 616 732

I, **Tebogo Edwin Nkanyani,** declare that the dissertation titled "**Teaching Difficulties of Natural Sciences Educators in the Planet, Earth and beyond Strand in the Sekgosese East Circuit of Limpopo"** is my work and all sources have been acknowledged by citing and complete reference.

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SIGNATURE **DATE**

ABSTRACT

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This study aimed to explore teaching difficulties of Natural Sciences teachers when offering lessons in the Planet, Earth and Beyond strand. The aim was to understand their teacher knowledge, type of instructional strategies, and classroom discourse and interactions in their Natural Science classroom. The following question guided the study: What are the teaching difficulties of Planet, Earth and Beyond strand? A qualitative case study design was used for the study. The data was collected through semi-structured interviews and observations. The study revealed that NS educators: carry misconceptions to class; show poor knowledge of context in specific aims and assessment strategies while also choosing poor and irrelevant instructional strategies and; still see themselves as authority in class by applying a one- way approach. It is recommended that: educators be trained on how to implement active and critical learning, while empowering them with knowledge on NS specific aims and assessment strategies; departmental heads, SMTs, and subject advisor should engage in regular class visits in the NS educators` classes, reviewing lesson plans that educators prepared; schools should provide educators with CAPS relevant documents; the DoE should provide more education to educators on the importance of following the curriculum as prescribed in the CAPS document; the department should provide educators with relevant teaching aids and practical apparatus and in the absence advice educators on how to improvise and; the subject advisors should assist educators in identifying misconceptions.

Keyword: *Teacher knowledge, Pedagogical content knowledge, Instructional strategies, Classroom discourse and interactions*

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- The Limpopo Department of Education together with principals for allowing me to do this research at their respective schools.
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DEDICATION

The study is dedicated to:

- My late grandfather and grandmother, Phineas and Josephine Lekitima for their continuous encouragement and support in my education from as early as its foundation.
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LIST OF ABREVIATIONS

GET	General Education and training
NS	Natural Sciences
OBE	Outcome Based Education
DoE	Department of Education
C2005	Curriculum 2005
RNCS 2005	Revised Curriculum
2005NCS	National Curriculum Statement
DBE	Department of Basic Education
CAPS	Curriculum, Assessment and Policy Statement
PEB	Planet, Earth and Beyond
PCK	Pedagogical Content Knowledge
SMK	Subject Matter Knowledge
CK	Content Knowledge
CPDF	Classroom Practice Diagnostic Framework
NOS	Nature of Science
PBL	Problem Based Learning
RTI	Reflective Teaching Index
PTD	Primary Teacher`s Diploma
ACE	Advanced Certificate in Education
B.Ed	Bachelor of Education
SMT	School Management Team

CHAPTER 1

1.1. INTRODUCTION

This chapter introduces the current study by giving its background on the national curriculum and its predecessors with a purpose of linking it to the teaching difficulties. The chapter, in addition, focuses at how the GET (General Education and training) Natural sciences (NS) build up to the FET (Further Education and Training) subjects such as Physical sciences, Life sciences and Geography by investigating how Grade 12 learner perform in these subjects in, specifically as they appear in the final matric results. Background on teaching difficulties is also given. Furthermore, the statement of the problem is stated and described, and this is followed by outlining of the aims, objectives and research questions of this study. Finally, this chapter details the contents of each chapter comprising the study.

1.2 BACKGROUND

The imbalances created by, and inherited during the South African former apartheid education system has led the post-apartheid democratic government which came into being on 27 April 1994 to introduce a new system of curriculum known as Curriculum 2005. This new curriculum was embedded in the principles and values of what came to be known as Outcome-based Education (OBE) (DoE 1997). The new curriculum was roped in to sweep out the pervasive method of "rote learning" of apartheid, by the learner-based methods that focus on critical thinking (Mason, 1999 in Pillay et. al 2013). Furthermore, its purpose among others was "to heal the divisions of the past and establish a society based on democratic values, social justice and fundamental human rights" as per constitution of the Republic of South Africa, 1996 (Mokhaba 2005). The C2005 curriculum however, received criticism late in its inception, with its complexity (Jansen & Taylor, 2003) been identified as its own downfall. Among others, the following were evident in support of a call to do away with the C2005: short training period for teachers, its lack of practicality, and coordinators lacking professional training (Sighn 1999 in Pillay et.al 2013). Poor relationships between curriculum and assessment policy, inefficient availability of resources that are meant to implement the curriculum and policy overload were indicated in some reports (DoE 2000). This resulted in teachers showing reluctance on implementing the programmes of the curriculum, ultimately failing to apply the curriculum in class (Pillay et.al 2013).

The curriculum was then modified into the revised curriculum 2005 (RNCS 2005) in 2002 (DoE 2004) which reduced the complexity by focussing more on "skills, content knowledge and grade progression" (Zenexfoundations 2013). The RNCS

narrowed its predecessor`s "design features from eight to the three: the critical and developmental outcomes, the learning outcomes and assessment standards" (DOE 2003). Studies however indicate the frustration the teachers had with the RNCS 2005 (HSRC 2009). According to the study (HSRC 2009), inefficient and ineffective teacher training, poor implementation, and lack of sufficient resources were cited as teachers` concerns about the curriculum. The teachers indicated "confusion, being overloaded, stress and demotivation" and therefore ultimately "underperformed" (DBE 2009). Furthermore, it was revealed that the NCS was worsening the division in the outcomes rather than alleviating it (Ramatlapana & Makonye 2012).

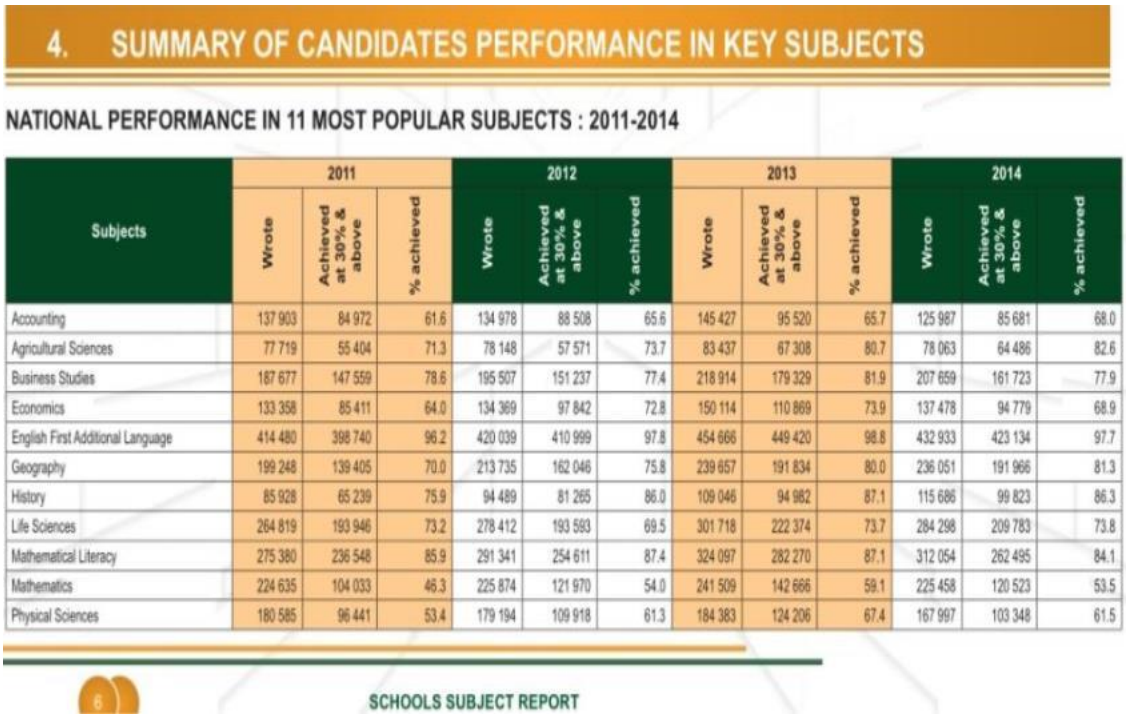
The challenges and concerns about the NCS paved way for the Curriculum and Assessment Policy Statement (CAPS) (DBE 2011a). Some studies indicate however that the teacher`s role in the current CAPS curriculum has been abated (Umalusi 2014). This indicates that teachers will perform their duties in class, sticking to the implementers` programme. They lose their freedom to design their own type of lesson or to alter the learning programme to suit the conditions in class or the type of learners they have (Umalusi 2014). Teachers are deprived of their will of being autonomous (Ramatlapana & Makonye 2012). CAPS is a learner-centred curriculum, where the teacher`s role is to control learning process in line with the curriculum programme (Umalusi 2014). Mbatha (2016) on the other hand indicate "resource shortage, teacher training, resistance to change, class size, lack of time, professional development, workload, administrative support, monitoring and language" as the inhibitors for effective implementation of CAPS. Teachers therefore still lack support in the implemetation of the CAPS curriculum (Mbatha 2016). That in itself shows the level of difficulties the teachers face when imparting knowledge in class. Teachers need to be in their best gear when facilitating lesson and in this case that proves to be impossible.

1.3 NATURAL SCIENCE AND ITS LEGACY IN THE FET SUBJECT

Natural Sciences (NS) is a very diverse area of science, consistently at the forefront of introducing the learners to the upper grade subjects such as Life Sciences, Physical Sciences (Chemistry and Physics), and Geography (DBE 2011a). These subjects are introduced through the strands; Life and Living, Matter and materials, Energy and change, and Planet Earth and Beyond, respectively (DBE 2011a). Since NS serves as a foundation to the abovementioned subjects which are very crucial for the world of science, it therefore needs teachers who are well qualified to prepare the learners for this bigger world. Further to that, teachers need to be subject specialists (DBE 2011a) in order to carry this task.

For as long as NS serves to prepare learners for the upper grade subjects, one will need to analyse the legacy it has given to the learners in the FET subjects: Physical sciences, Life Sciences and Geography. It was therefore crucial to analyse the Grade 12 subject performances. Figure 1 shows subjects' performances from 2011-2014 (DBE 2014). It is evident that even though the subject Physical Sciences showed a fluctuation in overall pass percentage at just above 60% for the period 2011-2014, it eventually showed a drop to 58.6 % (DBE 2014). The two other subjects: Geography and Life Sciences showed a slight increase throughout a four-year period, with the former fluctuating just around 70% and the latter varying between 75.8 % and 77.0 % (DBE 2014).

The performance of the three subjects displayed a slightly different trend to that of the National, in the Limpopo Province for the class of 2014 (DBE 2014) and 2015 class (DBE 2015a), respectively. As indicated of figures 2 and 3, the Geography and Physical Sciences showed a dramatic decline from 81.7 % to 76.9% for the former and 66.7% to 59.6% for the latter meanwhile Physical Sciences had a slight drop from 71.7% to 68.5% (DBE 2014; DBE 2015a).



4. SUMMARY OF CANDIDATES PERFORMANCE IN KEY SUBJECTS

NATIONAL PERFORMANCE IN 11 MOST POPULAR SUBJECTS : 2011-2014

Subjects	2011			2012			2013			2014		
	Wrote	Achieved at 30% & above	% achieved	Wrote	Achieved at 30% & above	% achieved	Wrote	Achieved at 30% & above	% achieved	Wrote	Achieved at 30% & above	% achieved
Accounting	137 903	84 972	61.6	134 978	88 508	65.6	145 427	95 520	65.7	125 987	85 681	68.0
Agricultural Sciences	77 719	55 404	71.3	78 148	57 571	73.7	83 437	67 308	80.7	78 063	64 486	82.6
Business Studies	187 677	147 559	78.6	195 507	151 237	77.4	218 914	179 329	81.9	207 659	161 723	77.9
Economics	133 358	85 411	64.0	134 369	97 842	72.8	150 114	110 869	73.9	137 478	94 779	68.9
English First Additional Language	414 480	398 740	96.2	420 039	410 999	97.8	454 666	449 420	98.8	432 933	423 134	97.7
Geography	199 248	139 405	70.0	213 735	162 046	75.8	239 657	191 834	80.0	236 051	191 966	81.3
History	85 928	65 239	75.9	94 489	81 265	86.0	109 046	94 982	87.1	115 686	99 823	86.3
Life Sciences	264 819	193 946	73.2	278 412	193 593	69.5	301 718	222 374	73.7	284 298	209 783	73.8
Mathematical Literacy	275 380	236 548	85.9	291 341	254 611	87.4	324 097	282 270	87.1	312 054	262 495	84.1
Mathematics	224 635	104 033	46.3	225 874	121 970	54.0	241 509	142 666	59.1	225 458	120 523	53.5
Physical Sciences	180 585	96 441	53.4	179 194	109 918	61.3	184 383	124 206	67.4	167 997	103 348	61.5

Figure 1.1: Summary of candidates' performance in key subjects in the period 2012-2015 (Source: DBE 2014)

PROVINCIAL PERFORMANCE IN SELECTED SUBJECTS IN 2014

Province	Accounting		Agricultural Sciences		Business Studies		Economics		English (FAL)		Geography		History		Life Sciences		Mathematical Literacy		Mathematics		Physi Scien
	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote
EASTERN CAPE	15 482	61.4	15 238	83.4	23 581	73.9	18 353	59.6	59 403	95.8	26 379	74.7	15 877	77.8	37 564	66.4	36 467	77.1	31 091	42.0	21 855
FREE STATE	6 620	79.7	1 608	90.2	11 009	80.0	6 822	64.2	22 953	98.7	9 409	87.0	4 062	89.3	12 644	81.8	16 462	90.5	10 135	65.8	8 641
GAUTENG	23 777	72.5	1 102	82.1	44 936	89.3	27 336	77.7	64 484	99.5	41 090	88.4	25 319	89.6	45 980	80.6	64 586	93.7	35 572	69.3	29 093
KWAZULU NATAL	37 968	63.0	18 837	78.0	60 157	71.7	36 230	69.7	112 978	95.7	64 057	77.0	31 224	89.7	74 496	72.7	70 070	75.9	71 634	40.7	45 143
LIMPOPO	17 320	69.7	22 400	81.6	20 717	67.1	22 002	65.1	71 308	99.0	37 603	81.7	11 202	74.9	44 889	71.7	41 044	83.2	32 122	56.9	26 691
MPUMALANGA	9 205	67.3	12 968	86.8	16 265	77.9	11 579	56.3	41 194	98.7	20 259	83.5	5 386	92.1	23 953	77.1	27 438	80.4	17 767	56.6	15 210
NORTH WEST	4 337	75.4	4 461	90.2	7 814	86.4	4 627	84.7	23 224	99.9	14 270	86.4	5 272	94.6	14 956	76.4	16 703	90.0	9 478	61.7	8 191
NORTHERN CAPE	1 726	65.7	712	86.8	3 251	77.8	1 513	75.1	7 759	99.7	4 366	71.3	2 525	86.1	5 331	63.5	6 454	89.9	2 411	63.4	2 082
WESTERN CAPE	9 552	74.2	737	76.7	19 929	82.2	9 016	78.3	29 630	98.0	18 618	82.5	14 819	85.2	24 485	72.7	32 830	87.7	15 248	73.9	11 091
NATIONAL	125 987	68.0	78 063	82.6	207 659	77.9	137 478	68.9	432 933	97.7	236 051	81.3	115 686	86.3	284 298	73.8	312 054	84.1	225 458	53.5	167 997

Figure1.2: The summary of performances in the nine provinces in 2014 (Source: DBE 2014)

4.2 PROVINCIAL PERFORMANCE IN SELECTED SUBJECTS IN 2015

Province	Accounting		Agricultural Sciences		Business Studies		Economics		English (FAL)		Geography		History		Life Sciences		Mathematical Literacy		Mathematics		Physical Sciences	
	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30 % and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above	Wrote	% Achieved 30% and above
EASTERN CAPE	18 021	52.7	21 999	75.0	29 344	68.9	23 020	53.9	78 824	95.5	35 312	66.9	22 827	72.5	50 440	59.8	48 877	55.6	39 084	37.3	27 749	45.9
FREE STATE	7 268	73.0	2 270	83.5	13 518	81.5	8 384	65.7	30 814	96.6	12 847	83.5	6 073	83.7	15 214	83.1	21 933	77.8	11 066	69.1	9 628	69.7
GAUTENG	24 203	70.8	1 143	81.7	48 925	88.9	29 015	81.8	73 032	99.6	49 348	85.7	30 508	92.7	50 265	81.4	72 765	85.9	37 053	69.6	30 548	67.7
KWAZULU-NATAL	39 671	51.5	22 463	73.1	69 615	69.1	41 626	60.8	135 805	94.2	78 898	69.3	39 930	79.6	86 927	65.2	79 549	57.7	85 057	33.2	50 163	51.8
LIMPOPO	22 945	56.3	32 106	76.2	28 300	62.8	30 742	68.4	99 756	98.0	55 617	76.9	18 478	77.4	62 531	68.5	61 282	68.2	40 673	52.1	33 680	59.6
MPUMALANGA	10 116	63.9	16 510	82.6	19 868	75.6	13 630	71.1	50 968	99.2	25643	83.3	7 190	88.5	29 513	78.0	34 608	74.8	20 596	55.5	17 528	62.6
NORTH WEST	6 019	61.5	6 022	81.7	11 270	89.3	7 348	81.6	30 098	99.9	18 413	82.3	7 118	90.8	16 081	74.1	22 744	82.8	10 761	59.6	9 090	62.0
NORTHERN CAPE	1 799	55.5	962	76.9	4 185	71.1	1 894	71.3	10 515	98.9	6 252	76.7	3 945	86.8	7 180	57.2	8 842	72.1	3 054	57.0	2 777	54.3
WESTERN CAPE	10 432	72.3	776	80.5	22 797	82.7	9 983	78.8	34 129	98.8	21 655	86.9	18 329	95.0	27 925	76.6	38 245	83.9	16 559	74.9	12 026	73.3
NATIONAL	140 474	59.6	104 251	76.9	247 822	75.7	165 642	68.2	543 941	97.1	303 985	77.0	154 398	84.0	348 076	70.4	388 845	71.4	263 903	49.1	19 3189	58.6

Figure1.3: Summary of Provincial Performances in selected subjects in 2015 (DBE 2015a)

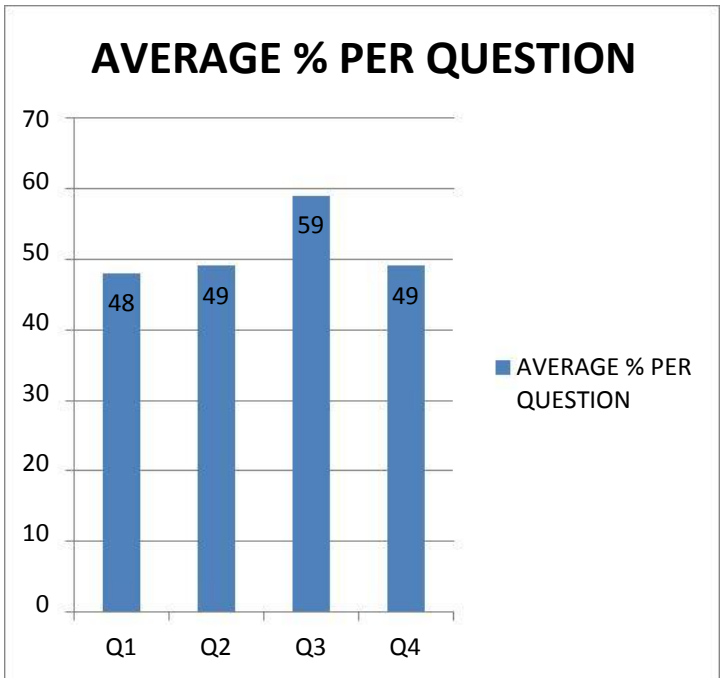
The question that arises from the above analysis is: Which topics are responsible for the drop in matric performances for the said selected subjects?

According to the CAPS subject statements of both the NS GET (DBE 2011a) and Geography FET (DBE 2011b), table 1.1 indicates topics that are common and form links between the NS GET syllabuses and Geography Grade 12 syllabus.

Table 1.1: A link between the Natural sciences GET and Geography Grade 12

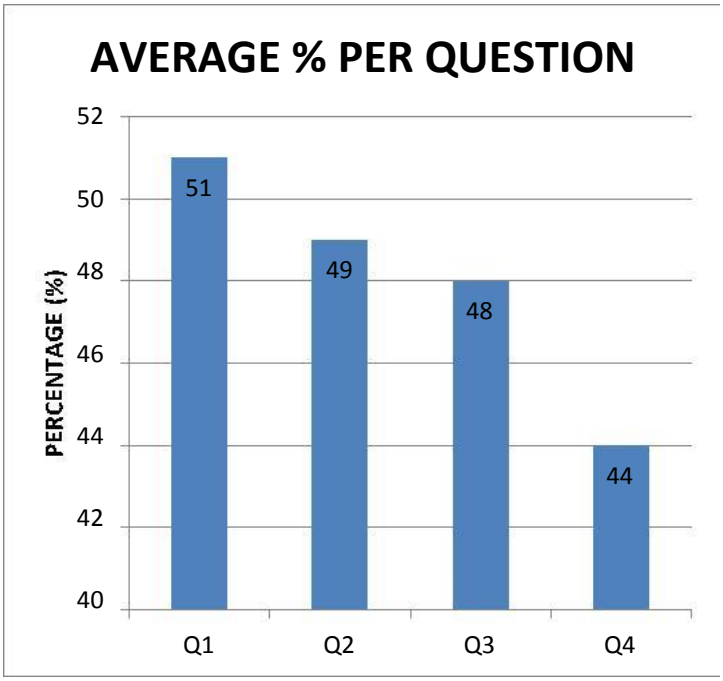
Natural Sciences GET	Geography Grade 12
The relationship of the sun to the earth in NS grade 7	Climate and weather in geography grade 12
Mining of mineral resources in NS Grade 9	Economic Geography of South Africa (Mining)
The Lithosphere in Grade 9	Drainage Systems in South Africa; Fluvial Processes; and Catchment and River Management

It is evident from table 1.1 that the Planet; Earth; and Beyond (PEB) strand of the Natural Sciences serves as a background for some of the Geography topics in the upper grades, specifically in Grade 12. Further to that, the topics indicated in table 1.1 are assessed in paper 1 Grade 12 examinations. Studies by Umalusi (2015) however revealed that the average performance of learners in Geography Grade 12 2015 NSC examinations was poor in paper 2 as compared to paper 1. As indicated in figures 1.4 and 1.5 respectively, the average top score from the four questions of the papers was 59 % in paper 1 and 51 % in paper 2. Moreover, no learner achieved level 6 and above in paper 1 (DBE 2015b). Even though the study attributes the poor performance to learners` poor "geographical skills" (DBE 2015b), one could link the consequences to the poor knowledge learners had attained in the lower grades.



Q1	Climate and Weather, and Geomorphology
Q2	Climate and Weather, and Geomorphology
Q3	Rural and Urban settlements, and Economic Activities of South Africa
Q4	Rural and Urban settlements, and Economic Activities of South Africa

Figure 1.4 Average performances of candidates for Geography P1 2015 Source: DBE (2015b)



Q1	Multiple Choice
Q2	Map Calculations and techniques
Q3	Application and interpretation
Q4	Geographical Information Systems

Figure 1.5: Average performances of candidates for Geography P2 2015 Source: DBE (2015b)

It is however not only in Geography where topics evident in the Planet, Earth and Beyond (PEB) strand of Natural sciences appear. Physical Sciences and Life Sciences are also home to some PEB strand as indicated in tables 1.2 and 1.3.

Table 1.2: The progression of GET Natural Sciences PEB strand topics in the FET Physical Sciences

GET PEB NATURAL SCIENCES	FET PHSICAL SCIENCES
Gravity, on the Grade 7 topic: Relationship of the Moon and Earth	Gravitational potential energy in Grade 10; Newton`s Law of Universal Gravitation in Grade 11; and Vertical projectile motion in one dimension
Refraction and reflection appearing the subtopic of telescopes in the Grade 8 topic: Beyond the solar system	Geometric optics in Grade 11 ; and Doppler effect with light and photoelectric effect in Grade 12
The hydrosphere in the Grade 9 curriculum	The hydrosphere in Grade 10
The lithosphere in the Grade 9	Exploiting the lithosphere and earth`s crust in Grade 11 curriculum

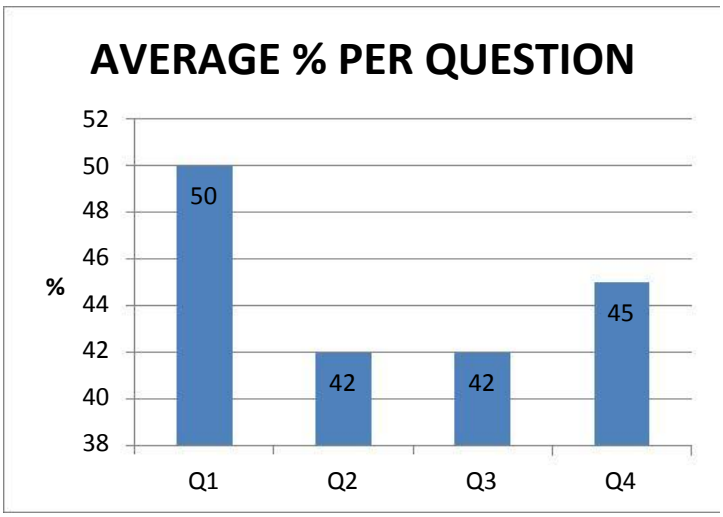
As can be noted in table 1.2, there are some topics belonging to the PEB Strand of NS GET band that serve as gateway to some topics in the FET Physical Sciences. And it is those topics that are assessed in Grade 12 as indicated in

figure 1.7. The topic of Vertical projectile motion was assessed in question 3 of the Physical Sciences Grade 12 final examination of 2015 and obtained an average achievement of 46 %, making it the fifth worst performing topic in the subject as shown in figure 1.7 and continues to be the most problematic topic of Physical sciences (Umalusi 2015). Even though a number of studies have been undertaken to determine the cause of poor performance in the topic, lack of appropriate prior knowledge amongst learners was identified as being one of the major causes (Mudau 2013). This prior knowledge would be knowledge of Gravity learnt in Grade 07 as indicated in table 1.2. Similar to Physical Sciences and Geography, Life sciences also has topics that rely on the foundation from GET Natural sciences PEB strand as indicated in table 1.3.

Table 1.3 Table showing the progression of GET Natural sciences PES topics in the GET Life sciences

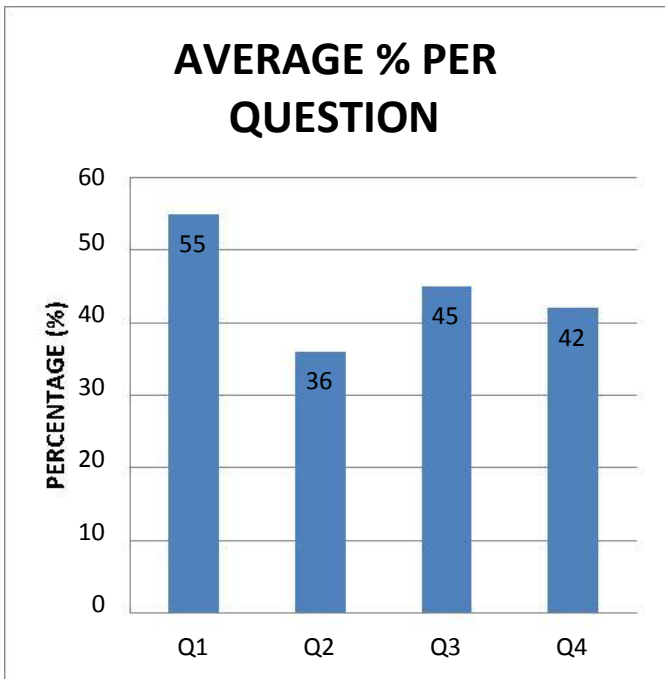
GET PEB Natural Sciences	FET Life Sciences
The greenhouse effect in the Atmosphere topic of Grade 9	Greenhouse effect and Global warming in the topic: Human impact on the environment of Grade 11
Mining in South Africa from Grade 9	Loss of biodiversity through mining; and effect of mining on quality of water – both in Grade 11 curriculum

The greenhouse effect and Mining in South Africa topics learnt in Grade 9 NS are taught in more detail in Life Science Grade 11. They are however assessed in Grade 12 as the 'Environmental impact', which in the 2015 Paper 1 exam was allocated question 3. As shown in figure 1.6, the topic of environmental impact received just an average of 42 % which is not satisfactory given the fact that the topic has been learnt frequently in lower classes, starting from Grade 9 NS.



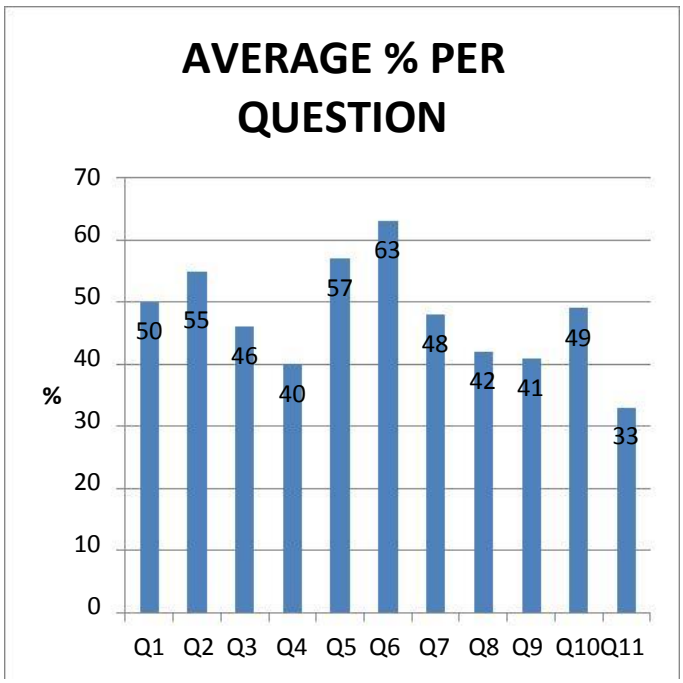
Q1	Multiple Choice, Terminology, Matching, Eye and Plant Hormones
Q2	Ear, Meiosis, Scientific Investigation on Reproduction and the Nervous System
Q3	Homeostasis, Scientific investigation and Human Impact on the Enviroment
Q4	Human Reproduction

Figure 1.6: Average performance of learners per question in Life Sciences P1 NSC Grade 12 exam Source: DBE (2015b)



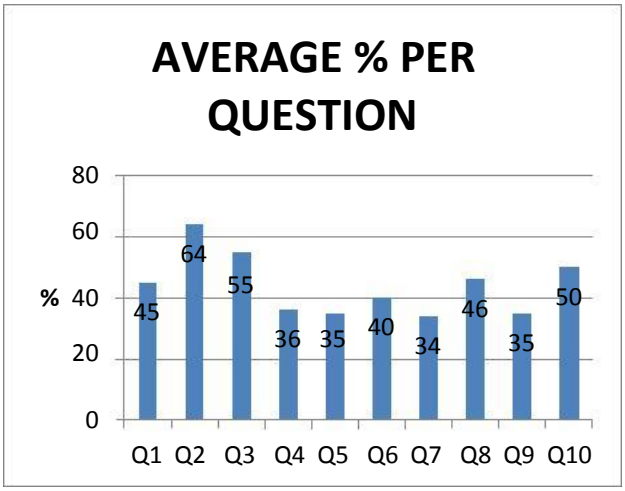
Q1	Multiple choice, Terminology, Matching , and Evolution
Q2	Evolution, Meiosis and Genetics
Q3	Nucleic acids, genetics, Scientific Investigation
Q4	Protein synthesis

Figure 1.7: Average performance of learners per question in Life Sciences P2 NSC Grade 12 exam Source: DBE (2015b)



Q1	Multiple choice questions – all topics
Q2	Newton`s Laws of Motion
Q3	Vertical Projectile motion
Q4	Momentum
Q5	Work, energy and power
Q6	Doppler effect
Q7	Electrostatics (Coulomb`s law)
Q8	Electrostatics (Electric Fields)
Q9	Electric circuits
Q10	Motor, generators and alternating current
Q11	Photo-electric effect

Figure 1.8: Average percentage of learners per question in Physical sciences P1 NSC Grade12 Nov/Dec 2015 exam Source: DBE (2015b)



Q1	Multiple choice questions – all topics
Q2	Organic nomeclature
Q3	Organic reactions
Q4	Physical properties of organic compounds & stoichiometry
Q5	Reaction rate & stoichiometry
Q6	Chemical equilibrium
Q7	Acids and bases & stoichiometry
Q8	Galvanic cells
Q9	Electrolytic cells
Q10	fertilisers

Figure 1.9: Average performance of learners per question in Physical Sciences P2 NSC Grade 12 Nov/Dec 2015 Exam Source: DBE (2015b)

In conclusion, it is evident how the PEB strand of the Natural Sciences GET band provides foundation to some of the key topics in the FET subjects like Physical Sciences, Life Sciences and Geography. It therefore implies if learners are taught with irrelevant instructional strategies, given poor or inefficient knowledge in class where there are poor interactions, the learners will do poorly in the above mentioned FET subjects, consequently affecting the matric results in our country. It is evidently clear something is done wrong in class, which this study seeks to discover.

1.4. TEACHING DIFFICULTY

Difficulty according to Oxford School Dictionary (2010:173) is “something that is not easy to do or understand”, whereas teaching refers to illustrating a particular thing to someone (Oxford School Dictionary 2010:608). Consequently, anything that will make that illustration uneasy will give rise to teaching difficulty. Poor teacher knowledge, instructional strategies and classroom interactions can impact poorly on teaching (Mudau 2013). It is the knowledge of the content from the teacher that makes learning and teaching smooth or problematic to attain (MET projects 2010). The how part of teaching relies specifically on the pedagogical content knowledge (PCK) (UNESCO 2011). The subject knowledge will give rise to knowledge of relevant instructional strategies which will create good interactions in class, as indicated in figure 1.10

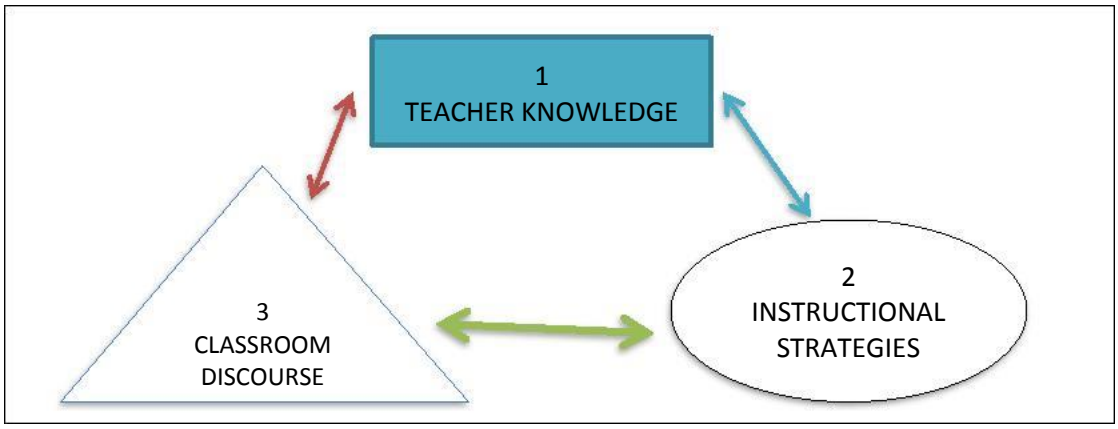


FIGURE 1.10 Illustration of relationship between teacher knowledge, instructional strategies and classroom discourse

Consequently, knowledge of geography/science content, knowledge of geographical/science skills can give rise to knowledge of an effective geographical/scientific instructional strategy yielding effective geographical/scientific interaction, with the absence of those resulting in teaching difficulty.

1.5. PROBLEM STATEMENT AND RATIONALE FOR THE STUDY

Teaching is indeed a calling as Lynch (2015) likes to put it. Teaching "encompasses both instruction in procedure, a process of guiding students to the information they will need and challenging them to engage in thinking about concepts they engage in their minds" (Mobus 2014). One of the most critical roles of a teacher is to be a subject specialist (DBE 2011a). It therefore becomes imperative that the teacher should be well informed about the subject with reference to content knowledge. If a person as an example carrying a code 10 driver's license [1] is given a task of driving a truck which requires code 14 driver`s license [2], the person is likely to cause accidents, resulting in more fatalities. With that statement in mind, teachers can be destroyers or architect of a child's future. They can either lead the way or send a child in the wrong direction. They are the navigators, and if the navigator is not well programmed it is likely to give people wrong directions. Teachers also do perceive themselves as actors while some refer to themselves as musical conductors as they are always at the centre of controlling the interactions, argumentations and the pace of learning in class (Veira 2015). It therefore becomes critical that teaching autonomy in class should be given room.

There is however great concern with the level of content knowledge the teachers take to class. Studies show that through assessments, content gaps have been spotted and strategies need to be created to close this gaps and consequently

[1] Code 10/C1 drivers are allowed to drive vehicles with GVM≤16000kg.
[2] Code 14/C drivers are allowed to drive vehicles with GVM>16000kg.

enhancing proceedings in class (DBE 2015). Moreover, Ventak and Spaull (2015) indicate that report by SACMEQ III (2007) show a serious concern in the teacher content knowledge level. The study indicates that Grade 6 Mathematics teachers failed to answer questions which were meant for Grade 6 learners, with some of the learners getting better marks than teachers (Ventak & Spaull 2015). It evident from this point of view that there are teachers who give learners in class knowledge that they themselves do not have. The question remains: What is it that Natural Sciences teachers are doing in class?

The researcher, who happens to be a Natural Science teacher, noted with much concern the attention his colleagues give during subject support meetings when subject advisors facilitate topics belonging to the Planet, Earth and Beyond strand. Most of them struggle with activities which form part of the meetings. It therefore gave the researcher an indication of some form of shortage of the content knowledge. Most of the colleagues indicate their poor Geography background from school and teacher institutions. Some of the colleagues specialised in Physical sciences and Mathematics from teacher institutions limiting their Geography knowledge. Furthermore, even though a number of studies were done on Grade 09 Natural science with the focus on instructional strategies (Nwosu 2013) and classroom discourse (Sitsebe 2012), none has been undertaken on those focusing on the strand Planet, Earth and Beyond. It was for that reason that the study on teacher knowledge, instructional strategies and classroom and interaction in the Natural sciences classroom in the strand Planet, Earth and Beyond was done.

1.6. AIM, OBJECTIVES AND PURPOSE OF THE STUDY

1.6.1. Aims

The current study aimed to uncover difficulties Natural sciences teachers have when offering lessons in the strand Planet, Earth and Beyond with a focus on the teacher knowledge, type of instructional strategies, and classroom discourse and interactions in the science classroom

1.6.2. Objectives

For the above aims to be achieved, the researcher will:

I. Explore the nature of the knowledge the Natural Sciences teachers have in the strand Planet, Earth and Beyond.

II. Identify the types and nature of instructional strategies used in class.

III. Observe the types of interactions and discourse in the Natural Science classroom.

1.6.3. Purpose of the study

This study was undertaken to unpack teaching difficulties in the topic of the Planet, Earth and Beyond strand of Natural science. The focus was on the teacher knowledge, instructional strategies, and interactions and discourse. A number of studies have been undertaken on any of the three above-mentioned aspects (teacher knowledge, instructional strategies, and interaction and discourse) however, the sequence at which the three aspects relate to one another in class was never determined. It was for that reason that the current study was done to discover how the three aspect in the Natural Science` Planet, Earth and Beyond classroom occurred and how the relate to one another. Furthermore, the study of this nature could be helpful in teacher development and in improving classroom practice in Natural sciences. Curriculum designers, consequently would be able to create the national curriculum having got a clear picture of how teaching occurs in class.

1.7. RESEARCH QUESTIONS

The study is guided by the following main research question:

What are the teaching difficulties of Planet, Earth and Beyond strand?

The main research question led to the following sub-questions:

I. What is the nature of the teachers' teacher knowledge of the Planet, Earth and Beyond strand?

II. What is the nature of the teachers` instructional strategies in the Planet, Earth and Beyond strand?

III. What is the nature of teachers` classroom interactions and discourse in the Planet, Earth and Beyond strand?

1.8. SIGNIFICANCE OF THE STUDY

In light of the aims, objectives and purpose of the study, the following points can be indicative on how significant this study is:

- The relationship between teacher knowledge, instructional strategies, classroom interactions and discourse will be noted in the topic of the strand: Planet, Earth and Beyond.

- The knowledge teachers have, the way they make use of instructional strategies when presenting lessons and the type of interactions in class can

help identify teaching difficulties teachers have when presenting lessons in the strand of Planet, Earth and Beyond.

- The study can also unpack the misconceptions teachers and learners have in the said strand.
- Workshop facilitators will also benefit from the findings of this study, helping them to plan accurately and effectively. The activities they will design will also be those that could be addressing the problems identified by this study.
- University will also be made to design their course programs which will not only be focused on teaching methodology but also the content knowledge which is rich and fruitful. The type of assessments being employed at the institutions will also be those that address teaching difficulties.
- Curriculum planners could also benefit from the study consequently including curriculum topics which are in line with the instructional strategies which are scientific.

1.9. DELIMITATIONS

This study was undertaken to investigate the teaching difficulties of Natural Science subject which is under the South African national curriculum. However, the research was undertaken in the three Sekgosese East Circuit schools only. Moreover, teaching difficulties are complex and numerous. However, for the sake of this study, the focus was only on teacher knowledge, instructional strategies, and interactions and discourse in the PEB strand Natural Science lessons.

1.10 CHAPTER OUTLINE

This study followed the following chapter structuring:

CHAPTER ONE – the chapter introduced the study by giving its background on the national curriculum and its predecessors with a purpose of linking it to the teaching difficulties. It also looked at how the GET Natural sciences build up to the FET subjects such as Physical sciences, Life sciences and Geography by examining how learners performed the respective subjects in Grade 12. Background on teaching difficulties was also given. Further, the problem was stated, together with the study aims, objectives and research questions. The subsequent chapters were then outlined

CHAPTER TWO – This chapter is centred on the difficulties the teachers experienced in their practice in the Natural Sciences classes. It focused on

previous research on topics such as the teacher knowledge, instructional strategies and interactions and discourse.

CHAPTER THREE - This chapter focuses on the research design and methodology, area of the study, population sampling methods, data collection methods, data collection procedure and instrumentations used in the data collection as well as their justification. Ethical considerations are included in this chapter.

CHAPTER FOUR – This chapter presents and discusses the data collected. Literature review is revisited in analysing the collected data.

CHAPTER FIVE – A detailed summary of the study and its findings is given in this chapter.

1.11 CONCLUSION

The study was introduced by giving its background on the national curriculum and its predecessors with a purpose of linking it to the teaching difficulties. It also looked at how the GET Natural sciences build up to the FET subjects such as Physical sciences, Life sciences and Geography by looking at how the said subjects perform in Grade 12. Background on teaching difficulties was also given. Further, the problem was stated, together with the study aims, objectives and research questions. The subsequent chapters are outlined

CHAPTER 2

2.1. INTRODUCTION

This chapter provides an overview of the curriculum and its principles. In addition, this chapter explains the subject Natural Sciences and its strand- Planet, Earth and Beyond in the context of CAPS curriculum.

2.2. CURRICULUM AND POLICY STATEMENT (CAPS)

In eradicating the imbalances of the past, a number of curriculums were introduced and implemented in the South African education fraternity. First was the curriculum 2005 (C2005), introduced in 1997 and based on values of OBE (DoE 1997). The OBE focused on the usage of knowledge by learners and how the knowledge can be used in achieving specific outcomes (Hattingh et al 2005 in de Villiers 2011). It was then criticised due to its complexity (Aldous 2004 in de Villiers 2011).

Through a number of reviews of the C2005, a new curriculum, the Revised National Curriculum Statement (RNCS) was proposed and further introduced and implemented in 2004 (Velupillai et al 2008 in de Villers 2011). Most teachers, however had a problem with RNCS, due to poor training, ineffective implementation and poor availability of resources (HSRC 2009). The challenges in RNCS grade R-9 and NCS grade 10-12 created a path for its amendment to CAPS, implemented in 2012 (DBE 2011a).

CAPS aims include creating a teaching and learning environment that allows learners to attain skills and knowledge in such a way that their lives would improve for the better (DBE 2011a). This was done by focusing on knowledge from real life issues that forms part of learners' everyday living in their communities. Moreover, it prioritises social constructivist approach to learning science (Luckay & Laugksch 2014).

The curriculum also has a purpose of:

- Furnishing learners with "knowledge, skills and values" in order to allow them to have "self-fulfilment and participation in society as free citizens of a free country". This is done not taking into cognisance, learners` "socio-economical background, race, gender, physical or intellectual ability".
- Offering access to higher education.
- Creating a mediation between places of learning and to the place of work.
- Offering the working sector with effective products of learning.

Moreover, CAPS has the following principles: Social transformation-with focus on provision of "equal opportunities" for all population groups; Active and critical

learning – emphasis is put on "active and critical approach to learning"; High knowledge and high skills; Progression – "content and context of each grade shows progression from simple to complex"; Human rights, inclusivity, environmental and social justice; Valuing indigenous knowledge system (DBE 2011a).

With high knowledge and high skills, the minimum level of knowledge is set in a particular grade (DBE 2011a). The emphasis of this is that learners should develop hunger for more which will be learned in upper grades. The role of the teacher in this regard is to provide learners with knowledge and tasks that will motivate them to develop love for science and want more of what they have already gained. The lessons should also involve projects which will connect the learners to the outside world inspiring them to pursue carriers that are science related.

Consequently, (DBE 2011a) revealed that learners who are a product of the curriculum will be able to:

- Note the problem, and determine the solutions by utilising "critical and creative thinking";
- Function well alone and cooperatively with others;
- Collect and control themselves and their "activities in a responsible and effective" manner;
- Gather, interpret, arrange, and significantly "evaluate" data;
- "communicate" well with help of "visuals, symbolic and/or language skills" in different forms;
- Utilise science and technology productively and decisively, demonstrating reliability on the "environment and health of others; and
- Show an "understanding of the world" as a series of interconnected systems through an awareness that "problem solving context do not exist in isolation".

Moreover, teaching and learning should accommodate inclusivity (DBE 2011a). This will assist in doing away with barriers in class. Therefore, the teacher can provide inclusivity by utilising a number of instructional strategies in their teaching (DBE 2011a).

2.2.1 Natural Sciences in CAPS (NS CAPS)

Science is a logical procedure wherein “explanation and connection of ideas” are considered (DBE 2011a). It allows learners to go through “inquiry and experiments “which are following scientific procedure. These methods are “objective” and allows learners to hypothesise, and carry experiments to test those hypotheses. Furthermore, validity of the results is a prerequisite (DBE 2011a). Natural sciences in CAPS further analyse the unknown confines, providing solutions for the world (DBE 2011a). CAPS Natural sciences also recognises indigenous knowledge. This is a knowledge concerned with “agriculture and food production, pastoral practices and animal production, forestry, plant classification, medicinal plants, management of biodiversity, food preservation, management of soil and water, iron smelting, brewing, making dwellings and astronomy” (DBE 2011a). It is one key knowledge which even biologist, pharmacist, and archaeologists are following on it (DBE 2011a).

Moreover, teaching of Natural sciences requires meticulous choice of content and a number of strategies for teaching and learning science. With that in note, the CAPS Natural sciences document (DBE 2011a) indicate that the teaching should advance:

- Science as a discipline that sustains enjoyment and curiosity about the world and natural phenomena.
- The history of Science and the relationship between Natural Sciences and other subjects
- The different cultural contexts in which indigenous knowledge system have developed
- The contribution of Science to social justice and societal development
- The need for using scientific knowledge responsibility in the interest of ourselves, of society and the environment
- The practical and ethical consequences of decisions based on Science. (DBE 2011a)

Furthermore, Natural Science teaching has a consequential effect on FET phase subjects such as Life Sciences, Physical Sciences, Earth Sciences or Agricultural Sciences. It therefore provides basis for those FET band subjects. It further provides learners with preparedness for “economic activity and self-expression “(DBE 2011a).
The Natural sciences curriculum has four knowledge strand: Life and Living (Life Sciences), Matters and Material (physics), Energy and Change (Chemistry), and

Planet, Earth and Beyond (Geography, Life Science and Physical Science) (DBE 2011a). Each of the knowledge strands allow progression for three academic seasons of learning in senior phase. Moreover, these strands provide framework for arranging content. Furthermore, the learners must be able to form connection between topics, knowledge strands and grades (DBE 2011a).

The curriculum also creates an arena wherein learners visit their thoughts of nature and where there will be probe questions which will allow sustained research and investigations. Three specific aims are forming part of the curriculum:

Specific aim 1:'Doing Science'

"Learners should be able to complete investigation, analyse problems, and use practical processes and skills in evaluating solutions."

Specific aim 2: 'knowing the subject content and making connections'

"Learners should have a grasp of scientific, technological and environmental knowledge and be able to apply it in new context"

Specific aim 3: 'understanding the use of science'

"Learners should understand the uses of Natural Sciences and indigenous knowledge in society and the environment" (DBE 2011a)

These specific aims should allow learners to relate the learning in class to daily authentic issues, consequently linking science with the society (DBE 2011a).

The curriculum is a tool for Natural Sciences teaching and learning hence it utilises science process skills. Science process skills allow learners to "think objectively "and utilise different "reasoning skills" (DBE 2011a). This will consequently ignite their "curiosity" while at the same time advancing "creativity, responsibility and growing confidence" (DBE 2011a).

The process skills in the Natural sciences include: "Accessing and recalling information; Observing; Comparing; Measuring; Sorting and classifying; Identifying problems and issues; Raising questions; Predicting; Hypothesizing; Planning investigations; Doing investigations; Recording information; Interpreting information; and communicating" (DBE 2011a).

Furthermore, science learning should follow the scientific process in order explore the world and provide solutions to problems.

The following steps are recognised as the stages of scientific process (DBE 2011a):

Step 1: Identify a problem and develop a question.
Step 2: formulate a hypothesis
Step 3: set an activity or experiment
Step 4: make observations
Step 5: analyse observations and results and ultimately conclude on your activity.

It is therefore of significance that when teaching Natural Science, the teacher should be well aware of what the curriculum is based on in reference to all the above-mentioned. Furthermore, the teaching of Natural Science should be able

to produce learners who will provide skills and solutions to the world. Moreover, the learners would be lifelong learners (DBE 2011a).

2.2.2 Planet, Earth and Beyond (PEB) Strand

This is one of the four strand of the Natural Sciences curriculum as indicated in the CAPS subject statement (DBE 2011a). It forms a basis for Geography FET subject (DBE 2011a), even though some of its topics appear in the Physical Sciences and Life Sciences contents. It is introduced from Grade 7 and concluded in Grade 9 (DBE 2011a). In Grade 9 curriculum, which this study focuses on, the PEB strand contains topics such as the Earth as a system; Lithosphere; Mining of mineral resources; Atmosphere; Birth, life and death of stars (DBE 2011a).

In the Earth as a system topic, the focus is on the four spheres: the atmosphere – mixture of gases, the lithosphere – soil and rocks, the hydrosphere – water in all its forms, and the biosphere – sphere of life (Bester 2013). The topic also looks at how the different spheres interact with one another (DBE 2011a). The second topic of the strand, the Lithosphere focuses on the four concentric layers of Earth and how a varied number of elements and compounds combine to produce different minerals (DBE 2011a). It also covers the rock cycle, which is initiated by looking at the three rock types: igneous, sedimentary and metamorphic (DBE 2011a).

The topic: Mining of mineral resources looks at how minerals are extracted and refined. The focus is also on mining from a South African perspective and its impact on the environment (DBE 2011a). The Atmosphere topic focuses on what constitute the atmosphere and the four layers that make up the atmosphere: the Troposphere, Stratosphere, Mesosphere, Thermosphere. The last aspect of the atmosphere topic focuses on the greenhouse effect of greenhouses gases such as carbon dioxide, water vapour and methane on global warming, climate change, rising sea level, food shortages, and mass extinctions (DBE 2011a). The last topic of the PEB strand: Birth, life and death of stars focuses on how the star`s birth processes, its life processes and finally processes leading to its death (DBE 2011a).

As per the focus of this study, the teacher should be well conversant with the curriculum, its values and principles and its contents. On the same note, the Natural science teacher should be well informed about the subject in line with the curriculum, in that way he/she will be utilising his/her pedagogical content knowledge (PCK). H/she should also be conversant with the contents of the subject (subject matter knowledge), ability to choose strategies to be used and the type of resources required for a particular lesson (contextual knowledge). The teacher should also choose from the curriculum, strategies that will allow interaction and discourses in class.

2.3. TEACHING DIFFICULTIES

Teaching difficulties are the proceedings and approaches in the classroom that do not promote, “misconception dissonance”, and evolution of “inquiry and problem solving skills” that have effect on learners’ progress (Mudau 2013: 113). It is the inability of an educator to achieve the aims and principles of the curriculum. There are a number of concepts that characterise educators` teaching difficulties in science, however the current study will focus on teacher knowledge, instructional strategies and, classroom discourse and interaction.

2.3.1 Teacher Knowledge

Teacher knowledge of the Natural Sciences is one of the imperative aspects (Diamond et al 2014) of teaching and learning. It is the individual knowledge that the teachers have based on their personal experiences in teaching (Rohaan et al. 2012). It is a consequence of blending understanding and transferring experience (Kolb 1984 in Carrier, Tugurian and Thomson 2013). It has an absolute impact on learners` achievement of outcomes of learning (Diamond et al 2014). It gives teachers a direction on how they should conduct themselves (Rohaan et al. 2012) and in choosing relevant teaching strategies when going to class (Halal & Khan 2011). Strategies that can have a positive effect, if chosen well, for successful teaching and learning in class. Shulman (1986) identified among others, three domains of knowledge when teaching: subject matter content knowledge (CK), PCK and curricular knowledge. In contrast, Grossman`s (1990) model of teacher knowledge as cited Rohaan et al. (2012) indicate four domains: Subject matter knowledge (SMK), general pedagogical knowledge, knowledge of context, and PCK.

2.3.1.1 Content Knowledge (CK)

Shulman (1986: 9) terms content knowledge, “the amount and organisation of knowledge per se in the mind of the teacher”. The teacher must able to retract the information from the “substantive knowledge” s/he has attained on his/her academic journey (Starkey 2012:94). Substantive knowledge is composed of “concepts, principles and the nature of the subject”. Moreover, the teacher needs to be in a position of questioning the “why” on the state/theory of a particular concept rather than accepting the theory as it is (Shuman 1986: 9).

The teachers’ understanding knowledge deals with “the knowledge of learners` prior knowledge, linguistic abilities, and learners` interests as well as their misconceptions” (Mudau 2013). If provided in sufficient quantity as required, it will be crucial in “interpreting reform ideas, managing the challenges of change, using new curriculum materials, enacting new practices, and teaching new content” (Ball et al 2001 in Diamond et al 2014:636).

It is however worrying that elementary school teachers indicate considerable aperture in their Science Content Knowledge (SCK), consequently barring adequate teaching (Diamond et al 2014). Knowledge for science content is most definitely the subject matter knowledge (SMK). SMK is an understanding of the content that must be imparted (Rohaan et al 2012). It is the significant precondition for PCK and if it is introduced and developed in teacher trainings, can motivate teachers and influence their PCK positively (Rohaan et al 2012). It is however worrying, as indicated in the study by Usak et al (2011), that teachers show insufficient amount of SMK. Moreover, some studies show that some teachers fail to transfer their SMK to the classroom (Bartos et al 2014). Subject coordinators should therefore create workshop activities that allows teachers to utilise their SMK, consequently positively inducing their PCK.

Learner prior knowledge is one of the most significant part of the lesson as it tells the teacher the level of knowledge the learners have already acquired from lower grades or previous learning experiences. It therefore becomes important that the teacher check on learners` prior knowledge, allowing them to match the previous knowledge with their new emerging learning (Mesa et.al 2014). Waight and Gillmeister (2014) indicate the significance of prior knowledge in selecting relevant instructional strategies and how its absence can affect learning.

Misconceptions speak more about the scientific misinterpretations of certain concepts of the subject (DiSpezio 2010). These misunderstandings can block learners' effective learning of science (Burgoon et.al 2010). Further, the misconceptions can arise in class, if a teacher gives learners a lot of content at once during a lesson (Rosenshine 2012). The teacher's knowledge of content therefore needs to be top notch in order to identify with certainty, the misconception associated with his/her topic in class. The teacher needs also to consider learners' different linguistic abilities. In linguistic abilities we have linguistic intelligence which entails one`s ability to use the language in varying forms (Woolfolk 2013).

The pedagogical content knowledge is the knowledge the teacher possesses as a result of being able to demonstrate with accuracy "how to teach the content and how to match instruction to student differences" (Woolfolk 2013: G-9). Given the above-mentioned, the teacher needs to be able to demonstrate remarkably, how to teach the content in the PEB taking into consideration all types of factors that may hinder the process of teaching and learning. Moreover, the teacher should be able to demonstrate to the learners how the content is accommodated in the science learning area/discipline (Price & Nelson 2007). What is more important to consider from a teacher`s point of view is that students learn differently and come from different environments and possess different learning experiences.

2.3.1.2 Pedagogical Content Knowledge (PCK)

Pedagogical content knowledge (PCK) is one of the most critical factors that have an effect on learning (Karisan et al 2013). According to Woolfolk (2013), PCK is the type of knowledge that a teacher has which is a combination of him/her being a subject specialist with being competent in teaching the content. It is an identification of what makes learning in any circumstances achievable (Shulman 1986). Furthermore, the teacher should have skills to teach learners "substantive knowledge" of one specific learning area (Shulman 1986 in Starkey 2012: 95).
In addition, PCK is a procedure offering learners specific "concepts, methodology or principle" with the focus on how they learn together with the "context and resources" forming part of learning (Starkey 2012: 95). As an example, for a teacher to teach environmental impact of mining, the teacher needs to have substantive knowledge about the environment in which mining takes place. The focus of PCK is not only on the knowledge of a particular topic by the teacher but also on his/her actions in class and reasons for those moves (Aydeniz & Kirbulut 2014). Moreover, according to Aydeniz and Kirbulut (2014), the teacher PCK is presented in two forms: "espoused/planned PCK and enacted PCK. With espoused PCK, the focus is on the development of teacher's PCK whereas enacted PCK deals with the implementation of PCK in class (Aydeniz & Kirbulut 2014).
Further, some studies indicate PCK as a form of identifying efficient instructional strategies to be used in a particular subject in order for students to understand (Ben-Peretz 2011; Kaya 2009; Shulman 1986 in Diamond et al 2014). Moreover, the teacher will not only be able to choose the strategy but will also be able to know how and when to use them, consequently allowing learners to excel in "concepts, skills and methodologies" relevant to the learning area (Starkey 2012:95). Such a teacher is effective in his/her teaching (Starkey 2012). The said instructional strategies, if chosen well can help in rooting out misconceptions of the subject matter by "reorganising learners` understanding". Olfos et al (2014) identified "the development and selection of tasks, the election of representations and explanations, the facilitation of productive classroom discussions, interpretation of learners' responses, the emphasis on student comprehension and the quick and appropriate analysis of student mistakes and difficulties" as components of PCK. More significantly, the teacher should be able use instructions that accommodate learning differences. This can be helpful in the creation of well-planned lessons (Woolfolk 2013).
Furthermore, Berry et al (2012: 224) add that "PCK is the transformation of subject matter, pedagogical and contextual knowledge into a unique form a Transformative model". According to Shulman (1986) in Halai and Khan (2011), transformation of knowledge implies the ability of a teacher to utilise specific instructional methods in teaching a particular topic, allowing him/her to adjust his/her subject knowledge for "pedagogical purposes", and to reorganise his own

knowledge of the science content. Moreover, each teacher is special in his/her own way and has a distinctive PCK (Halal & Khan 2011).

Pollard (2010) labels pedagogy as a set of instructional practices for educational purposes nourished by knowledge structures. The said knowledge will be comprised of both the experiences and evidence combined with values and morals (Pollard 2010). Berry et.al (2012) term it a “bag of teaching tricks”. These tricks should convert passive learning to the more active learning (Shindler 2010). It therefore becomes very imperative that the teacher should be advanced in knowledge to facilitate the latter mentioned in class.

Jang and Chen (2010) view PCK as the break-even point between the content and the pedagogy. In addition, Halai and Khan (2011) as cited in Carlsen (1999); Grossman (2005) and Shulman (1986) indicate that PCK emerge from science content knowledge and general pedagogical knowledge. Therefore, for an effective PCK one should consider transformation of the pedagogy, content knowledge and contextual knowledge as indicated by Berry et.al (2012). This is also substantiated by Otto and Everett (2013: 400) who indicate that a “simplistic presentation of PCK is: context + content + pedagogy”.

Further to that, Rohaan et al (2012) in Rohaan et al (2010) identifies three components for the PCK in primary school technology education: “(1) knowledge on learners’ concept of technology and knowledge of their pre- and misconception related to technology; (2) knowledge of nature and purpose of technology education; (3) knowledge of pedagogical approaches and teaching strategies for technology education” (Rohaan et al 2012).

However, since the focus is on science teachers` PCK, Magnusson et al (1999) as cited Karisan et al (2013) seems more relevant. According to Karisan et al (2013) Magnusson et al (1999) introduced five components of PCK: “orientation towards science teaching; knowledge about science curriculum; knowledge about science students` understanding of specific topics; knowledge about assessment in science; and knowledge about instructional strategies for teaching science”. With knowledge on learners` understanding of Science the focus is on teachers` focus on topics of a particular PEB strand that are perceived to be tough. Moreover, the teacher should be well aware of his/her learners’ different abilities in order to facilitate the lessons efficiently (Karisan et al 2013). The teacher should also know which parts of learning can be assessed and also which assessment techniques should be applied (Karisan et al 2013).

Moreover, Ball et al (2008) in Chapman (2013) identifies three kinds of PCK: “knowledge of content and students, knowledge of content and teaching, and knowledge of curriculum”. It is therefore critical that misconception and pre-conceptions about the PEB topics, nature and purpose of science and knowledge of relevant instructional strategies when teaching the PEB in a Natural Sciences class should be considered and resolved. The teacher should also be well conversant with the curriculum in general.

The above-mentioned components of PCK indicated by Rohaan et al 2010, Ball et al (2008) and Magnusson et al (1999) can be summarised as in table 2.1 below

adapted from Abell et al (2009) and Veal and MaKinster (1999) in Faikhamta and Clarke (2013).

Table 2.1: Teaching framework for teaching Science (2013)

PCK components	Sub-components	Descriptions
Orientations toward teaching about teaching Science	Beliefs about learning how to teach	A general way of teacher educator's thinking about science teachers` learning to teaching science
	Beliefs about teaching how to teach	A general way of teacher educator's thinking about purposes and goals of the method course and ways to help science teachers reach the goals
Knowledge of science teachers' conception of learning	Knowledge of science teachers' PCK for teaching science	Understanding of science teachers' conceptions of the nature of science, teaching and learning science, science curriculum, student conceptions and learning, teaching strategies and assessment for learning science.
	Knowledge of science teachers' learning	Understanding of science teachers' variations approach to learning, their abilities and skills in the teaching as well as their difficulties in teaching.
Knowledge of science methods course curriculum	Knowledge of a science teacher education curriculum	Understanding of goals and objectives proposed in a science teacher preparation program and a science method course
	Knowledge of curriculum saliency	Understanding of goals and objectives in the topic(s) or issues in science teaching being taught during the term, and what science teachers learned in the previous year and what they are expected to learn in the later years
Knowledge of instructional strategies for the teaching of the course	Knowledge of subject-specific strategies	Understanding overall instruction processes or sequences for teaching the science method course
	Knowledge of domain-specific strategies	Understanding of ways to represent specific concepts of PCK for teaching science and PCK for teaching chemistry, biology or physics
		Understanding of how to support student teachers' thinking by using specific representations such as analogies, illustration, examples, demonstrations, and simulations
Knowledge of assessment for scien	Knowledge of dimensions of	Understanding of what teacher educators know about aspects of science teachers' learning, for

	science teachers' learning	example, their reflective thinking, PCK, attitudes towards teaching science, problem-solving abilities etc
	Knowledge of methods of assessing science teachers' learning	Understanding of ways or strategies teacher educators use to assess of science teachers' learning in a particular unit of study, for example journal writing, surveys, reports and portfolios, etc.

(Source: Abell et al (2009) and Veal and MaKinster (1999) in Faikhamta and Clarke)

In their study of experienced science and technology teachers' PCK, Karisan et al (2013) found that the teachers under study indicated knowledge on goals and objectives of the science curriculum, learners' prior knowledge, and forthcoming teachings of the liquid pressure topic. Some studies prove that teachers` "knowledge of other subjects and technological PCK" among others have an effect on application of a consolidative procedure to Mathematics and Science education (Riordain et al 2016)

Moreover, it is also imperative for a teacher to consider the context at which learning and teaching is going to occur. That is what is referred to as the contextual knowledge which Feldman and Herman (2014: 1) call "knowledge of the context of teaching, which includes who they teach, where they teach and what they teach". It relies on ethical, political, economic and social factors. It therefore should be indicated that "one size fits all should be rejected at all costs" (Feldman & Herman 2014: 1).

2.3.1.3 Classroom contextual knowledge

The context knowledge deals with the ability of the teacher to consider contextual factors associated with learning. The teacher should "create a real world environment" (Nieman & Monyai 2006:8) since "learning should take place in realistic and authentic settings" (Nieman & Monyai 2006:8). To add on that, Booyse and Du plessis (2008) indicates that a teacher needs to take into much consideration, the context of learning when designing lesson programmes. Furthermore, learning is a process of social interactions and as a consequence should take place from a social context (Rutten 2014). Starkey (2012) contends that having effective contextual knowledge will result in pedagogical decisions.

Koens et al (2005) classified context into three dimensions: the physical dimension of context; the sematic/cognitive dimension of context; and the commitment dimension of context. The physical dimension of context refers to the "physical surrounding" that a learner finds him/herself in (Koens et al 2005: 1246). Its components are not directly relying on the learning activities (Koens et al 2005). The sematic/cognitive dimension of context is about the coherence between what the learner knows and his/her information of the context that can

assist him/her in the learning activities which also include the learner's prior knowledge (Koens et al 2005). The commitment dimension of context on the other hand deals with issues relating to the "learner`s motivation" in a learning activity which comprise their "emotional involvement and their will" to participate in the activity (Koens et al 2005: 1247).

Furthermore, context is composed of "resources, policies, procedures, goals, culture, identity, and language" (Starkey 2012: 98). Resources in the science context can include tools, apparatus, materials, books, and consumables (DBE 2011a). The local community, the libraries, models, posters, and internet are other resources that can create a good context of learning (Starkey 2011a). Moreover, educational policies such as CAPS, Natural Sciences subject policies, assessment policies, are designed in such a way that they offer procedures relevant to the natural sciences. It therefore is of significance that the teacher considers all relevant policies that are directly linked to Natural Sciences as that could channel the way for an effective teaching and learning in the subject. Moreover, the teacher must be able to select relevant resources for a particular type of a lesson with its specific topic in mind.

The context also should assist the teaching and learning to achieve its goals (Starkey 2012). The teacher could have goals such as having 75% of the learners passing the subject or learners attaining some particular skills such as observing or analysing. The goal might be attained from different levels – the class/subject level, the school level or/and the national level (Starkey 2012). Therefore, the teacher should consider planning in a way that they achieve these goals (Starkey 2012). Moreover, the goals should be structured in a way as to accommodate the three specific aims as outlined in CAPS NS document (DBE 2011a).

Furthermore, the teacher need to create the culture that pertains to Natural Sciences. Culture in a subject context is the manner of doing things. Wearing laboratory coats, holding hot chemicals in bottles with toggles, performing experiments of flammable or toxic chemicals in fume cardboards, not eating in laboratories, are some of the cultures in Natural Sciences. Moreover, the culture and language utilised in Natural Science context should be able to assist learners in achieving identity (Starkey 2012). Further, language usage in science is of importance (DBE 2011a). The Natural Science learners are required to be able read and write well as this would allow them to "communicate" effectively, ultimately expressing their feelings and thinking throughout their learning (DBE 2011a). The teacher therefore is required to create an effective context for language usage, ultimately having successful Natural Sciences teaching and learning.

2.3.2 Instructional Strategies

This is the critical point of any lesson. Before an educator resumes a lesson, he/she needs to know which direction she/he would be taking. That of course will begin with how the lesson was planned. Booyse and Du Plessis (2008) emphasise the significance of choosing the relevant strategy whenever planning

lessons in order to accommodate learners` needs. This is in line with Killen (2007: 57), who indicate that when planning the lessons, the teacher will need to make decisions and considerations of the lesson outcomes – what outcomes need to be achieved, how they will be achieved and how the achievement will be determined. Further, the learning outcomes are key in modifying and varying the teaching strategies in class (Nieman & Monyai 2012). In addition, it is intriguing to note that "achievement, motivation and efficacy" is proportional to the teachers` usage of a variety of instructional strategies in the learning class (den Brok et al 2005; Pianta 1999 in Smart & Marshall 2012). Therefore, a teacher cannot rely on only one strategy in facilitating the lesson (Halal & Khan 2011).

The Classroom Practice Diagnostic Framework (CPDF) identifies among others, epistemological perspectives, traditional teaching methods, explanatory frameworks and activities as main components of instructional strategies (Mudau 2013). In epistemological perspectives, epistemology "is the philosophy of knowledge" (Siemsen 2011: 246). The teacher needs to have epistemological beliefs in order to build learners' motivation, affecting strategies being used (Woolfolk 2013: 442). Epistemological beliefs are beliefs about how knowledge is attained putting into consideration, its "structure, stability and certainty" (Woolfolk 2013: G-4). Cho et al (2011) describe them as "the Nature of Science (NOS), which are context-specific beliefs about knowledge and knowing of science". The NOS is the approach used to attain knowledge or "values and beliefs" that are intrinsic to the advancement of "scientific knowledge (Cho et al 2011).

Moreover, Abd-El-Khalick cited in Karakas (2008:236-237) presents undergraduate students` views on NOS as follows:

- Tentativeness – scientific knowledge will transform from emerging observations with the repeated analysis of such observations.
- Empirical bias – scientific knowledge originates from observation of the surrounding.
- Subjectivity – science relies on scientific theories and laws currently available.
- Creativity – scientific knowledge emerges from cognitive abilities of individuals.
- Social and cultural embeddedness – science depends on the communities and backgrounds under practice.
- Observation and inferences – science is built on observations and their deductions.

- Theories and laws – laws indicate connection between variables whereas theories are interpreted observations.

Explanation frameworks are schemas teachers apply when using “analogies, metaphors, examples, axioms and concepts” (Geelan 2003) in teaching the topics in Planet, Earth and Beyond. Analogies are frameworks which are followed by activities wherein learners would draw, label, write, and model, investigate, discuss, name, sequence, dissect, research (DBE 2012). The activities would in the context of PEB strand, engage in modelling how the spheres of earth - lithosphere, biosphere, and hydrosphere interact with one another and with the biosphere (DBE 2012).
Traditional teaching methods are methods which are teacher-orientated (Boumová 2008) and do contrast with active learning strategies which are learner focused (Nottingham & Verscheure 2010). Traditional methods are widely criticised as they are perceived as passive form of learning, where learners just sit, listen to the teacher and take notes (Kaddoura 2011). Consequently, the learners taught with this method become “shallow, surface thinkers” who basically depend on memorising instead of properly understanding the content (Kaddoura 2011). Furthermore, these methods do not accommodate “higher order skills such as application in analysis” (Cashin 1985 in Nouri 2016). It therefore becomes imperative that the educator applies teaching methods which are learner – centred, actively involving them throughout the process.

In order to do away with traditional methods of teaching, active learning should be followed in class. Willams (2007) terms active learning as a “pedagogy that requires students to confront directly the complexity of real world events within appropriate theoretical framework”.
Some learner-centred strategies include problem based learning (PBL) which adopts the constructivism approach (Hmelo-Silver 2004). According to Holm 2011 in Habok and Nagy (2016), PBL is a learner-centred directive that takes place at a prolonged interval whereby learners prepare, investigate and bring about an outcome that serves as a response to a difficulty. Furthermore, PBL also bases its outcomes on advancement of skills with the focus on knowledge obtainment (Habok & Nagy 2016). In addition, PBL allows learners to investigate authentic task which supports team work and allows emergence of “cross-curriculum skills” (Hopper 2014). Further, the tasks act as “springboards for investigations and inquiry” (Arends 2012: 396).

Arends (2012: 397) outlines the following as special features of PBL:

- Driving questions or problem

  PBL structures guidance on questions and issues that have social and

personal significance to learners, deal with authentic life cases requiring cognitive demanding responses which carries critical solutions.

- Interdisciplinary focus

In this regard, the problem is given in such a way that it can be solved by exploring different subjects or learning areas. In the context of NCS, the integration of related subjects.

- Authentic investigation

Learners need to undertake investigations that follow authentic problems to achieve authentic solutions. They should be able to follow authentic science procedure such as definition of a problem, hypothesising, predicting, collecting data, analysing information and concluding. This procedure will vary according to the type of the problem.

- Production of artefacts and exhibits

PBL requires learners to produce from science inquiry, their own artefacts and exhibits. Learners may produce scientific reports that will report on their work that they need to display to others.

- Collaboration

PBL allows learners to work in teams when learning. This has a good effect on learning as some tasks might prove difficult to some while easy to others, so having learners working in teams allows them to have alternative paths for inquiry and discussion, increasing their motivation.

Nieman and Monyai (2006: 112) identify inquiry learning, problem solving and research project as the PBL strategies. According to Nieman and Monyai (2006: 113), inquiry learning is an approach wherein learners are urged to "question, explore and discover". Learners are the active participants of a number of stages of learning that permit the advancement of "knowledge" (de Jong 2006 in van der Meij et al 2015). Furthermore, it is through scientific inquiry that knowledge is developed (Kock et al 2013). The stages of inquiry would involve "formulating hypothesis, experimenting, and drawing conclusions" (de Jong 2006 in van der Meij et al 2015). Further, inquiry allows learners to develop knowledge of basic science procedures (Hartikainen 2008) and utilise them to engage in the science content (Miller et al 2014).

Moreover, in their study, Chang et al (2010) introduced and displayed the four *Facets of Competence in Scientific Inquiry* as follows:

Applying the above mentioned facets of scientific inquiry in class is crucial, as it would allow learners to experience science in progress (Kock et al 2013). It is therefore proper that the Natural science teacher should be well conversant with the mentioned four facets as they are basis of scientific inquiry. Moreover, some studies indicate that teaching learners' science through inquiry moulds their classroom experience and attitudes on science (Zhai et al 2014).
Problem solving is one`s ability of utilising "cognitive" techniques to work out authentic, "cross disciplinary" circumstances which do not bear apparent resolution route and where "curricular areas" to be utilised are not found in individual field of mathematics, science or reading (OECD 2003:156). Moreover, the OECD countries formulated the following as a tool to assess learners` ability:

- Identify problems in cross-curricular settings,
- Identify relevant information or constraints,
- represent possible alternatives or solutions path
- select solution strategies
- solve problems
- check or reflect on the solutions, and
- communicate the results (from OECD 2003)

Further, some research shows analytical problem solving skills have a positive impact on school learners` progress and advancement of higher order thinking (OECD 2004 in Scherer and Beckmann 2014). These skills are the most definite intelligence accomplishment of an individual (Polya 1962 in Doorman et al 2007). Interestingly, learners need to have a number of knowledge forms in order to solve scientific problems effectively (Pol et al 2005). Declarative knowledge, procedural knowledge, conditional knowledge, conceptual knowledge and situational knowledge are the kinds of knowledge identified by De Jong and Fergoson-Hessler (1996). Arends (2012) adds factual knowledge to that list of knowledge types. Learners with factual knowledge know "basic elements" with regard to a particular subject theme (Arends 2012: 268). With declarative knowledge, the focus is on "knowing about something" whereas with procedural knowledge, the emphasis on the knowledge on "how to do something" (Price & Nelson 2007: 4).
Price and Nelson (2007) recognise facts, concepts and principles as the components of declarative knowledge. With facts, the focus is on details, for example; it is a fact that the atmosphere, biosphere, lithosphere and the hydrosphere make up the earth`s system. Concepts are "objects, events, actions, or situations that share a set of defining characteristics" (Price & Nelson 2007: 4). Compounds are example of concepts. All compounds are made up of two or more atoms of different elements. Principles are laws that determine the

homogeneity between two or more variables (Price & Nelson 2007). As an example, a rise in the average temperature of the atmosphere will result in global warming.

Knowing how to do something is procedural knowledge (Price & Nelson 2007:4). For a learner to know how to do something, they must know the basics first-declarative knowledge. As an example, for learners to undertake an experiment on global warming, they must be conversant with the method of measuring temperature. Therefore, both procedural and declarative knowledge work together and rely on each other (Price & Nelson 2007: 4). Moreover, it is critical for the teacher to have timing on when to apply a given knowledge and therefore s/he will be displaying conditional knowledge (De Jong & Fergusson-Hessler 1996). Hence, it is very important for the teacher to know which knowledge you expect the learners to gain (Price & Nelson 2007: 4).

Situational knowledge is a knowledge about specific situations as they may appear in a particular dominion (De Jong & Fergusson-Hessler 1996). This is key knowledge for a problem solver since it allows him/her to analyse significant pieces from the problem statement and even complement the statement (De Jong & Fergusson-Hessler 1996). Moreover, the problem solver should have conceptual knowledge that allows him/her to supplement facts to the problem, ultimately providing solutions (De Jong & Fergusson-Hessler 1996). In order to initiate problem solving, the teacher should display most if not all these types of knowledge in class.

Research/projects or project based learning is the type of learning which puts its focus on life-daily issues, which with the teacher`s help allows learners to explore and solve problems through team-work (Lee & Tsai 2003). Further, this learning focuses on “authentic” cases which learners appreciate. Learners would in the process attain “content, knowledge and skills” (Lee & Tsai 2003).

Instructional strategies are like gears needed to take a car forward. They are the methods or approaches to learning. Conklin (2007: 5) indicate these strategies as those “needed by teachers to enhance learning for diverse learners”. However, a teacher should not rely on one strategy when going to class (Halai & Khan 2011). Further, in order for one to correctly consider which strategies to apply in class, learners’ individual differences need to be considered.

Bennett (2007) introduces the concept of differentiation instruction which would meet leaners’ individual needs. Differentiation strategies are those strategies which allow teachers to have a proper and imperative lesson planning in order address learners` diverse needs, consequently achieving specific goals (Bennett 2007). It is further added that most children fail to progress in class because teachers do not afford leaners room to utilize their individual style of learning in the classroom (Bennett 2007). Learning style is an individual`s manner of advancing learning (Woolfolk 2013) in his or her preferred way (Nieman & Monyai 2006). It involves visual or auditory learning, engaging in group work, individual work or even being allowed room to move when learning (Nieman & Monyai

2006: 82). The teacher should accommodate learners` different ways of learning when approaching teaching. This can lead to adequate and effective learning (Nieman & Monyai 2006: 82).

2.3.3 Interactions and discourse

Classroom discourse is the "distinctive type of discourse that occurs in classroom" (Behnam & Pouriran 2009: 118). Maree (2014) refers to it as the self-expression with words and using many forms of language and making it flexible as it is normally used. It is a diverse engagement that takes place between the teacher and learner, which are best practiced orally (Smart & Marshall 2012). Consequently, discourse can assist learners in "meaning making of science concepts" (Duit & Treagust 2003 in Smart & Marshall 2012). Moreover, Classroom interactions have a good impact in moulding and creating effective learning (Van den Oord & Rossem 2002 in Smart & Marshall 2012).

Three forms of discourse are known. Mudau (2016) mentions these forms as authoritative, reflective and dialogic.

2.3.3.1 Authoritative discourse

This is a type of discourse which restricts combination and consideration of ideas in class (Scott et al 2006). It relies on the dominant voice which cannot be adjusted to suit the receiver (Hsu & Roth 2014). As a result, a no direction approach of learning is taken (Mortimer and Scott 2003 in Gan Joo Seng & Hill 2014), with the focus on a single achievement (Bielik & Yarden 2016). Its primary purpose is to transmit definite details to the obedient acceptors (Tytler & Aranda 2015). Further, learners are lead to the cultural received thoughts wherein the scientific viewpoint is offered (Kanadlı & Sağlam 2016). This simply implies that what the teacher says goes, whether it bears fruits to learning or not.

2.3.3.2. Dialogic discourse

Dialogue is the type of interchange of language between two people wherein one offers while another receives (Uebel 2007 in Kim 2011). The speaker talks while the listener responds, followed by the same the other way around (Bakhtin 1986 in Kim 2011). In the context, the teacher asks questions to trigger learners` thinking and opinions, consequently forming a correlation between them (Lemke 1990 in Smart & Marshall 2012). This is what is referred to as teacher questioning. It is a critical aspect in a classroom that results in an adequate classroom discourse (Smart & Marshall 2012).

Moreover, teacher questioning can be implemented from two perspectives - the inquiry and non-inquiry context (Smart & Marshall 2012). In inquiry context, the teachers` aim is to bring out learners` thinking and opinions and ultimately allowing them to work on them (Lemke 1990 in (Smart & Marshall 2012). The teacher applies his/her flexile skills by varying his/her questions to elicit learners

in higher-order thinking (Chin 2007 in Smart & Marshall 2012). This method proved to be effective as according to Redfield and Rousseau (1981) as cited in Arends (2012: 434), probing high-order and "thoughts-provoking" questions influence learners success and cognitive ability positively. Moreover, the type of

DIALOGIC DISCOURSE	**Low level of inter-animation of ideas**	**Different ideas are made available on social plane. For example: teacher lists student ideas on the board.**
	High level of inter-animation of ideas	Different ideas are explored and worked on by comparing, contrasting, and developing

Questioning the teachers adopt in class relies on the type of learners they have together with the outcomes they wish to attain (Arends 2012).

The "level of difficulty" in the teachers` question should also be considered. Brophy and Good (1986) in Arends (2012: 434) remarked three guidelines to be considered by the teacher in structuring the questions considering the difficulty:

- A large proportion (perhaps as high as tree-fourths) of a teacher`s questions should be at a level that will elicit correct answers from students in class.
- The other one-fourth of the questions should be at a level of difficulty that will elicit some responses from students, even if the response is incomplete.
- No question should be so difficult that students will not be able to respond at all.

TABLE 2.2: Discourse and Inter-animation of Ideas. Source: Scott et al (2006)

In contrast to the inquiry, in the non-inquiry context the teacher asks "closed questions" as a way of assessing learners` knowledge (Smart & Marshall 2012). One other important aspect of dialogic discourse is the inter-animation of student ideas. In this regard ideas can either have low levels or high level as shown on Table 2.2.

Dialogic discourses were explored by Vavilis and Vavilis (2004). They expanded it to the level of debate and inquiry. Inquiry is an "approach in which the teacher presents a puzzling situation and students solve the problem by gathering data and testing their conclusion" (Woolfolk 2013: 366). Vavilis and Vavilis (2004: 282) indicate that students need to participate fully in the subject matter in order to undertake activities in certain areas of the subject. Subject matter need not be

rooted in isolation in order to make learning conditions more favourable and effective (Vavilis and Vavilis 2004).

The findings of the study by Molinari et al (2013) indicate that the discourse in the class may undergo four different ways: dialogic sequences as a result of pure questions, monologic sequences that meet calculated didactic by the educator, co-constructive sequences that encourage reasoning and thinking coupled with being deductive, and finally scaffolding which assist children with difficulties (Molinari et al 2013). However, Schiller and Joseph (2010) interestingly came up with a tetrahedron framework for a classroom discourse which replaces the traditional approach. In the said framework, teachers and students are equal partners in the learning process. The framework allows more interaction between students, creating a dialogic discourse. Furthermore, the framework gives room for more inquiry in class (Schiller & Joseph 2010).

2.3.3.3. Communicative approach

The communicative approach focuses on how a teacher communicates with the learners (Scott et al 2006). It is critical in establishing opinions and awareness of learners which rely directly on social coherence (Belik & Yarden 2016). Scott et al (2006) came up with two dimensions of communicative approach in learning: dialogic-authoritative and interactive/non-interactive.

Dialogic-Authoritative

In this regard, the teacher uses the Authoritative discourse approach in class which he/she later adapts to the dialogic discourse. in the context, the teacher approaches the lesson with a focus on a single meaning, however during the point where learners attempt to comprehend the meaning, different ideas are therefore acknowledged (Scott et al 2006). In Planet, Earth and Beyond, the teacher focuses on the learners` prior knowledge on the topic: Spheres of Earth. He/she later on asks learners to draw a flow diagram on interaction of the four spheres on earth. In this case, a varied number of ideas will be explored (Scott et al 2006), between learners and teacher, and also among learners themselves.

Interactive/Non-interactive

In this case the focus is on whether the communication approach allows involvement of other people or not. If two or more individuals are involved in the communication, then the communication is interactive, and if not, the communication is non-interactive as others are left out (Scott et al 2006).

TABLE 2.3 Four classes of communicative approach

	Interactive	No interactive
Dialogic	Interactive/Dialogic	Non-interactive/Dialogic
Authoritative	Interactive/Authoritative	Non-interactive/Authoritative

(adapted from Scott et al 2006)

2.3.3.4 Patterns of discourse

Graesser et.al (2003) recognises the initiation, learners' response and teacher`s feedback as patterns of discourse in class. The three components were included in the study by Molinari et al (2013) who introduced the initiation response-feedback (IRF) pattern belonging to Sinclair and Coulthard. The IRF is a three-fold figure wherein, firstly the teacher initiates communication by probing a question to a learner, the learner will then respond to a question, and then the teacher will finally respond, giving feedback in the process (Molinari et al 2013). This is what is referred to as traditional classroom discourse, a too teacher-centred approach where all occurrences in class revolves around him/her (Schiller & Joseph 2010; Arends 2012). In the context, the teacher dominates the talk in the class, with a small number of learners taking part (Arends 2012).
Moreover, Lemke (1990) labelled the abovementioned discourse as the "triadic discourse" which follows the Initiation-response-evaluation (IRE) form, wherein the "E" represent the evaluation of learner/s` response instead of the teacher feedback in the IRF. Further, Scott et al (2006) identify the authoritative discourse as a discourse wherein IRE pattern is fully practiced, hence it is unable to support "collaborative learning" (Alexander 2004 in Seng and Hill 2014). It is however interesting to note that 70 % of the classroom discourses follow the IRE patterns (Wells 1999 in Moore & Hoofmaan 2012). This is expatiated by Alexander (2001) cited in Molinari et al (2013) by indicating that IRF is the most prevalent and prominent pattern of classroom interactions, hence the most important element of "classroom talk". Some authors however indicate the "harmful" effect of this dominance in class (Arends 2012: 457). Therefore, the usage of other alternative discourses such as "think-pair-share" might be considered in class as it yields learners` improved thinking (Arends 2012: 457).
Despite the recognition of IRF/IRE pattern`s dominance and significance, criticisms have also been labelled on the pattern. Cazden (2001) as cited in Moore and Hoofmaan (2012) indicate the usage of "display questions" by teachers in class as one of the critiques. "Display" questions are the ones the teacher probes to learners with the answer in mind (Moore & Hoofmaan 2012). They are however not negative as they allow critical understanding of content (Moore & Hoofmaan 2012). Cazden (2001) in Moore and Hoofmaan also indicates the limitations on the "complexity of the classroom discussions in terms of reaching goals for higher-level thinking and the active engagement of learners in meaning making processes".

Interestingly, the patterns can have open and closed chain patterns (Scott et al 2006). According to the author, the open and closed chain patterns provide an alternative for evaluating the learner/s wherein the teacher evaluate the response to the students, with a purpose of aptness on their view point (Scott et al 2006). The open chain pattern is characterised by the I-R-**P**-R-**P**-R- form with **P** representing prompt. The teacher`s prompt allows the learners response to move from a response to another response instead of evaluation. However, some sequences may have evaluation at the end of the chain (I-R-P-R-P-R-P-R-**E**) – and hence be referred to as closed chain pattern (Scott et al 2006).

Further, the discourse in class may also follow other non-triadic patterns (Scott et al 2006). In this regard the form will follow I-Rs1-Rs2-Rs3-Rsn wherein Rsn represents a respond from one specific learner. In the context, the teacher initiates the lesson with a question followed by a response from one particular learner, which will influence a comment or response from other learners in sequence. Moreover, the learners in that particular pattern may not be directly responding to the teacher but end up responding to each other (Scott et al 2006).

The CPDF also indicate teacher questioning and communicative approach as other aspects of classroom discourse (Mudau 2013). Teacher questioning is believed to have a positive effect on learning as it allows learners to think deeply and apply their knowledge (Graesser et al 2003). With teacher questioning, the focus is on combining the classroom interactions with problem solving (teflpedia.com).

McNeill and Pimentel (2010) determined argumentation in an urban high school classroom. Transcripts were used to collect data from three teachers` classrooms. The analysis was made on both the arguments and dialogic interplay between the students. The findings indicate dialogic interactions in one classroom which indicated student-to-student interactions which were more positive. Students engaged on their views and views of others, focusing on their thinking. In as far as argumentation is concerned, between 19 to 35 % of student were part of science argumentations in other classrooms, using evidence and reasoning. This was due to the use of open-ended questions by teachers (McNeill & Pimentel 2010)

On the other hand, Julie and Jeff (2013) studied the interaction between the teacher questioning classroom discourse and the students` cognitive engagement in middle school science. The questioning was structured in the following aspects: questioning level, complexity of questions, questioning ecology, communications patterns, and classroom interactions. 10 middle school science classrooms were observed with aid of the Electronic Quality of Inquiry Protocol. The findings indicated a direct correlation between the classroom discourse and students` cognitive level (Julie & Jeff 2013).

Another study by Navas (2013) explored the lecturer-student interactions in English medium science university lectures. The study found that with the dialogic lecturer-student interaction, students are more active in their discussions in contrast to the non-dialogic interactions through recitation scripts. The former

proved to yield an environment which is more helpful to learners, who ultimately develop content language. The student-lecturer interaction proved to be triggered by the language proficiency even though learners felt that the approach used by lecturers as more important (Navas 2013).

Killen (2007) mentions the reflective teaching index (RTI) developed by Zeichner and Liston. The RTI was based on the four types of discourses: factual, prudential, justificatory, and critical. Factual discourse looks at what had happened in class. Prudential discourse deals with assessing how effective were the occurrences in class (Killen 2007). Justificatory discourse justifies the occurrences in class. Critical discourse is based on values and beliefs (Killen 2007). It therefore becomes imperative that a teacher who is good in planning a lesson should also be a good in reflecting the said lessons.

2.4. THE CONCEPTUAL FRAMEWORK

The conceptual framework is the body of idea/s that outlines all details given out in the write-up (Antonenko 2015). It relies entirely on the views of the researcher on the "construct of theory" (Antonenko 2015:55). It is a string or chain indicative of the reasons for undertaking the study (Ravitch and Riggan 2012 in Antonekko 2015). This study utilised the theory of constructivism as its lens.

Constructivism is a learning perspective that focuses on construction of knowledge and realisation of details and facts by prioritising vivacious learning (Woolfolk 2013; Shutkin 2004). Learners will therefore "create ideas based on their previous experience, test them, and draw their conclusion" (Fire & Casstevens 2013) . Hence prior knowledge is critical in a constructivism classroom (Doolittle & Hicks 2003). To add on that, the construction of knowledge is based on two ideas: active learning and social interactions (Woolfolk 2013). The former focuses on individual learner`s perspective whereas the latter is based on construction of knowledge from the social context. This is line with Vygotsky`s view of learning - "Knowledge is constructed based on social interactions and experience" (Woolfolk 2013).

Social interactions stress the knowledge make-up from a social perspective (Doolittle & Hicks 2003), it does not rely on one`s individual world but within a group working together in seeking answers (Bakhtin 1984 in Doolittle & Hicks 2003). The emphasis in this regard is on learning with others` help rather than learning alone (Hickey 2014). "Learners learn from one another as well as from the instructor" (Tinzmann et al. 1990 in Fire and Casstevens 2013). Further, communication is key in social constructivism class (Moore, Beshke & Bohan 2014). It is when learners communicate and interact that they formulate meaning (Moore, Beshke & Bohan 2014). Hence, social interactions in this regard are far-reaching and discrete (Hickey 2014). It is in a particular classroom setting that interactions could occur and it is the purpose of this study to observe such in a natural sciences classroom.

The role of the teacher in a constructivist classroom is more important in that instead of being in the centre of learning as a know it- all, his/her role should

include being able to assist in achieving learning progress (Grier-Reed & Conkel-Ziebell 2009). Furthermore, “Knowledge is not directly transmitted from teacher to learners”, but will be easily received through the teacher`s support (Mikusa & Lewellen 1999 in Brewer & Daane 2003). Such teachers will be in joint-venture with learners in controlling their learning, through “discussions, group projects, and inquiry-based projects” (Carrier et al 2013). Moreover, the teacher must act as a stimulant for the effective learning process (Sharma 2014). The teacher should design lessons in such a way that they foster cooperative learning (Sharma 2014).

Classroom is a social context in which when the conditions are effective can create a good vacuum for learner`s individual construction of knowledge. It is with that in mind that the conditions in class - teacher `s knowledge, the instructional strategies and interactions in the Natural Science classroom can have an impact on the construction of learners` knowledge.

The classroom practice diagnostic framework (CPDF) by Mudau (2016) was considered in building up the conceptual framework. It has a constructivism background and focused on teacher knowledge, instructional strategies and interactions and discourse as does this study (Mudau 2016). The following conceptual framework was constructed for the current study.

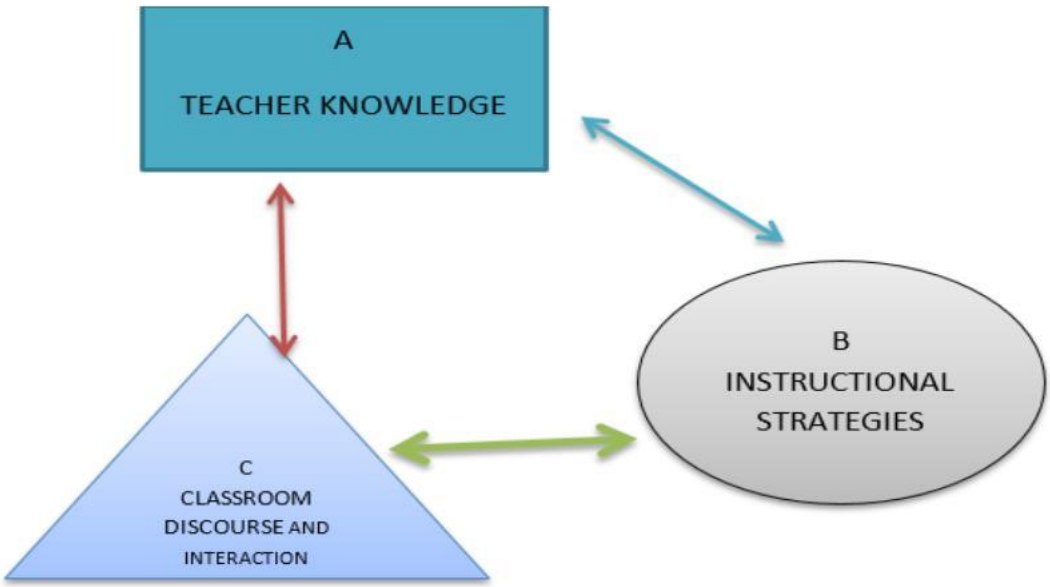


Figure 2.1. The conceptual framework for Natural Sciences classroom practice in the Planet, Earth and Beyond strand

The idea behind the framework is that the teacher`s Natural Science content knowledge, PCK and contextual knowledge will allow him/her the leverage of choosing instructional strategies that are relevant to the PES topic in Natural Sciences class. The approach chosen which include traditional/non-traditional methods, epistemological perspectives and explanatory frameworks will give rise to a choice on types of discourses- authoritative and/or dialogic discourses plus

the patterns of discourses. The most interesting part is that if the types of discourses under area C are not effective, the teacher can always go back to area B to select another approach which can yield efficient discourses and interactions. In other words, moving between these areas would be involuntary (Mudau 2016), with the ultimate goal of eliminating teaching difficulties.

2.5. CONCLUSION

This chapter created an overview of the curriculum and its principles. It also explained the subject Natural Sciences and its strand- Planet, Earth and Beyond in the context of CAPS curriculum. A conceptual framework was therefore created with constructivism as its theory. The teaching difficulty in Natural Sciences is therefore viewed with a focus on teacher knowledge, instructional strategies, and classroom interactions and discourse.

With teacher knowledge, the review was on subject matter knowledge, PCK and contextual knowledge. The instructional strategies looked at the use of traditional/non-traditional methods, epistemological perspective, and explanatory frameworks. The review was mostly done on Problem based learning, inquiry learning and collaborative learning. The classroom discourse looked at the types and patterns of discourse. Several studies were reviewed throughout the chapter. Even though most studies covered most of the topics under review, none of them to the researcher`s knowledge covered the Natural Science subject, specifically in the PEB strand which this study seeks to uncover.

CHAPTER 3

3.1. INTRODUCTION

This study followed a qualitative approach of research (Mcmillan & Schumacher 2010). It was a patchwork case study (Wilson 2013) on educators` content knowledge, instructional strategy and the type of interactions and discourse in the Natural Sciences classroom in the stand of Planet, Earth and Beyond. The data was collected from three different Natural Science teachers using interviews and observations. The chapter covers the following sub-sections: the research design; the qualitative research approach, which includes research instruments used, sampling strategies employed. Validity and reliability of the methodology are outlined; with how research ethics were upheld concluding the chapter.

3.2. RESEARCH DESIGN

The research design is a strategy that portrays the state and course of action for gathering and interpreting the information (McMillan & Shumacher 2010). It is a strategy that gives direction to the researcher in order to allow for the "collection, analysis and interpretation of the observations" (Nachmias & Nachmias 1992 in Yin 2009: 26), ultimately putting the hypothesis to test and answering the research question/s (Johnson & Christensen 2008). Moreover, the research design places the researcher in the "empirical world", consequently linking the research questions to data (Punch & Oancea 2014: 142). Furthermore, research design seeks to answer four issues: "what questions to study, what data are relevant, what data to collect, and how to analyse the results" (Philiber, Schwab & Samsloss 1980 in Yin 2009: 26). This study employed a qualitative study design which Frankel and Devers (2000) as cited in Devers and Frankel (2000: 264), refers to it as a "rough sketch" to be completed by the researcher in the process of the study.

3.2.1 Case study design

The qualitative research has a number of strategies which include among others: case studies, ethnographies, grounded theories, and action research (Punch & Oancea 2014). Johnson and Christensen (2008) adds phenomenology and historical research to the list of qualitative strategies. The researcher's intention in this study was to explore teaching difficulties in Natural Sciences. An interpretive multiple case study design was therefore chosen to investigate a "single case" (Mertens 2010: 233), which in the context of the study is the teacher and his/her practice in class. Further, the reason for choosing a multiple case study was that the phenomenon under study involved more than one teacher (Mudau 2016).

Moreover, the case study inspects the entire "social unit" (Best & Kahn 1993: 193), with the focus on the "kind of the person" rather than the "person" (Bromley 1986 in Best & Kahn 1993: 193), "typicalness rather than uniqueness" (Best & Kahn 1993: 193). Furthermore, there is an intense scrutiny and evaluation of components under study in case study, which seeks to give a clear picture of the circumstances as they occur (Best & Kahn 1993), how they emerge, and how they were dealt with (Newby 2014), which in the current study were teaching difficulties in Natural Sciences.

Furthermore, ethnography is another research design that utilises interviews and observations as its data gathering instruments. However, it is more focused on issues such as "classroom behaviour, learning process, values and behaviour and organisational management" (Newby 2014: 61), which is contrary to the focus of this study whose primary purpose is on exploring teaching difficulties, making the utilisation of the case study design more relevant. Further to that, case study provides an arena for researchers to achieve comprehensive and concise picture of authentic phenomenon (Yin 2009), consequently retaining data which provides a clear portrait of teaching difficulties in Natural Sciences that no other design will show (Hopkins 2008). This notion is amplified by Wilson (2013: 256) who reiterates that the case study is a "versatile", qualitative procedure of research that allows for the realisation of complicated cases and makes the researcher more conversant with the case under study in the way that none of the different designs will.

Moreover, Yin (2009: 4) indicates that it is through case study approach that an input to the knowledge we have about "individuals, group, organisational, social, political and related phenomenal" will be achieved. These are cases (Thomas 2011 in Punch & Oancea 2014). Furthermore, Case study explores teaching practice of participants and opinions of a specific predicament (Bertram & Christiansen 2014). On the same note, it is through case study that a researcher would be able to get to the gist of the "case in depth", and its spontaneous environments, with focus on its "complexity and context" (Punch & Oancea 2014: 148), consequently explaining "what is like" to teach Natural sciences (Bertram & Christiansen 2014: 42). Hence, utilising this approach will allow us to understand better the teacher knowledge in Natural Sciences, the instructional strategies they apply and the type of discourse, and interactions and discourse existing in their classroom.

Furthermore, according to Punch and Oancea (2014: 153-154), case study can have a meaningful contribution to educational research in a number of ways: Firstly, it can build on what is already known but "not yet understood"; Secondly, it can due to its "in-depth" nature, create understanding of significant details of consistent complicated research field, and "conceptualising" them for future research; Thirdly, "exemplary knowledge" of case study can link naturally with "experiences of the participants, readers and beneficiaries of research"; and lastly case studies can play a crucial role in linking with other methods which might yield quantitative data but unable to give a complete "understanding of the

phenomena". This above mentioned steps give a clear rationale for choosing a case study approach to unpack the persistent problem in teaching difficulty which literature has shown to be negatively affecting mathematics and sciences performances.

Case study approach however, has been criticized for its lack of "robustness" (Zainal 2007: 2). However, using multiple-case study can create room for that "robustness" (Herriot & Firestone 1983 in Yin 2009: 53). This is due to the fact that in multiple case study design, "cases are parallel" to one another (Thomas 2011 in Punch & Oancea 2014: 150). Other weaknesses identified to be associated with case studies are due to its inability to represent a bigger chunk of the population, consequently focusing on just a particular confined area (Stark & Torrance 2005 in Miles 2015). However, Newby (2014: 54) contends that studying "individuals case" gives a clear picture of the general predicament. Further, focusing on a particular area creates room for sense of purpose and elicit focus on "value and insight" in the research field (Thomas 2010 in Miles 2015: 314).

Moreover, Flyvbjerg (2006: 221) indicates five criticisms of case studies which he claims were based on misunderstandings. The misunderstandings (Ms) were structured as follows:

Ms1 "General, theoretical (context-dependent) knowledge is more valuable than concrete, practical knowledge";

Ms2 "One cannot generalise on the basis of an individual case; therefore, the case study cannot contribute to scientific development";

Ms3 "The case study is most useful for generating hypotheses, that is in the first stage of a total research process, whereas other methods are more suitable for hypotheses testing and theory building";

Ms4 "The case study contains a bias toward verification, that is, a tendency to confirm the researcher`s preconceived notions";

Ms5 "It is often difficult to summarise and develop general propositions and theories on the basis of specific case studies".

Flyvbjerg (2006: 222-241) therefore came up with corrections (Cs) to the misunderstandings/criticisms:

Cs1 "predictive theories and universals cannot be found in the study of human affairs. Concrete, context-dependent knowledge is, therefore, more valuable than the vain search for predictive theories and universals";

Cs2 "one can often generalise on the basis of a single case study, and the case study may be central to scientific development via generalisation as supplement or alternative to other methods. But formal generalisation

is overhauled as a source of scientific development, whereas the 'force of example' is underestimated";

Cs3 "the case study is useful for both generating and testing of hypotheses but it is not limited to these research activities alone";

Cs4 "the case study contains no greater bias toward verification of the researcher's preconceived notions than other methods of inquiry. On the contrary, experience indicates that the case study contains a greater bias toward falsification of preconceived notions than towards verification";

Cs5 "it is correct that case study summarising is difficult, especially as concerns case process. It is less correct as regards case outcomes. The problem in summarising case studies, however, are due more to the properties of the properties of the reality studied than to the case study as a research method, often it is not desirable to summarise and generalise case studies. Good studies should be read as narratives in their entirety".

Case study utilises a number of approaches or instruments which include among others, documents sources, statistics, external reports, as well gathering data through interviewing, formulation of questionnaires, and observations (Newby 2014). In this study, both interviews and observations were used as research instrument. Interviews were utilised to probe teachers on their experiences in teaching the PEB topics and on how they teach and assess it. The teachers were also observed in the classroom, teaching the topic.

3.3. QUALITATIVE SAMPLING STRATEGY

Qualitative sampling strategy is a technique employed to choose information-opulent cases for a thorough and comprehensive study (Patton 2002 in McMillan & Schumacher 2010). Further, the strategy amplifies the usefulness of the information gathered from minor samples (McMillan & Schumacher 2010). It is simply a strategy employed to choose a "number" of participants in a population (Mertens 2010: 309) in a such a way that that little number would give a clear picture of the whole population (Gay & Airasian 2003). In the same voice, sampling creates a good connection between a sample and the population, consequently allowing the researcher to form deductions from the data (Newby 2014). Moreover, even though this study was a case study research, whose selection of cases is very direct, there was a necessity for sampling of the cases (Punch & Oancea 2014). The sampling for this study, a collective (multiple) case study (Mertens 2010), was structured such that, the difficulties Natural sciences teachers experience in class when teaching the PEB strand topic were identified.

3.3.1 Population and sample size

A population is a set of persons that possess individual or multiple features which are similar and a target of the researcher (Best & Khan 1993). Moreover, it is within the population that a sample is found (McMillan & Schumacher 2010). The population of this study consisted of all Natural Sciences Grade 9 teachers of the Limpopo Province. A sample is a collective consisting of participants who serve as sources for data gathering and who stand for the particular population (McMillan & Schumacher 2010). The sample of the study represented three Natural Sciences Grade 9 educators from the Sekgosese East circuit of the Mopani district.

3.3.2 The setting

The study took place as was stated above in the Limpopo province, in the three school of Mopani District under the Sekgosese East circuit of the Mopani district. The researcher chose the schools under this circuit as it is where he is employed, minimising the costs and travelling distances towards the schools, saving time in the process, and consequently addressing "logistical constraints" (Johnson & Christensen 2008: 243).

3.3.3 The participants

Three teachers from three different schools participated in the study. All of them were Natural Sciences teachers and have been teaching the subject for a number of years. Non-random convenience sampling was employed to select the participants since the teachers were from the schools in a circuit that the researcher is employed, making it simple to reach them (Wilson 2013). Moreover, the three participants were Natural Sciences teachers at their school teaching Grade 9 at the time of the collection of data and had been teaching experience of more than six years. The reason for the choice of the afore-mentioned years of experience was so as to have an insight about the teaching difficulties in the subject.

3.3.4 Sampling strategies

A purposeful sampling strategy was employed in the study wherein the researcher selected participants based on their potential to answer the research question (Teddlie & Yu 2007; Bertram & Christiansen 2014) and also on the selected group of participants` ability to present the features of the population which are of significance to the study **(**McMillan & Schumacher 2010; Wilson 2013). The rational for the usage of purposeful sampling is based on choosing "information-rich cases" for the study (Patton 1990: 169). Moreover, some of the study indicate purposeful sampling as the commonly utilised sampling method in

qualitative research (Palinkas et al 2013) and is very crucial in providing quality insurance (Punch & Oancea 2014).

Criterion sampling was identified as the relevant type of purposeful sampling for this study. This was done so to pinpoint and single out all issues that are relevant to a particular criterion of significance (Palinkas et al 2013; Patton 2002), which in the case of this study is teaching difficulties. Moreover, criterion sampling involves sampling of cases which are "special and unique" (Teddlie & Yu 2007: 81). Furthermore, the criteria chosen provide the blueprint for the methodological rigour (Suri 2011). Moreover, the criteria selected was able to provide participants who are very relevant in answering the research questions and helping achieve study objectives (Niewenhuis 2007).
The participants who met the criterion were teachers who found teaching the Planet, Earth and Beyond topic difficult. The teachers were identified during the Natural Sciences workshop and meetings facilitated by the subject coordinators. Moreover, the teachers chosen were all having teaching experience of more than six years. This was done to make sure the teachers have taught in at least two national curriculums, eliminating the inexperience as difficulty. Furthermore, the teachers had to be teaching grade 9, since Grade 9 was the last grade where Natural Sciences was taught and it is the class that gives final preparation for the FET classes and hence providing gateway for FET subjects such Geography, Physical Sciences and Life Sciences.

The following table summarises the participants` work experience and qualifications. Pseudonyms were used to present the participants.

Table 3.1: Table summarising the participants` information on their gender, qualifications and teaching experience

Pseudonym of teacher	Gender	Highest qualification	Overall teaching experience	Teaching experience in Natural Science	Post level
Mr P	Male	PTD(SP), ACE (NS)	24	10	2
Mr JB	Male	B.Ed	22	22	1
Mr M	Male	PTD, ACE	18	6	1

3.4. DATA MANAGEMENT

3.4.1 Data collection process

3.4.1.1 Interviews

Interviews are the dominant and frequently used qualitative approach (Gehart et al 2001 in Frels & Onwuegbuzie 2013), regularly employed in case study research (Hancock & Algozzine 2011). Moreover, Yin (2009) labels interviews as the most essential instrument of case study data. It is through the interviews that ample and intense information is gathered (Roulston 2010 in Frels & Onwuegbuzie 2013; Mason 2002 in Hancock & Algozzine 2011). Moreover, interviews give a rich descriptive information than in instruments such as questionnaires (Bertram & Christiansen 2014). Furthermore, according to Ary et al (2010), interviews are used as tools for collecting data on people`s beliefs, opinions and experiences. Moreover, interviews tell the researcher what the participants know (Sharp 2012: 74). They can either or both give information that is missing from observations and confirm what was observed (Ary et.al 2010). They also give concrete responses which add more information (Koshy 2010: 85). More significantly, they bring matters which were not initially in the thoughts of the researcher (Wilson 2013), broadening the research in the process.

However, Bertram and Christiansen (2014) indicate the negative impact of power relations between the interviewer and interviewee, more especially if the interviewer is holding a higher post to that of interviewee and consequently affecting the responses from the interviewee. However, with regard to this study, the interviewer is conducting research with participants who are from different schools from where he is employed, consequently eliminating the consequences of power relations.

Semi-structured interviews which are more relevant for a case study (Hancock & Algozzine 2011), and beneficial due to their straightforwardness (Gürbüz et al 2013), were utilised in this study. This was done to elicit particular circumstances of teaching in the classroom (Hopkins 2008), which in the context of this study were teaching difficulties. Furthermore, semi-structured interviews create room for thorough and extensive responses from participants, with new ideas emanating in the interviewing process (Dearnley 2005 in Cuellar-Moreno 2016). Moreover, through semi-structured interviews, the researcher modified questions by relying on responses from participants (Punch & Oncea 2014). It is for that reason that interviews were partially structured wherein questions were designed but altered during the interviewing session (Ary et al 2010: 438) by asking “follow-up question” in order to get deep into the teaching difficulties (Hancock & Algozzine 2011: 45).

Despite criticisms individual interviews receive due to its wastage of time (Hancock & Algozzine 2011), they are found to be collecting meaningful and considerable information. It is for that reason that the three sampled teachers were interviewed individually than in groups in order to acquire significant data on teaching difficulties.

The interviews were conducted in the following way as outlined by Patton (2002), cited in Elliot et al (2011):

- The conditions of the location where the interviews took place were very convenient and relaxed in a room that disruptions were minimal;
- Participants were reassured that interview audiotapes and verbatim transcripts were to be utilised by the researcher only and no one else, also guaranteeing their confidentiality;
- The interview guide was designed by the researcher prior to the interview;
- A mini-talk took place between the participant(s) and the researcher in order to build up cooperation and understanding amongst themselves;
- "Probing" questions were asked to allow the participant(s) to be open and free in order to expatiate on their responses;
- Quietness was acceptable in order to create room for the participant(s) to reach deep to their introspection and understanding;
- "Leading questions" were not utilised; and
- Room was created for participants to provide more information and similar instances of cases being dealt with.

Moreover, the usage of audiotapes allowed the researcher to play the recording a number of times, allowing the researcher to compare with what is written in his/her records (Wilson 2013).

The interviews were conducted in two forms: before the observations (pre-observation interviews) and after the observation (post-observation interviews). In the pre-observation interviews, the researcher asked the participant questions on their qualifications and training, experience in the subject, their involvement in science, epistemological beliefs and challenges they experienced when teaching the topic/subject. Interview questions also included were on how the participant would teach the PEB topic of spheres of earth and their relationships (PCK), how they would assess the topic and lastly where they would teach the topic (contextual knowledge). They were further asked on the type of instructional strategies they would employ when teaching the topic, the explanatory framework they would utilise and their epistemological perspective (Mudau 2016).

With regard to the qualifications and training section, the questions were based on participants` education history, major subjects, training received through workshops on subject in question. With the work experience the focus was on years of teaching Natural Sciences as a subject. The involvement of educators in the subject focused on science from a broad point of view with emphasis on the projects the educator has been supervising including science expos. This was done to elicit the educators` amount of interest in science.

The last part of data collection method included interviews which for the sake of this study can be termed post – observation interviews. These interviews were semi – structured in that most of the questions arose from the aspects of the

observation meanwhile some questions emanated as the interview progressed (Ary et.al 2010). The researcher`s focus was on the participant`s reflection of the lesson. Furthermore, the interview was recorded with a voice recorder (Ary et.al 2010: 435).

3.4.1.2 Observations

The next point of the research involved observations. This is a research process that allows the gathering of data from conditions which are natural (Johnson & Christensen 2004), original, authentic and most importantly social (Cohen et.al 2007; Koshy 2010). In other words, the researcher has an opportunity to obtain "first-hand data" (Bertram and Christiansen 2014: 84). Moreover, it was through this process, unlike in the interviews, that more "objective information" was acquired (Gay & Airasian 2003: 198). In other words, observations allowed the researcher to observe whether what the participants said s/he does in lesson is actually done, consequently measuring teaching occurrences against presumptions, ideologies and principles acquired in interviews (McQuiggan 2012; Bertram & Christiansen 2014).

Moreover, observations allowed the researcher to observe among others: "the teachers` classroom practice; the educational environment which include the teaching and learning styles, the use of resources and the curricular; and the interactions that take place" in the Natural Sciences classroom (Bertram and Christiansen 2014: 85). As such naturalist observation were employed (Gay & Airasian 2003: 205). Naturalists observation are a significant qualitative method (Gay & Airasian 2003). Furthermore, unlike with the simulation observations which is highly characterised by the researcher`s manipulation of occurrences, naturalistic observations look into teachers` classroom occurrences as they occur (Gay & Airasian 2003). Among others, classroom behaviour such as how the teacher teaches the PEB topic as well as interactions occurring in the Natural Sciences class were observed. Moreover, the researcher applied the non-participant observation where he was isolated in a particular area of the classroom during the course of the session (Koshy 2010). Furthermore, each of the three educators were observed with regard to their knowledge in the subject; the type of instructional strategies they employed in class; the nature and type of interactions and discourse in the class.

Further to that, the researcher employed field notes as instruments of gathering data from observations (Koshy 2010, Gay et al 2011, Johnson & Christensen 2008). Field notes are the notes written down by the researcher in the arena of research, be it the "classroom or school" (Bertram & Christiansen 2014: 90). Ary et al (2010) refers to field notes as the most widely used method of gathering data. Not only do they record the participant`s views and opinions but also record the whole process (Wilson 2013) of teaching. According to Hopkings (2008), field notes focus mainly on certain matters or teaching occurrences over a space of time.

Among other occurrences, teacher knowledge which included subject matter knowledge, PCK and contextual knowledge; instructional strategies which the educator employed; and classroom discourses and interactions with focus on the type and patterns of discourses used, teacher questioning and communicative approach were observed and recorded. The observations and recordings also included the classroom environment, whether the participant addressed the three specific aims of Natural Science as indicated in the CAPS document and most importantly the way in which s/he imparted his/her knowledge during the lesson. That was the descriptive part of the field notes during observations (Gay & Airasian 2003).

The second part of field notes dealt with a reflection of the observation by the educator (Ary et.al 2010; Gay & Airasian 2003). The researcher reflected on his ideas and views of the lesson having taken place, on issues of discretions taken by the educator, ethical issues (Ary et al 2010) and finally on issues of data analysis and its reliability (McMillan & Schumacher 2013). The video camera was also employed throughout the observations (Johnson & Christensen 2008) with the participants` consent.

Observations were employed mainly to see exactly what the three participants said from interviews that they did in their classes. Participants were observed on their Subject knowledge, PCK, contextual knowledge, epistemological beliefs, types of instructional strategies they used, types and patterns of classroom discourse and interactions. Furthermore, field notes, together with video camera were employed in the classroom. Despite the criticism the usage video camera receives due to its consummation of time (Wilson 2013), they were very effective due to the fact that the video was played plenty of times (Wilson 2013) in the analysis of results, intensifying the analysis and allowing some aspects that were missed in observation to be identified.

3.4.2 Data analysis and presentation

3.4.2.1 Data from the interview transcripts and observation field notes

The data was analysed from the interview transcripts and observation field notes (Maree 2007). The data was analysed as follows as outlined by Creswell (2014):

- The interviews were transcribed from the audio tapes, comparing the contents of the tapes with the gestures and reactions of the participants noted down by the researcher (Nieuwenhuis, 2007). The field notes from the observation were typed for analysis.

- The transcripts and field notes were then read thoroughly to make sense of the evidence to grasp the logic of the participants. The ideas and opinions were written on the margins of the interview transcripts and field notes (Creswell 2014; Merriam 2009).

- The data was at this stage coded, by reading the transcripts cautiously and picking transcripts from the participants one by one (per interview schedule and per observation field notes of each participant). From reading and writing on margins, a list of topics was created, consequently clustering together similar topics, which were "interesting" and critical for the study (Merriam 2009: 178). The topics were therefore assigned codes and placed next to the relevant segment of the text. That means they were "open coded" since the researcher was still exploring in open minded manner (Merriam 2009: 178). The topics were then turned into categories after clustering similar ones together. The data belonging to one category was then prepared for analysis.

- Coding was done on topics that were related to the research questions and sub-questions/ topics and subtopics. That is the topic – teaching difficulty, with sub – topics: teacher knowledge, instructional strategies, and classroom discourse and interactions.

- The coding process was then used to form a description of settings as well as themes. The themes were reduced to a smaller number and will appear as the main findings.

- The outcomes were therefore interpreted by comparing them with the literature.

- Moreover, when reading and re-reading the transcripts, the CPDF was continuously consulted and referred to (Mudau 2016) for its assistance in answering research questions.

3.4.2.2 Data presentation

The data was presented through tables by utilising themes that appeared on the data collection instruments and the CPDF. The questions from the interview guide were converted into themes and subthemes. The table consisted of three columns: with themes on the first, sub-themes on the second and participants` responses on the third column. Furthermore, to apply triangulation, the responses from interviews were tabulated against each other as per theme and sub-theme to see if there is a correlation between what the participants said he/she will do and what he/she did.

Moreover, the data form the observations was presented by using topics that appear from the observation guide. The topics and subtopics were also tabulated against participants` responses, giving room for comparisons of their responses. Triangulation was also applied in this regard.

3.4.2.3 Data and findings discussion

The findings from the data collection instruments were evaluated and discussed by comparing them with the literature and the conceptual framework. The main focus of the discussions was on teacher difficulty with the themes: teacher knowledge, instructional strategies, and interactions and discourse, and was

based on the constructivism theory. Moreover, interview questioning process together with observation allowed the emergence of other sub-themes which were not initially in interview guides and on observation protocol.

3.4.3 Rigour in case study instruments

Validity and reliability focuses on the "quality" of the research instrument (Punch & Oancea 2014: 295) and its effect on what it is supposed to measure. They are collectively being referred to as the "psychometric characteristics of an instrument" (Punch & Oancea 2014: 295). Guba (1981) in Shenton (2004) adds confirmability as a criterion for ensuring rigor while Bertram and Christensen (2014) indicate that credibility, dependability, confirmability together with the aforementioned help in achieving trustworthiness of the research.

Validity

Validity in qualitative studies is the measure of coherence amongst the way phenomena are discussed and their worldwide correctness (McMillan & Schumacher 2010). It is the certainty of the reasoning and explanations that are a consequence of data gathered (Johnson & Christensen 2008). The whole idea of validity is on whether what we are measuring with really measures what we want to measure (Punch & Oancea 2014).

Validity in case studies are categorised by Bertram and Christiansen (2014:43) into three purposes:

- To make certain that the data gathered echoed the case;
- to make sure that cases are backed by the data and "not generalised" above what can be justified by the case; and
- In case of instrumental cases, attention must be on "how typical the case may be", and wherein "findings" can or cannot be transmitted or transformed to other case.

Moreover, this study utilised the following strategies as they appear in McMillan and Schumacher (2010: 330):

- Lengthy and Tenacious Fieldwork. This was done by administering long interviews and prolonged classroom observations.
- A multi-method approach which permitted triangulation in the gathering and interpretation of the data (McMillan & Schumacher 2010). This was done by utilising both interviews and observations to study the same themes: teacher knowledge, instructional strategies, and classroom interactions and

discourse. Moreover, employing multi-method allows construct validity to be achieved (Yin 2009)

- Participants` language and verbatim records. This was achieved by audio recording interviews and transcribing them. Further, field notes were utilised the record occurrences in class which included verbal reactions.

- "Low-inference descriptors". To achieve this simple language as opposed to more "abstract" language was used when conducting interviews and recording field notes during observations.

- Electronically and technologically recorded data. Instruments such as audio tapes, cameras, video cameras which are mechanical and electronic in nature were employed. Their faults and poor performances were taken into consideration when employed.

- Participants` engagements and reviews. The researcher kept on engaging with the participants on what was recorded in class observations and what was gathered in interviews. This was done by giving participant copy of the interview transcript and field notes to allow for corrections on omissions and misquotes.

Pilot Study

Moreover, the interview instrument was tested through a pilot test. Dikko (2016) argues that instrument piloting is one of the approach a researcher can employ in order to achieve validity. Furthermore, a pilot study can help in examining the research instrument prior to the main research (Barker 1994 in Teijlingen & Hundley 2001) to find if any, faults and glitches in the research instrument (Teijlingen & Hundley 2001). Further to that, the significance of this approach can help in validating the approach utilised in the research instrument, consequently having a smooth flow of the proceedings (Dikko 2016). One more advantage of employing the pilot study is that it allowed the leverage for the researcher to develop and gain better interviewing ability (Nunes et al 2010).
The pilot test for the interview guide in the current study took place with one teacher. The teacher was purposefully sampled and had to have taught Natural Sciences for more than 6 years, and had to be teaching the subject in Grade 9. The participant for the pilot has been teaching for 14 years, with Natural science been taught in those number of years. Moreover, the participant met the criterion of finding teaching Natural science difficult as he was one of the teachers identified in the workshop and subject meetings.
The results of the pilot test elicited the researcher to adjust some of the questions on the interview guide which the participant seemed to be uncomfortable with. Moreover, the whole process allowed the researcher to gain some knowledge on

how to conduct semi-structured interviews (Nunens et al 2010). Moreover, the researcher was able to determine the approximate duration of one interview session.

Credibility

Internal validity or credibility seeks to explain if the outcomes of the study displays certainty with the real world (Merriam 2009; McMillan & Schumacher 2010) and should paint an authentic picture of the participants (Bertram & Christiansen 2014). According to Patton (2002) in Merriam (2009: 228), "credibility involves intellectual rigor, professional integrity, and methodological competence". Moreover, Lincoln and Guba (1985) in Shenton (2004) argue that credibility is one crucial factor in achieving trustworthiness. For the current study, credibility was ensured by employing two different data collection methods, namely observations and semi-structured interviews; by collecting data from three different participants, being the Natural Science Grade 9 teachers and; using three different schools as research sites, applying triangulation in the process (Shenton 2004).

Furthermore, using research approaches which are effectively stabilised in qualitative research can help in maintaining credibility (Shenton 2004). For this study, observation and semi-structured interviews which have a greater reputation due to their "objectivity" (Gay & Airasian 2003: 198) and; consistency and dominance (Gehart et al 2001 in Frels & Onwuegbuzie 2013) respectively in qualitative research, were utilised. Moreover, the participants for the study were given leverage to withdraw from the study whenever they felt like or decline to participate in the study (Shelton 2004). This was done to afford the study relevant people who will be open and free to participate fully in order to assist the researcher in answering the research questions and allow the study to achieve its objectivity (Shenton 2004).

Confirmability

Confirmability speaks more about the ability of the research process to display its translucence and allow the reader through its contents to scrutinise and review if they could have arrived at the same outcomes (Bertram & Christiansen 2014). Moreover, the confirmability depends on the researcher`s lack of objectivity (Morrow 2005). The notion is that the data are the sources for the findings and recommendations irrespective of the researcher`s values and beliefs (Shenton 2004; Morrow 2005) as was the case in the current study.

Dependability

Dependability in research is about the potential of the researcher to justify for the disparities in the cases of the study and further, match the outcomes of the study with previous literature (Bertram & Christiansen 2014). Shenton (2004) argues that in order to achieve dependability, the procedures employed in the study should be detailed effectively, to allow the future researchers to follow the same

procedures and achieve same outcomes. As such the following were implemented in the current study: the research designs and how they were employed were outlined as indicated in 3.2 and 3.3; and also justifying for each data collection method utilised (Shenton 2004). Moreover, dependability is based more on the homogeneity of the outcomes with gathered data (Merriam 2009) and hence its reliability which will be discussed more on the next section.

Reliability

Reliability refers to the ability of the instrument or design to give same outcomes when "replicated" over and over again (Bertram & Christiansen 2014: 186; Merriam 2009: 221). The focus is on the "consistency" of the data gathering instruments (Punch & Oancea 2014: 295; Johnson & Christensen 2008: 144; Mertens 2010: 380) on what it is supposed to measure (Gay & Airasian 2003: 141; Best & Kahn 1993: 208).

This study utilised a multiple case study which allowed the researcher to compare and look for resemblance and dissimilarity (Johnson & Christensen 2008: 408). Moreover, having 3 or 4 cases will allows the researcher to anticipate replication (Yin 2009: 54). Further, achieving resemblance from multiple cases may give rise to replication (Yin 1994 in Johnson & Christensen 2008: 408).

Reliability in this study was achieved by exposing the three participants to semi-structured interview questions that followed the same interview guide. The three participants were observed under same themes: teacher knowledge, instructional strategies and, classroom discourse and interactions. Moreover, the time allocated for the interviews and classroom observation were the same.

Triangulation

Triangulation in the current study was easily achieved by employing "multiple sources of data" (Merriam 2009:216). Further to that, triangulation allowed the researcher in the current study to correlate and review observations and interviews data collected from three different "sources" (Merriam 2009: 216, Bertram & Christiansen 2014: 188), correlating the information from the three participants in the process (Merriam 2009). Moreover, triangulation helped in achieving trustworthiness (Bertram & Christiansen 2014).

3.5. ETHICAL CONSIDERATIONS

As a qualitative researcher, it is critical for one to outline ethics in the research (Gay et al 2011). Research ethics are the principles and guidelines that help the researcher to uphold the things the researcher values (Johnson & Christensen 2008). They are a measure of the "good, right or virtuous" procedure of research (Punch & Oancea 2014: 58). Moreover, ethics are embedded in "honesty and integrity", upholding the law, and "doing the right thing" (Wilson 2013: 90). Ethics go hand in hand with morals and therefore it is imperative for one to maintain a morally guided research from the beginning to the end (Hopkings 2008).

Informed consent

"In a qualitative research, the most pervasive ethical issues related to informed consent and the researcher`s abilities to have closely aligned personal and professional ethical perspective" (Gay et al 2011: 119). Furthermore, the participants should be fully aware of the research intentions and what it seeks to achieve (Hopkings 2008). Johnson & Christensen (2008: 109) add that "the researcher must give the prospective participant a description of all the features of the study that might reasonable influence his or her willingness to participate". The participants must be made aware on his/her "freedom" to participate or not to participate, and if they feel like participating, they have a right to withdraw from the study whenever they feel like doing so (Best & Kahn 1993: 45; Johnson & Christensen 2008: 117). Moreover, consent must also be afforded by the participant prior to the researcher utilising the information gathered for analysis and other purposes (Johnson & Christensen 2008).

For the current study, the approval was requested from the Limpopo Department of Education to carry out the research. The meetings were also arranged with school principals of selected schools and selected participants (Natural Science teachers) to describe the whole process and its significance to the whole education fraternity. A form of consent or agreement with a clear purpose of the research together with the description of the methods and duration of the data collection (Johnson & Christensen 2008) was thereafter given to participants and signed to indicate their will to form part in the study. The forms also indicated the opportunity to withdraw at any moment if they so wished (Johnson & Christensen 2008; Best & Kahn 1993).

Anonymity and Confidentiality

It is a sole responsibility of the researcher to provide his/her participants a protection on their rights and welfare (McMillan & Schumacher 2010), affording them respect in the process (Hopkings 2008). As a consequence, anonymity and confidentiality need to be considered. Anonymity entails withholding the participant`s identity from all concerned, including the researcher whereas with confidentiality, the identity of the participants together with the data gathered are kept from everyone except the researcher (Johnson & Christensen 2008; Gay et al 2011; Best & Kahn 1993). Confidentiality is critical in assuring that research participants are free from discomfort and unnecessary publicity as well as safeguarding participants in cases where they disclose information to a researcher that others can use against them who are curious in the findings of the research (Gay et al 2011). On that note, privacy was considered (Johnson & Christensen 2008).

To address confidentiality, the names of the schools and participants were assigned labels. The first school was labelled School A, second school named School B while the third school will be referred to as School C. The participants were referred to as Mr P, Mr JB, and Mr M respectively.

Invasion of privacy

As was indicated in the methodology section above, electronic instruments such as video and photo cameras and, audio recorders as well as non-electronic field notes were used as recording instruments in interviews and observations. However, utilising cameras, audiotapes and field notes without the participants` knowledge and consent is an "invasion to privacy" (Best & Kahn 1993: 46). As such, all the three participants were informed prior to the observation and interview on the intended usage of the mentioned recording instruments.

Knowledge of outcome

The participants were informed what the study intended to achieve, its significance to the education fraternity, more specifically the Maths, Science and technology (MST) stream. Furthermore, they were informed on where the outcomes will be published as well as giving them (participants), access to the outcomes of the study (Best & Kahn 1993).

In summary, the research ethics were upheld in the study in the following manner as indicated by Hopkins (2008: 201):

- The research was constructed, reassessed, and embarked on in order to maintain its "integrity and quality".
- The participants were informed thoroughly in respect of the motive, procedure of the research. The participants were further made aware of the impact of their participation in the research and on the outcomes of their participation.
- Confidentiality of information and anonymity of participants was upheld.
- Participation in the research was voluntary and without coercion.
- The research was independent and impartial.

3.6. CONCLUSION

The current chapter covered the following sub-sections: the research design, with intense literature on the choice of case study design; the qualitative research approach, which included research instruments used, sampling strategies employed. Validity and reliability of the methodology were expatiated; with how research ethics were upheld concluding the chapter.

CHAPTER 4

4.1. INTRODUCTION

This chapter presents the data collected for the purpose of this study. In addition, the data is discussed and findings reported. The cases (participants) were exposed to the same questions and same observation protocols and taught the same topic. Moreover, the cases were interviewed and observed separately to elicit more insight in their classroom practices. The three cases were given the pseudonyms MR P, Mr JB and Mr M and were from Schools A, B, and C. Furthermore, it is only the elements that can assist in answering the following research question that are presented: the following question guided the study;
What are the teaching difficulties of Planet, Earth and Beyond strand?

And the following sub-questions:

What is the nature of the teachers` knowledge in the content of Planet, Earth and Beyond?
Here the researcher was interested in the teacher`s content knowledge in the topic: Spheres of Earth, their student understanding knowledge in the topic, and their knowledge of context for teaching the topic.

What is the nature of the teachers` instructional strategies in the Planet, Earth and Beyond strand?
In this regard the researcher wanted to note the teaching route the teachers took, the teaching methods they chose, the frameworks they employed to explain the contents and their epistemological perspective in the topic.

What is the nature of teachers` classroom interactions and discourse in the strand Planet, Earth and Beyond?
The researcher wanted to understand the type of discourse of the teachers, their discourse patterns, and the communicative approach they used in the natural science classroom.

The purpose of the study was to unpack teaching difficulties in the topic of the Planet, Earth and Beyond strand of Natural science. The focus was on the teacher knowledge, instructional strategies, and interactions and discourse. A number of studies have been undertaken with any of the three above-mentioned aspects (teacher knowledge, instructional strategies, and interaction and discourse) however, the sequence at which the three aspects relate to one another in class was never determined. It was for that reason that the current study was done to discover how the three aspects in the Natural Science`s Planet Earth and Beyond classroom occurred and how they relate to one another.

Furthermore, the study of this nature could be helpful in teacher development and for improved classroom practice in Natural sciences. Curriculum designers, consequently would be able to create or/and modify the national curriculum having got a clear picture of how teaching occurs in class.

4.2. CASE 1 (MR P)

4.2.1. Data presentation

A. Teacher knowledge

KEYS:

M: Mr P
LS: Learners
L1: Learner 1
L2: Learner 2
L3: Learner 3
L4: Learner 4
L5: Learner 5
L6: Learner 6
L7: Learner 7
L8: Learner8
R: Researcher
P: Participant

THEME	CATEGORY	DATA	Coding
Teacher knowledge	Content knowledge	**M**: how is earth (writing on the board)? From the shape, how is earth? **L**: round. **M**: the earth is round in shape (with emphasis) **R:** Okay, and then eh you were at one point teaching about the shape of the earth. What were you intending to achieve with that? **M:** Eh! Learners must know how….the shape of the earth and in that, there is this word sphere. Eh in that word sphere they must know the synonym of sphere. That the sphere is round, therefore, as the. This new system of education we must teach English across all the…..the subjects, hence I was trying to do that.	Irrelevant content taught

		R: Uhummm. So in other words you wanted to emphasise the issue of the shape, the sphere meant, the word sphere meant? **M:** Yah (yes)	
		R: Explain to us. Ehh. What the Planet, Earth and Beyond strand is all about in the Natural Sciences? **M:** That's the…because… eh..if you are human being.. you must be conversant with what is happening around you. We are in the planet earth. Whatever happens on this earth…we must know. We must be able to know. So that we can predict…let's say for instance, whatever happens today, you must be able to predict for tomorrow. **M:** Name the features of earth? **L1**: Water **L2**: Air **L3:** Soil **M:** You should say land which include soil and rock **M:** In the water, in the air, in the land life is there then that I why they are collectively	Subject matter knowledge

		called biosphere because the biosphere consists of water, air and land.	
	Students understanding	**R:** Then what misconceptions do learners have? do you sometimes meet in you class? **P:** Uhmmm. Sometimes when i...When you tell them neh…because i...i was once. Told that... The earth is so fast… even now if I tell learners that, when maybe you can take the fastest car on this earth and when you compare this car with the earth... the earth is faster than that car. Neh! Learners don't believe.. yah. **M:** …and then I told you one day about where this education started. This education it stared somewhere long time ago. Where? Ok. It was started by the first civilised people, the Greeks neh! (writing on the board).	misconceptions
		R: Uhmmm. Can you please tell us…. how you teach….. the Grade 9 learners the topic Spheres of Earth? How would you teach them if you had teach them now? Where would you start? **P:** Uhmmm. What i`m going to start… let`s say for instance..the first.. im going to ask this question. How many planets are in	Incorrect baseline assessment

		this?..how many planets are found in the universe? Be in the universe.. amongst those planets, which planet.. is eh what… maybe which planet is there…maybe there is life on them. Lets say for instance…like mercury is there any life on the mercury whatever? They must tell us. From there I will go on. **M:** How many planets are there? **LS:** nine! **M:** nine? Can you mention them? (Learners had their hands up). Yes! One! **L1:** Neptune! **L2:** Mercury! **L3:** Earth! **L4:** Jupiter! **L5:** Venus! **L6:** Mars **L7:** Uranus! **L8:** Saturn (the teacher wrote on the board all responses) **M:** then amongst this (pointing to the planets written on the board) where do you think life exists amongst those? (Learners rose their hands). Yes! (pointing at a learner) **L:** Earth!	

		M: Earth! Is it Earth only? Heh! (No response from learners) okay, the way you were taught. (Another learner had his hand up) yes! (pointing at a learner) **L:** Mars **M:** Mars? Do you believe or heard? **L:** heard! **M:** okay	
	Context knowledge	**R:** Explain to us. Ehh. What the Planet, Earth and Beyond strand is all about in the Natural Sciences? **M:** **T**hat's the…because… eh..if you are human being.. You must be conversant with what is happening around you. We are in the planet earth. Whatever happens on this earth…we must know. We must be able to know. So that we can predict…let's say for instance, whatever happens today, you must be able to predict for tomorrow.	Poor contextual knowledge-(resources-curriculum)
		R: Uhmmm, where would teaching of this topic take place. Would it be in classroom? would it be in the library? The laboratory? Outdoors or any other area? Where will it be?	Contextual knowledge-resources

		M: I can tell you it's everywhere, because… it's a natural thing. In the classroom, there are some things that you can take and show them The class was well organised with desks well packed. It was also clean and not over crowded.	
		R: Uhmmm, which language is dominant in your class? **M:** You know the medium of instruction is English. But Sepedi… they are used to it. **M:** (in Sepedi) Where Nitrogen is coming from?	Contextual knowledge-language

B. Instructional strategies

THEME	CATEGORIES	DATA	CODING
Instructional strategies	Teaching route	**M:** Face!? …… you find that…. learners are coming from secondary...that is a problem because…. people are afraid to name it. You find that… in a classroom…instead of being two-way interaction. You find that is a one way. You are the only one giving them information.	Rote learning

		M: (paused his lesson) Any question? (Learners never got a chance to ask since the teacher quickly went back to his lesson pointing straight on the atmosphere from the board). There is a certain gas on the atmosphere which cost too more percentage than any other gas. What is that gas? (Learners did not respond they were not given a chance since the teacher quickly asked) What air is?	
	Epistemological perspective	**R:** Uhmmm, according to you in what way should knowledge be attained? How knowledge should be achieved? **M:** Ehhhh…..knowledge! The more you interact with people, the more you read books, is then that you-you are going to. to gain knowledge or achieve what you want.	Theoretical construct/ social embeddedness
	Teaching methods	**LS:** Argon! **M:** Argon!? (sounded surprised) **M:** There is also methane. **M:** name the features of earth? **L1:** water	Lecture method Question and answer

		L2: air **L3:** soil **M:** you should say land which include soil and rock **R:** Ohkay. Uhmmmm. You used a lecture method together with question and answer method, instead of science methods like inquiry methods and problem based methods, project based methods and others. Why did you use to choose….. why did you chose to use lecture and questions and answers methods? **M:** Sir! During our time, when we were at the college, for three years learning one method of teaching. Therefore in…once you indoctrinate a person, it will take time to change him or her. Therefore, I am used to that and I enjoy using that methods. Telling method and question answer	
	Explanatory framework	**M:** When teaching this to- ….-pic. I compare it with….maybe when doing chemistry. In chemistry we have got the so called the atoms, uhmmm, you basic unit of matter. That… when you study this planet earth, you must compare it with what? The earth because atoms	Examples

		consist of all electrons and electrons are found around the what? ….atoms. and around the nucleus. And are always in what? In motion. Even the planet is like what? The…the electrons, is always what? On the move around the…the sun. **M:** for example the South African government is a system, because there… there are many departments which work as a system. For instance eh. the Department of education, and other departments work as systems. Even the hydrosphere, the atmosphere, and the lithosphere work as systems, they work together to sustain life. **R:** Thank you. Y ah you decided to give examples of atoms and and also examples of government systems. How do those examples used eh help learners in understanding the content you taught? **M:** Eh! The atmosphere being part of the earth, that's why….once i…when I was referring to the atoms, I take it as an earth and around it I take it as an earth. And around there are some elements,, for example	

		charges which are always in the atmosphere there are things that are always in…..motion. **R:** Okay, then why did you…how did the example of government assist? **M:** Ehhhh, the government has got many parts. On its own it won't function. Like the earth, the earth has got those spheres hydrosphere, lithosphere and atmosphere. Maybe if it was having only the hydrosphere, it won't function. Therefore they must got integration, there must be a unity.	
	Differentiation of Strategies that addresses learning differences	**R:** OK sir. Uhmmmm…. How do you address learning differences... In class? In that learners would learn differently. **M:** Ehhhh… because I was taught… during that time… long time. The… I was taught about this principles… eh we have got a principle of individualisation. Ehh. Totalisation and differentiation. Therefore I..i must be able to differentiate learners who are able and those	No differentiation in teaching strategies

		who are not able so that I can attend them individually. (no differentiation of strategies was visible during the lesson)	

C. Classroom interactions and discourse

THEME	CATEGORIES	DATA	CODING
Classroom interactions and discourse	Type of discourse	**M:** Too much I use dialogic, That is why I want someone... that maybe the period ends,…… someone- everyone must feel free **M:** For example methane. Which amongst those gases is having more percentage than other gases? Anyone? (Within 3 seconds when no learner responded, he was quickly back to teaching and wrote on the board at the same time reciting) Nitrogen is having 78 % while other gases share only 22 %. Nitrogen's 78 %. It is an approximate value, it can be 77 % or 79 % and 22 % is shared by other gases. **R:** Uhmmm. You seemed to be enjoying explaining concepts to the learners, than allowing them to engage with you. For example you would spend	Authoritative discourse

		more time talking as compared to the learners…I mean you spent more time talking to the learners as compared to allowing the learners to. Engage with you. Why was that? **M:** Ehhhh, we were taught in our time during our time, that once you teach, if you don't see any response you go on and there after you will ask questions. **R:** Okay. Oh that is why okay. You enjoyed talking a lot. You believed that when you talk you will be able to see learners 'reaction. **M:** Yah (yes)!	
	Patterns of discourse	**R:** Can you please explain the sequence at which…… you introduce the lesson, how your learners react and finally how you conclude the topic that you will be explaining. **M:** First I go to the them by asking questions,to..to see their understanding of what I'm going to..to teach, once…they show that they don't understand or do understand. Maybe I will go to. The	IRF

		main topic…explaining. At the end I will ask question whether they. To see whether they understood or not. **M:** what do you call the biosphere inside water (initiation). **L:** hydrosphere (Response). **M:** yes. The hydrosphere. The? Hydrosphere! (reciting with the learners while writing on the board) feedback).	
		LS: (raised a hand) planet mars. **M:** do you believe or heard or knew about that? **L:** heard! **M:** what can you tell me...anything about earth (referring to the whole class). **L:** (raised his hand) earth is a planet which has only one move.	Open chain patterns – I-R-P-R-P-R/I-R-P-R-P-R-E

		M: earth is the planet which has only?...one move (reciting with the learners)	
		M: tell me the gases that you know of **L1:** carbon dioxide. **M:** (pointed the next one) **L2:** Nitrogen. **L3:** Oxygen. **L4:** Argon	Non-triadic patterns I-Rs1-Rs2-Rs3-Rs4-Rsn
	Communicative approach	**R:** Can you please explain the communication that takes place in your class? how your learners communicate with each other and how they communicate with you? **P:** Maybe, lets say for instance, everyone is given a permission to.. talk, once he/she is raising to show me that he wants to…..talk. **M:** (paused his lesson) any question? (Learners never got a chance to ask since the teacher quickly went back to his lesson pointing straight on the atmosphere from the board). **M**: there is a certain gas on the atmosphere which cost too more percentage than any other gas.	Authoritative/non-interactive

		Who can tell me what that gas is? (Learners did not respond since they were not given a chance since the teacher quickly asked them) what air is air? (No learner responded) **R:** Uhmmm. You seemed to be enjoying explaining concepts to the learners, than allowing them to engage with you. For example you would spend more time talking as compared to the learners…I mean you spent more time talking to the learners as compared to allowing the learners to. Engage with you. Why was that? **M:** Ehhhh, we were taught in our time during our time, that once you teach, if you don't see any response you go on and there after you will ask questions.	

Key

1	**Data from interviews**
2	Data from observations

4.2.2. Discussions

4.2.2.1. Teacher knowledge

Shulman (1986: 9) terms the content knowledge, "the amount and organisation of knowledge per se in the mind of the teacher". Mr P was disorganised in the articulation of his knowledge since he was at one point teaching the correct content and most dominant part of the lesson giving learners irrelevant content. For example, he taught learners about the composition of the atmosphere and the dominance of Nitrogen with its 78%, even though the topic was supposed to be taught at the end of the term. Therefore his SMK was poor (Rohaan et al 2012) as it was not clear from the educator what the PEB strand is all about from the interviews, and also on what must be taught during his teaching. The NS CAPS document (DBE 2011a) shows clearly that the topic: spheres of earth focuses on the four spheres namely the biosphere, the lithosphere, the hydrosphere, and atmosphere and how these spheres interact with one other. It was expected from the teacher to demonstrate without fail as outlined, however the teacher chose to move back and forth, choosing to rely on general knowledge rather than following the content as indicated in the NS CAPS document. As such the teacher generally lacked SMK, an understanding of the content that is specific for the topic spheres of earth (Rohaan et al 2012).

Furthermore, it is very evident that Mr P did not have sufficient teacher understanding knowledge since he has proved limited usage of curriculum materials. According to Ball et al (2001) in Diamond et al (2014: 636), the teachers' understanding knowledge is crucial in "interpreting reform ideas, managing the challenges of change, using new curriculum materials, enacting new practices, and teaching new content". However, Mr P failed to utilise the new curriculum-CAPS and relied on previous curriculum that promote rote learning. Further to that, even though the educator revisited the names of planets in his teaching as he indicated in the interviews, the knowledge was irrelevant. The CAPS document (DBE 2011a) required the teacher to revisit the content from Grade 7 Social Sciences which could have helped him to demonstrate through drawing and labelling, the concentric layers of the earth. However, the teacher did not follow suit. Moreover, the educator chose to focus and talk about the shape of the earth as a prior knowledge.

> ***MR P: how is the Earth? (writing the question on the board), from the shape how is the Earth?***
> ***Heh?!! (makes gestures to the learners trying to give a hint of the shape)***
> ***Learner: Round?***

He indicated that he wanted the learners to relate the word sphere with the shape in that it meant round.

Furthermore, Mr P continuously revisited irrelevant and insufficient prior knowledge throughout his teaching.

Mr P: …and then I told you one day about where this education started. This education it started somewhere long time ago. Where? Ok. It was started by the first civilised people, the Greeks neh! (writing on the board).

This was a downside of his teaching since checking prior knowledge of learners in a correct way would have allowed the teacher to match the learner`s knowledge with the emerging knowledge (Mesa et.al 2014), consequently allowing learning to gel well throughout the lesson. Furthermore, prior knowledge is critical in a constructivism classroom (Doolittle & Hicks 2003).

Moreover, even though the teacher had indicated some of the learners` misconceptions during his interviews, none was identified and rectified during the lesson. However, as was evident in the lesson, the teacher gave a lot of content at once, which was irrelevant and outside the Natural Sciences curriculum and as a consequence created misconceptions (Roseshine 2012).

Moreover, since the lesson was about the sphere of earth, it was expected that the teacher would opt for outdoor teaching, to allow the contents and context to be authentic, however the teacher chose to teach inside the classroom, limiting clear observation and first-hand learning experience for the learners that was in contrast with Nieman and Monyai (2006:6) who indicate that "learning should take place in realistic and authentic settings".

Researcher: Uhmmm, where would teaching of this topic take place. Would it be in classroom? would it be in the library? The laboratory? Outdoors or any other area? Where will it be?-

Participant:I can tell you its everywhere, because… it's a natural thing. In the classroom, there are some things that you can take and show them

Furthermore, even though the teacher indicated that he would use materials in class to demonstrate to the learners, he did not. He however relied on giving examples to explain lesson concepts. Moreover, learning is a process of social interactions and as a consequence should take place in a social context (Rutten 2014). However, it was not the case in Mr P`s class. There was no interaction between the learners and the interaction was mainly between the teacher and individual learners.

The teacher relied on chalks, a duster and boards as resources used during the lesson. He did not employ textbooks or any materials that could be used to

demonstrate the content to the learners. According to the CAPS Natural Sciences document, resources in the science context can include tools, apparatus, materials, books, and consumables (DBE 2011a). In addition, the local community, the libraries, models, posters, and internet are other resources that can create a good context of learning (Starkey 2012).

Furthermore, Starkey (2012) identifies goals as one component of the learning context. Specific aims outlined in CAPS NS document (DBE 2011a) form part of the goals to be achieved. It was evident that Mr P only achieved one of the three specific aims in the CAPS NS document - aim 3: 'understanding the uses of Science' since the teacher revisited and acknowledged history of science inventions (DBE 2011a).

> ***Mr P: condensation takes place up there (pointing above) and when precipitation takes place, the water comes down again, and that is a cycle. The water which was used by Biblical Moses and Jesus is the same water that is used today.***

Mr P failed to utilise specific aim one, which involves doing science. It was expected that teacher would implement specific aim one since science is a doing subject and should be demonstrated through experiments. Moreover, the fact that no assessment in the form of classwork, which could have also helped achieve specific aim 2, was not administered and hindered achievement of goals in science teaching and learning.

In terms of the language used, the teacher created an environment where both Sepedi and English were used interchangeably accommodating linguistic abilities and differences of learners. It is however a downside of his classroom`s teaching and learning since the language of teaching, learning and assessment of science is English, and applying Sepedi could have acted as a learning barrier since assessment is done in English.

Moreover, the teacher indicated a poor usage of the CAPS policy document and ultimately poor content knowledge as he showed poor understanding of what Planet Earth and Beyond is about.

> ***Researcher: Explain to us. Ehh. What the Planet, Earth and Beyond strand is all about in the Natural Sciences?***
> ***Participant: That's the…because… eh..if you are human being.. you must be conversant with what is happening***

around you. We are in the planet earth..whatever happens on this earth…we must know. We must be able to know. So that we can predict…let`s say for instance, whatever happens today, you must be able to predict for tomorrow.

Table 4.1. A summary of MR P`s teacher knowledge

Content knowledge	Poor SMK
Teacher`s student understanding knowledge	Irrelevant utilisation of prior knowledge Teaching created misconceptions
Contextual knowledge	Chalks and duster Inefficient goals – only specific aim 2 applied Language variation used – English and Sepedi

4.2.2.2. Instructional strategies

According to Geelan (2003), explanation frameworks are schemas teachers apply when using "analogies, metaphors, examples, axioms and concepts" in teaching the topics in Planet, Earth and Beyond. Moreover, the CAPS document for NS (DBE 2011a) indicated drawing and labelling of concentric layers as a way in which the teacher can demonstrate the contents of the lesson on spheres of earth to the learners, consequently helping learners in writing, modelling, investigating, discussing, naming, sequencing, dissecting, researching (DBE 2011a). Mr P, however relied on giving explanations and examples as schemas for his teaching.

Researcher: So what examples, analogies, or illustrations would you use when you teach this topic?
Participant: When teaching this to- ….-pic. I compare it with….maybe when doing chemistry. In chemistry we have got the so called the atoms, uhmmm, you basic unit of matter. That… when you study this planet earth, you must compare it with what? The earth because atoms consist of all electrons and electrons are found around the what? ….atoms. and around the nucleus. And are always in what? In motion. Even the planet is like what? The…the electrons, is always what? On the move around the..the sun.

Participant: Something that is round shaped is called a sphere and because our earth is round shaped is a sphere (again reciting the answer with the learners). All planets which are spherical are round in shape. In some planets there is no life but because in planet earth there is life then it called a biosphere.

Moreover, he repeatedly wrote all the concepts which were under the topic spheres of earth. Furthermore, the teacher also discussed those concepts he was writing on the board with his learners. There were instances wherein he was asking his learners to name the types of gases. However, he did not bring any model with him to class to demonstrate his lesson contents to the learners.

Furthermore, the teacher employed a traditional approach to his teaching throughout the lesson which was consequently teacher-orientated (Boumová 2008). He did not foster active learning strategies which are learner focused (Nottingham & Verscheure 2010) and supposed to be eminent in a science classroom. In many instances he was found to be reciting or speaking aloud on the concepts being taught, indicating that he preferred the approach because that is how he was trained at college and believed is the best method. However, Kaddoura (2011: 4) indicates that the traditional approach could lead to learners becoming "shallow, surface thinkers" who basically depend on memorising instead of properly understanding the content. Furthermore, the learners could have suffered from a deficiency of "higher order skills such as application in analysis" (Cashin 1985 in Nouri 2016).

Mr P`s lesson also did not accommodate PBL since no task or activities were given. PBL adopts the constructivism approach (Hmelo-Silver 2004), consequently encouraging team work and allowing emergence of cross-curriculum skills (Hopper 2014). Moreover, PBL creates room for collaboration amongst learners, which was not evident in Mr P`s classroom, despite him indicating his will to group learners prior to the lesson, which he did not.

Researcher: So..ok then.. how do they engage with each other in class..
Participant: Eh ….sometimes I group them.. and tell them that after they must give me a feedback. How they….Maybe they were doing the research…maybe amongst the groups…each group must…..maybe select one.. to represent… them.

As a result, learners had to rely on his rote teaching, hence suffering from a lack of social interactions in class. Moreover, the teacher did not accommodate for learning differentiation since he did not vary teaching strategies and had to utilise only one strategy which is traditional. Employing differentiation strategies would

have allowed the teacher to have a proper and imperative lesson planning in order to address learners` diverse needs, consequently achieving specific goals (Bennett 2007), which in this case are the three specific aims (DBE 2011a). Furthermore, when teachers do not afford leaners room to utilize their individual style of learning in the classroom, they fail to progress (Bennett 2007).

Table 4.2. A summary of MR P` s Instructional strategies

Teaching approach	Rote teaching/traditional teaching method
Instructional method	Lecture method
Explanatory framework	Examples
Epistemological perspectives	Theoretical construct/ social embeddedness

4.2.2.3. Classroom discourse and interactions

Despite the indication by the teacher of his application and choice of dialogic discourse over authoritative discourse,

> ***Mr P:Too much I use dialogic,.that is why I want someone.. that maybe the period ends,…… someone-everyone must feel free***

Mr P`s class was generally dominated by the authoritative approach of teaching. The teacher was simply transmitting definite details to the obedient acceptors (Tytler & Aranda 2015), which in this case are leaners.

> ***Mr P: Which amongst those gases is having more percentage than other gases? You can raise your hands. (Within 3 seconds when no learner responded, he was quickly back to teaching and wrote on the board at the same time reciting) Nitrogen is having 78 % while other gases share only 22 %. Nitrogen is 78 %. it is approximately 78%, meaning it can be 77 % or 79 % and 22 % is shared by other gases.***

The teacher also employed question and answer when he was facilitating his lesson. He asked questions to trigger learners` thinking and opinions, consequently forming a correlation between them (Lemke 1990 in Smart & Marshall 2012). That made his articulation in class partially dialogic but was dominantly authoritative due to his usage of lecture method. As a result, a no direction approach of learning was taken (Mortimer & Scott 2003 in Gan Joo Seng & Hill 2014).

The communication in class was non-interactive/authoritative (Scott et al 2006). This was due to the fact that even though there was communication between the teacher and the learners, the teacher was the dominant voice in his class, choosing the authoritative approach. The teacher approached the lesson by asking learners questions on their prior knowledge, but minimally gave them a chance to respond and interact with him since he kept on feeding them with information.

The pattern of discourse that the teacher applied in his class was IRF (Graesser et.al 2003). The teacher at one stage initiated the concept of the lesson in this way: He wrote on the board the question on how is the earth. He sustained his question by asking how the earth looks like while moving his arms to the sides as a gesture for shape. One learner raised a hand and said it is round in shape (response). The teacher then emphasised and said the earth is round in shape (feedback) with most learners joining him in agreement and reciting that statement. He continued to apply the IRF pattern five times more in his lesson when introducing other concepts (see appendix G).

Additionally, Mr P employed the open-chain (I-R-P-R-P-R-E) patterns in his teachings (Scott et al 2006):

Participant: Yes!
Learner: Mars
Participant: Mars? do you believe or you heard or you know?
Learner: I heard!
Participant: You heard neh! Okay about the earth, what can you tell me about the earth. Anything about the earth. Yes! (pointing to another learner)
Learner: It`s a planet that has only one move.
Participant: it`s the planet that has only one move. Neh!

Moreover, his teaching was characterised by the non-triadic patterns (I-Rs1-Rs2-Rs3-Rs4) (Scott et al 2006):

Participant: How many gases do u know? You said something about what? (pointing to one learner)
Learner 1: Carbon dioxide.
Participant: Carbon dioxide! What? (pointing to another learner)
Learner 2: Nitrogen.
Participant: Nitrogen. What? (Pointing to another learner)

Learner 3: Oxygen
Participant: Oxygen! (points to another learner)
Learner 4: Argon.

Table 4.3 Table of Mr P`s classroom interactions and discourse

Type of discourse	Authoritative discourse
Patterns of discourse	IRF, open-chain (I-R-P-R-P-R-E) patterns and the non-triadic patterns (I-Rs1-Rs2-Rs3-Rs4)
Communicative approach	Interactive/authoritative

4.2.3. Findings

i. Irrelevant Content

Mr P`s lesson was dominated by a lot of content at once, which was beyond and outside the Natural Science curriculum. The teacher at one point was outside the scope of the curriculum, talking about the emergence of education. He would later on talk about the content and composition of air, which learners are supposed to be learning as the last topic of the strand (DBE 2011a) and also in Grade 10 Life Sciences (DBE 2011c). That as a result was in contrast with the CAPS NS policy document (DBE 2011a) which stipulates that knowledge has to be linked and progressed throughout the grades. Moreover, giving learners a lot of content at once during a lesson could have led to misconceptions (Rosenshine 2012). Furthermore, the teacher was directionless in his articulation. He would move from one point of the lesson to another, then ultimately come back to original point after some. He just did not follow the sequence of the contents to be taught as indicated in the CAPS NS document and was there disorganised, and hence indicated minimal content knowledge (Shulman 1986).

ii. Poor accommodation of learning differences

Learning differentiation involves visual or auditory learning, engaging in group work, individual work or even being allowed room to move when learning (Nieman & Monyai 2006). The teacher should accommodate learners` different ways of learning when approaching teaching. This can lead to adequate and effective learning (Nieman & Monyai 2006). It was however not the case with Mr P who utilised and relied on one learning strategy, the lecture method. He indicated that he believed in that approach since he was trained in that particular way from college. Moreover, learners remained still on desks limiting any form of free movement or even free engagement with their peers, an approach which is in contrast with the assertion by Nieman and Monyai (2006).

iii. Lower level of engagement in class

Science is dominated by its practicality, hence a doing subject. Learners are expected to "work effectively as individuals and with other members" as a team (DBE 2011a). That was however not evident in Mr P`s class as learners had to rely on his directive. Learners learned individually limiting room for engagement with their peers. As a result, the engagement was between the teacher and individual learners characterising his approach as authoritative.

iv. Poor knowledge of curriculum saliency

Mr P indicated a lot of disregard and failure to recognise the CAPS document as the navigator of his teaching. He relied squarely on how he believed learning should take place rather than how it should occur as it appears in the policy document (DBE 2011a), hence showing poor SMK (Rohaan et al 2012). As a result, he gave learners knowledge from a general content rather than from a specific point. For example, the topic: Spheres of earth focuses only on one planet the earth, however the teacher spent much time on all the planets which are available in the universe and on details about them. This was inconsistent with grade 9 CAPS NS curriculum. Moreover, the fact that teacher did not even administer a single task in between or after the lesson in the form of either a classwork or homework is intensified by his dislike towards NS CAPS, failing to achieve its aims at the end.

v. Dictatorship driven class

Despite the NS curriculum policy document indicating active and critical learning as one of its principles, MR P chose the opposite route, implementing rote learning in his class. His teaching was a one-way traffic, with the emphasis on what he says rather than what the learners say. His lesson was passive, resulting in his learners spending most of the time seated still, listening to what he says (Kaddoura 2011) and waiting for his directives. His lesson did not foster social interactions among learners and was therefore in contrast to Vygotsky`s view of learning - "Knowledge is constructed based on social interactions and experience" (Woolfolk 2013). As a result, his teaching did not uphold constructivism which involves construction of knowledge and realisation of details and facts by prioritising vivacious learning (Woolfolk 2013; Shutkin 2004). He indicated that that is the way he was trained at college and has a lot of confidence in that approach.

4.3. CASE 2 (Mr JB)

4.3.1. Data presentation

This section presents the data from Mr JB

A. Teacher knowledge

KEY: **R**: Researcher **JB**: Mr JB **LS**: Learner **P:** Participant

THEME	CATEGORY	DATA	Coding
Teacher knowledge	Content knowledge	**R:** Can you explain to us what the Planet, Earth and Beyond is all about? **JB:** That one is about systems. You know systems eh eh a whole which is made of parts. The parts interact together to form on thing. So when we say the earth, we are not talking of the soil. We are not talking of……the trees. We are not talking of.. the nor the water. But we are talking of different things which are working together to bring one thing we refer to as earth. So in short I can say earth is made up of systems which are the pot of water, air, the soil. These things work together to support each other to sustain life. **JB:** Here at the centre, that`s where we have what? Biosphere! (pointing at the diagram drawn on the board). What it means is.. in the atmosphere, we have biosphere, in lithosphere we have biosphere, in hydrosphere we have biosphere. So it means hydrosphere, lithosphere, atmosphere, in all the three we get the portion of biosphere.	Sufficient SMK Good content knowledge Good knowledge of the content

		JB: In atmosphere and lithosphere, there`s an area (pointing the space on the diagram) which is common in both atmosphere and lithosphere. In hydrosphere there`s a part (pointing on the diagram) which is common in both the lithosphere and hydrosphere. In hydrosphere and biosphere, we have a part (pointing on the space on the diagram) which is common. These parts (pointing on the board) which are common are called interactions (labelling them on the board)	
	Students understanding	**R:** Okay thanks for that. Uhmmm, what misconceptions do you know of that is associated with the topic spheres of earth? **JB:** Yah some learners you know they take earth as one thing this one and it's a misconception. Some will also think the earth is like… a disc. It's a (inaudible). Yet the earth is round spherical. And in trying to remove that misconception, i.. try.. to bring even a ball when I am introducing the topic of… universe- remember the universe, that`s when we talk of planets and all those things, before we come to the earth. Normally some would think air is..is not part of the earth. Some would think water is not part of the earth. Because there is that misconception to say this is the earth the soil. Yet the earth is.. a complex of things. (there is laughter in the room)	Misconception, Learners 'Misconception

		JB: There is a gas which huge about 78 % in the whole composition **LS**: Photosynthesis **JB**: Yah the misconceptions were on the relationship of earth and sun. So… to move or reduce misconceptions asked them to draw diagrams which will show how they are thinking. And when I say how they are thinking I can correct you with what its wrong. So more is more of developing what we call the pictorial diagram or mind eh! With the picture in mind so that they know exactly what they want to see? Is it the real thing that they are seeing? What they hope to see is it the real thing they are seeing? From the diagram I think we can tell that.	
		JB: Then from grade 8, which gases are those? **JB**: Yah the prior knowledge which I wanted to find out is that do they know what earth is like. Do they know the shape of the earth? Do they know the relationship of the earth and the sun? Do they know the relationship of the earth and the other spheres? So I wanted to find out where are they exactly so that when I tell them about the other spheres then it becomes very smooth.	Irrelevant Prior knowledge

		R: What challenges do you normally face when you teach the topic to the learners, Spheres of earth? **JB:** Spheres of Earth? Yah learners lack imagination, because that one is an abstract concept. You will have to imagine things which you are not seeing. Are they really there? Do I have a picture in the mind of what they are saying? Of course I may get it from the book. But myself do I imagine…those things being there? So lack of imagination among learners is…something which is lacking and to assist that area normally I use a lot of pictures, I use lot of videos, and sometimes I use lot of eh what I can say work from the internets, the websites. **R:** Then what-when you were busy discussing with them, where did you find learners finding it difficult for them to discuss and how did you intervene? **JB:** Yah especially when there is new knowledge which is coming which is not part of their everyday life, sometimes you have to explain using the examples, uhmmm like the earth, eh is roundish but sometimes they don't think is roundish because they see it as a flat layer. Eh that is.. to them is new knowledge. So you have to tell them no is like this and this because of this. So through discussions, you will end up	Difficulties

		understanding it and through diagrams, through illustrations, and through collaboration with friends the end up with certain knowledge of the spheres of the earth.	
	Context knowledge	**R:** Alright, where would the teaching of this topic take place? Would it be in the classroom? or the library, laboratory, outdoor- **JB:** It`s in the classroom. The class was organised with desks in order. The class also had a black board, chalks and dusters. **R:** You decided to teach the topic in class and not in the laboratory or even outdoors. What was the reason behind that approach? **JB:** Doing it in class you know there's this chalkboard I wanted to illustrate using diagram, in a lab (laboratory) we don't have eh... chalkboard, outside I don't have that platform where I can illustrate using the chalkboard. That was the main reason of using the classroom.	Poor Contextual knowledge
		The class was organised with desks in order. The class also had a black board, chalks and dusters. **JB**: What I am going to do is.. I am going to give this pamphlet to the two of you, this to the two of you….. (The educator	Resources – teaching aids Resources– textbooks/copies Resources- empty papers

		started issuing learners in their pairs copies from a text book). **JB**: Then I want you to use this for writing (the educator issued the pairs of learners with empty papers	
		R: Which language is normally dominant in your class? **JB:** English The educator utilised English throughout his lesson.	Dominant language

B. Instructional strategies

THEME	CATEGORIES	DATA	CODING
Instructional strategies	Teaching route	**JB:** I want you to sit in pairs. You know in pairs – two-two. You! (Pointing to a learner) next to someone. Just get closer. You! (Pointing to another learner), sit with someone. **R:** Okay thank you sir. And then when you were teaching them you grouped them in pairs, when you give them a task, why! What was the purpose of that approach? **JB:** Yah sometimes you don't learn from the book or the teacher. You also learn from your friends. Other friends you know they are learning faster, so as they are learning**,** they also teach others, so it's more of peer teaching. Yah developing know…knowledge	Learner-centred

		from your friends. Knowledge doesn't just come from the book or from the teacher but is even from your friends you learn new things. **R:** So you wanted them to learn from one another, so in other words that was cooperative learning. **JB:** Yes, that was cooperative learning.	
		JB: About the earth, I want us to give the (writing on the board and talking at the same time): 1. Name of the parts of earth interacting with each? 2. Give the name of four spheres interacting on earth? 3. Draw the diagram showing the spheres of the earth interacting? 4. Describe interactions between – lithosphere and hydrosphere, atmosphere and hydrosphere, and atmosphere and lithosphere? **R:** Okay, oh thank you. Then you started the lesson with a task. What was the purpose of that task? What did you want to achieve? **JB:** With the task I wanted to..to find out the prior knowledge. You know when you are teaching learners sometimes they got their own knowledge. So you	Activities- classwork

			should first of all identify what do they have about this area. And from there you develop new knowledge linked to prior knowledge. So the task was to find out the prior knowledge so that I can find out how I can link the new knowledge to the old knowledge.	
	Epistemological perspective	**R:** **JB:** **JB:** **R:**	According to you in what way should Knowledge be attained? Knowledge should be attained through collaboration. A person should interact either with another person, and in that way we say we are not. Collecting knowledge but we are building knowledge we should build knowledge through collaboration-we collaborate with the environment. What really is happening, why it is happening like this, you ask you friend. How do you see it? If you don`t know ask your friend. It`s not a test.	Creativity/ social and cultural embedddness Creativity/ social and cultural embedddness
	Teaching methods		Please make mention of the teaching strategies that you know of? And the	Classroom discussion

		ones that you would employ when the topic Spheres of Earth? **JB:** Yah there`s demonstration teaching, there`s experiment, then there`s discussion. So in Spheres of Earth I cannot I will carry out an experiment, I cannot I will demonstrate but we will be discussing what really is an Earth, what do we know about earth? What are we going to learn about earth? How…are we going to learn about it? **JB:** Let us discuss now! **R:** Okay. Okay. So your class was dominated by discussions. What was the significance of that approach? **JB:** Yah cooperation normally there's what we call collaborative learning. Yah when you are learning you are building knowledge. And you can build it through discussions. Yes not just by reading. Cause when you read sometimes you will have a certain perception of things which may be wrong. But if you are talking to a friend then a friend can give you the other side , then you know you build knowledge from those discussions.	

		R:	Oh-kay. The next question… how is active learning and social interactions occurring in your class?	Cooperative learning Collaborative learning Group work/ cooperative learning
		JB:	Active learning?! Normally my teaching is child centred. I do most of the teaching via learner interaction. Learner-to-learner, learner-to-teacher, leaner-to-environment.	
		R:	So but then how do learners interact among themselves?	
		JB:	Learners…! Will be working in groups. I normally give them work in groups in the form of questions. They may ask each other. They may ask the book. As a class, we discuss the work together as class discussion. To find out if there are other learners who are left behind, or other learners who have missed the point.	
		JB:	Let me see what you are writing (checking the pairs).	

	Explanatory framework	**R:**	Can you please tells us how you would teach the Grade 9 learners the topic Spheres of Earth, putting into consideration, the analogies, the examples and illustrations that you would employ?	Analogies
		JB:	Yes, my approach normally is through question and answer. I would present learners with eh what I call.. lesson activities. They are going to work on those activities using textbook because nowadays our teaching is more of textbook based. Is no longer that OBE. So I would give them a set of questions…and they would go a the textbook, try to link the question to the textbook. As they are going over the textbook there will be learning so many things, but myself I would direct them to what I want via the questions, then after that, the questions would involve even drawings. So during drawing you know they will try to get that skill of knowing what really is happening. How are these things going to interact? Why are they interacting this way? After that, we now discuss as a class, to find out really, did they get what I want them to get?	

		JB: Another one. Another one. If you compare these two diagrams, we have atmosphere (pointing to the the first diagram), we have atmosphere (pointing to the second diagram. Where this two circles are meeting each other or are crossing each other (showing a gap or intersection between the atmosphere and lithosphere). Here we have biosphere (pointing on the first diagram), here we have nothing (pointing on the second diagram)	
	Differentiation of Strategies that addresses learning differences	There was a number of strategies- question and answer method , collaboration methods, demonstration method which were used interchangeably.	Variation of strategies

C. Classroom interactions and discourse

THEME	CATEGORIES	DATA	CODING
Classroom interactions and discourse	Type of discourse	**R:** Yah the discourses. You have your dialogic, or authoritative discourses- and which ones do you use? The one that is dominant in class. **JB:** Normally I prefer the one where we….have a dialogue, I don't prefer where we…..just…. learners receiving, receiving. I must also learn from learners. Because when i`m teaching normally im carrying a research (He laughs) **JB:** Let us discuss now. **R:** Okay. Okay. So your class was dominated by discussions. What was the significance of that approach? **JB:** Yah cooperation normally there's what we call collaborative learning. Yah when you are learning you are building knowledge. And you can build it through discussions. Yes not just by reading. Cause when you read sometimes you	Dialogic discourse

			will have a certain perception of things which may be wrong. But if you are talking to a friend then a friend can give you the other side , then you know you build knowledge from those discussions.	
	Patterns of discourse	**JB:**	As I told you before, today we are going to talk about the earth, the earth. Do you know what the earth is? Can you tell me what is earth? (initiation). Yes..!(pointing to a learner who raised the hand)	IRF
		L:	it`s a planet where people live. (response)	
		JB:	It`s a planet where people live (feedback)	
		JB:	What are these spheres? Can you name the four spheres? (learners raise their hands and MR JB points them one after the other). Yes! (pointing at a learner).	Non-triadic patterns I-Rs1-Rs2-Rs3-Rs4-Rsn
		L1:	atmosphere!	
		JB:	atmo-s-phe-re! (writing on the board). This is is sphere just like this one (circling the suffix	

		sphere). Yes! (pointing at another learner). **L2:** biosphere! **JB:** biosphere! (writing on the board). If you check there is sphere (circling the suffix sphere). Yes! (pointing at another learner). **L3:** hydrosphere! **JB:** if you check there is sphere (circling the suffix sphere after writing the response on the board) Yes! (pointing at another learner) **L4:** lithosphere! **JB:** (write the response on the board) again there is sphere (circling the suffix sphere)	
	Communicative approach	**JB:** Let us discuss now.	Dialogic/jnteractive

Key

•	**Data from interviews**
	Data from observations

4.3.2 Discussions

4.3.2.1. Teacher knowledge

Mr JB indicated his awareness of what content is to be taught in his class hence showed sufficient SMK (Rohaan et al 2012).

> ***Mr JB: So when we say the earth, we are not talking of the soil. We are not talking of……the trees. We are not talking of.. the nor the water. But we are talking of different things which are working together to bring one thing we refer to as earth. So in short I can say earth is made up of systems which are the pot of water, air, the soil. These things work together to support each other to sustain life.***

Moreover, Mr JB`s knowledge was plausible (Shulman 1986) as he was able to show without fail how the three spheres – atmosphere, lithosphere and hydrosphere interact with one another and how they interact with the biosphere as outlined in the NS CAPS document (DBE 2011a)

> ***Mr JB: Here at the centre, that`s where we have what? Biosphere! (pointing at the diagram drawn on the board). What it means is.. in the atmosphere, we have biosphere, in lithosphere we have biosphere, in hydrosphere we have biosphere. So it means hydrosphere, lithosphere, atmosphere, in all the three we get the portion of biosphere.***

Despite the good content knowledge and adequate SMK that was evident in Mr JB`s classroom, the same cannot be said about the prior knowledge that he revisited. The CAPS document (DBE 2011a) required the educator to revisit the content from Grade 7 Social Sciences of the concentric layers of the earth. However, the teacher chose to revisit the content from grade 8. Even though it was not entirely irrelevant, the knowledge did not build up to new emerging knowledge (Mesa et.al 2014).

> ***Mr JB: Then from grade 8, which gases are those?***

Moreover, the educator showed his awareness of the importance of prior knowledge when he indicated that learners should develop new knowledge from their background knowledge and hence gave learners a task. However, the questions asked from the task contained the main themes of the lesson and hence cannot be regarded as themes to elicit prior knowledge.

Moreover, some learners demonstrated misconceptions. One learner when asked to name gases, mentioned photosynthesis which is a process. Further to

that, Mr JB taught irrelevant content of the composition of the atmosphere which belongs to the topic the atmosphere, and such could have created content overload leading to misconceptions (Rosenshine 2012).
Furthermore, Mr JB utilised resources such as chalks, dusters, black boards, text book copies and empty writing papers as teaching aids. The educator could have achieved more had he utilised the local community, the libraries, models, posters, and internet as other resources, consequently creating a good context of learning (Starkey 2012).

Moreover, the educator chose to teach the topic in a classroom. His main rationale for his choice was to draw the spheres of earth on the board, which he indicated was absent in the laboratory or outdoors, in order to create a good picture in the learners` minds. This was a downside of his teaching since he failed to create relevant and realistic setting (Nieman & Monyai 2006) for the topic which could have been easily achieved had he chosen to utilise outdoor teaching, allowing learners to have direct and original learning.
Furthermore, the context should assist the teaching and learning to achieve its goals (Starkey 2012) and these goals should be structured in a way as to accommodate the three specific aims as outlined in CAPS NS document (DBE 2011a). Despite showing satisfactory knowledge of the three specific aims during the interview, the educator focused on achieving specific aims 2 and 3, knowing and applying science respectively.

> ***Mr JB: About the earth, I want us to give the (writing on the board and talking at the same time): 1. Name of the parts of earth interacting with each 2. Give the name of four spheres interacting on earth 3. Draw the diagram showing the spheres of the earth interacting 4. Describe interactions between – lithosphere and hydrosphere, atmosphere and hydrosphere, and atmosphere and lithosphere***
> ***Mr JB: The one you use at home is what?***
> ***Learner : liquid!***
> ***Mr JB: (wrote the word liquid on the board)***

The educator indicated that he could not achieve specific aim one: doing science due to the fact that he did not institute an experiment.

Table 4.4. A summary of MR JB` s teacher knowledge

Content knowledge	Sufficient SMK
	Good content knowledge
Teacher`s student understanding knowledge	Irrelevant utilisation of prior knowledge
	misconceptions
Contextual knowledge	Chalks, dusters, chalkboards, textbooks – teaching aids
	achievement of goals –specific aim 2 and 3 applied
	No language variation – English only

4.3.2.2. Instructional strategies

Mr JB utilised instructional strategies which were learner centred. This was made possible through his approach of teaming up learners in their learning, allowing collaboration between them (Arends 2012).

> ***Mr JB: I want you to sit in pairs. You know in pairs – two-two. You! (pointing to a learner) next to someone. Just get closer. You! (pointing to another learner), sit with someone.***

Mr JB indicated that he initiated team learning because he believed that learners should learn from one another. Moreover, collaboration had a good effect on learning as some tasks might prove difficult to some while easy to others, so having learners working in teams allowed them to have alternative paths for inquiry and discussion, increasing their motivation (Arends 2012).

Conklin (2007: 5) indicates instructional strategies as those "needed by teachers to enhance learning for diverse learners". However, an educator should not rely on one strategy when going to class (Halai & Khan 2011). Consequently, Mr JB utilised both collaborative learning and classroom discussion in his class, accommodating individual learning differences.

The educator utilised analogies in his classroom to explain different concepts. This was done to indicate variations and similarity between the two diagrams presented on the board. That allowed learners to draw, label, write, model, investigate, discuss, name, sequence, dissect, research (DBE 2011a).

> ***Mr JB: Another one. Another one. If you compare these two diagrams, we have atmosphere, we have atmosphere. Where this two circles are meeting each other or***

are crossing each other (showing a gap or intersection between the atmosphere and lithosphere). Here we have biosphere (pointing on the first diagram), here we have nothing (pointing on the second diagram)

That approach by the educator helped the learners in creating a clear picture of how the three spheres – the lithosphere, the biosphere, the hydrosphere interact with one another and with the biosphere.

Table 4.5. A summary of MR P` s Instructional strategies

Teaching approach	Learner centred
Instructional method	Classroom discussion
	Collaborative learning
	Demonstration
Explanatory framework	Analogies
Epistemological perspectives	Creativity/ social embeddedness

4.3.2.3. Classroom discourse and interactions

Classroom discourse is the diverse engagement that takes place between the teacher and learner, which are best practiced orally (Smart & Marshall 2012). As he indicated during the interviews, and evident in class, Mr JB`s lesson was highly characterised by a dialogic discourse. This was so since the educator asked questions to trigger learners` thinking and opinions, consequently forming a correlation between them (Lemke 1990 in Smart & Marshall 2012).

Mr JB: what is the other form?
Learner: solid water.
Mr JB: then what it is the name given to solid water?
Learner: ice.
Mr JB: Yes ice.

Further to that, the educator believed allowing learners to engage with him and amongst themselves allowed them to learn from one another rather than learning from a book alone.

Mr JB: Let us discuss now.

As such his class was predominantly dialogic/ interactive. According to Scott et al (2006), the communicative approach focuses on how a teacher communicates with the learners. Moreover, if effective, the communicative approach can establish opinions and awareness of learners which relies directly on social coherence (Belik & Yarden 2016).

Furthermore, Graesser et.al (2003) recognise the initiation, learner's response and teacher`s feedback as patterns of discourse in class, which were evident in Mr JB` s class. In the context, firstly the educator initiates communication by

probing a question to leaners, the learner then responded to a question, and then the teacher finally responded, giving feedback in the process (Molinari et al 2013).

Mr JB: As I told you before, today we are going to talk about the earth, the earth. Do you know what the earth is? Can you tell me what is earth? (initiation).
Mr JB: Yes..!(pointing to a learner who raised the hand)
Learner: it`s a planet where people live. (response)

Mr JB: It`s a planet where people live (feedback)

Table 4.6. A summary of Mr JB` s Classroom discourse and interactions

Type of discourse	Dialogic discourse
Patterns of discourse	IRF
	the non-triadic patterns (I-Rs1-Rs2-Rs3-Rs4)
Communicative approach	Dialogic/interactive

4.3.3. Findings

i. Curriculum content congestion

Mr JB was at a particular stage found to be talking about the content which is not part of the topic: spheres of earth. The educator was found to be teaching about the composition and the abundance of Nitrogen in the atmosphere which he indicated to be containing 78%. That was a downside to his teaching since the content belonged to the incoming topic: the atmosphere, which happens to be last topic of the PEB stand for grade 9 (DBE 2011a) and consequently, learners received a lot of content at once which can lead to misconception and misunderstanding (Rosenshine 2012).

ii. **Relevant gears for science teaching**

The educator displayed great awareness of the principles and aims of the science curriculum as he employed methods that sought to achieve active and critical learning and do away with uncritical rote learning (DBE 2011a). That was easily achieved by his usage of discussion and collaborative learning method wherein he paired learners and encouraged them to work together on problems given. As such he initiated the PBL learning which allows learners to investigate authentic task, supporting team work and allowing emergence of relevant curriculum skills (Hopper 2014). He also employed great analogies wherein he demonstrated and illustrated accurately through drawings how the three spheres – the lithosphere, the atmosphere, and the hydrosphere interact with one another and with the biosphere.

iii. Wrong playing field

As was expected, the planet, earth and beyond deals with elements which are available outside the classroom. The spheres of earth, are the atmosphere – "a layer of gases around the earth", the lithosphere – soil and rocks, and hydrosphere – "water in all its forms" (Bester et al 2013: 202). It would have been ideal for the educator to use outdoor teaching to demonstrate and point out things like the soil, the rocks, the atmosphere, rivers and dams and others that learners can have a clear view on and would make learning more bona fide (Nieman & Monyai 2006).

iv. The pie was not his

Mr JB generally used an approach which was learner centred. He however in particular occasions did not allow learners to dictate their learning, doing what was supposed to be done by learners. After learners drew two different diagrams of interaction of spheres on the board, it was expected that he would direct learning in such a way that would allow them to spot the difference and similarities on the diagram, depriving them of eating their own pie. Consequently, this approach does not accommodate "higher order skills such as application in analysis" (Cashin 1985 in Nouri 2016) resulting in learners becoming "shallow, surface thinkers" who basically depend on memorising instead of properly understanding the content (Kaddoura 2011). Moreover, the NS CAPS curriculum encourages learning to be active and critical, something the educator should have taken into consideration.

4.4 CASE 3 (Mr M)

4.4.1. Data presentation

This section presents the data from Mr JB

A. Teacher knowledge

KEYS:

M: Mr P
LS: Learners
L1: Learner 1
L2: Learner 2
L3: Learner 3
L4: Learner 4
L5: Learner 5
L6: Learner 6
L7: Learner 7
L8: Learner8
R: Researcher
P: Participant

THEME	CATEGORY	DATA	Coding
Teacher knowledge	Content knowledge	**M:** When these spheres (pointing at the lithosphere, atmosphere and hydrosphere) interact with one another, they are going to make the biosphere **M:** In other planets we don`t have the lithosphere, we don`t have the atmosphere, we don't have the hydrosphere **M:** Yah the difficult thing to achieve during my teaching as I have indicated earlier, is that one where we find that these learners….they did not know that if one of the spheres is..is..is interupted, the other spheres are also going to be affected. So I just wanted them to know that all these spheres of the	Poor SMK Irrelevant content

		earth, they interact together so that the..the system can..can take place.	
	Students understanding	**M:** and again we have got four spheres of earth, what are those? Yes! (pointing at a learner) **LS:** Hemisphere! **M:** He says hemisphere, Is he correct? (referring to the whole class) Majority of learners: Yes! **M:** Sometimes, learners they do not understand the difference between the atmosphere and the lithosphere. Sometimes when you ask them questions based on the lithosphere, they will give you answers which are from the…the…the hydrosphere. So they don't know the difference between these sphere of earth. **M:** And again we have got the lithosphere, so the lithosphere this is the solid part of the earth. **R:** Okay. And then you said the lithosphere is the solid part of the earth, what were you implying?	misconceptions

		P: So when we talk of the solid part of the earth here, we are talking about…we are talking about the..the..the soil, talking about the rocks, and other layers of the earth which are in the form of the solid. **R:** Okay. And then when you were referring to the solid part you were reffering only to the lithosphere, the rocks and the soil- **P:** The rocks, the soil…those are the parts because this other..for example this other living organisms even though they are solid, but they are found on the ..the…the depend on the lithosphere for…for growing such as plants, they grow..they grow on lithosphere.	
		M: So now I want you to…I want us to go back. We know that in Grade 7 we learnt about the earth which is one of the coordinates of the world. Are we together. So what are the… what are the structure… what is the structure or what are the layer of the earth? What are the layers of the earth?	Relevant but insufficient Prior knowledge

		R: Okay thank you. Then what prior knowledge did you revisit and what was the reason for your choice? **P:** Yes the prior knowledge that I have revisited is that one of eh asking learners to give layers of the earth as well as the spheres of the earth. The reason for that I just wanted to check as to whether, they still remember what they taught in the previous grades so that I can link that with the..the the interaction of these four spheres of the earth, so that they know that these spheres of the earth, they are eh..eh they act together so that they can form a system wherein we have got the living organisms and many other things where in this different spheres of the earth we know that we have got eh what we call we have got this eh, the output, the input as well as the..the process.	

		P: Yah…the problem with the spheres of the earth, the challenge that I usually have here at school, is eh the problem is teaching aids, for example charts and so on. So sometimes I used to improvise by making some brochure and so on so that when I go class, then that learners must…be able to understand me very well because I got those teaching aids and paste them on the board . Challenges that I'm facing is that one of teaching aids. Because our school is not well resourced. The educator did not use teaching aids in class	Difficulties
	Contextual knowledge	The classroom (mobile classroom) was untidy, having no door, very small. The learners were sited on their desks in an unordered manner. There were also a lot of noise coming from the nearby class.	Poor contextual knowledge – dimensions
		M: Eh specific aims sometimes when we teach learners, we….want them to…to.. to know something for example, if you want them to know more about the..the importance of…of the…of the hydrosphere, how they must gentle the sources of water. So	Poor contextual knowledge - curriculum ` goals

		that is one of the aims that I used to tell learners when I'm in class. **M:** Okay. Uhmm Natural Sciences has got three specific aims, that is doing science, knowing science and applying science. Which ones did you attend to in your class and how did you attend to them? **P:** Yah because I was teaching in the class, in other words as we just talking, is that one of knowing science how it works. So that is why I decided to go to class so that I can achieve that aim of knowing that eh Natural Sciences is one of the science subjects and most of the things that are happening on earth applies to…apply to science.	
		M: Yah the assessment strategies that sometimes I'm used to employ, eh can be any question and answer method, telling method, and sometimes I'm used to apply the….the…the…the practicals where I am going to pose questions to learners so that they can give us…they can come up with some solutions regarding the…the..the spheres of…of the earth.	Poor context knowledge – resources

		No written assessment took place in class **R**: Okay. Uhmmmm you did not assess the learners during the lesson. What was the reason behind that? **M**: Yah I..i have assessed them but assessment was verbal. It was verbal because I was asking questions. Even though I did not give them the formal …writing assessment in the class but I have assessed them by verbal questioning eh so..so that I can check as to whether they understand what I was ..i was teaching about.	
		R: So how do you then address the learning differences in class? You see we have leaners who are slow, some are fast, some are moderate. How do you the address those differences. **M:** Actually, these kind of learners are there but when I come across that kind of problem where maybe some are slow learners, and so on, then I used to give myself time with them, so that I can teach them, so that	Learning difference

		they can understand this very well, so that they can be at the same level with other learners who are well gifted.	
		R: Okay. Then where would…where would you teach this topic? It might be the classroom, the library, the laboratory, outdoor or any other area. **M:** Yah. Because of a large number of learners that we are having, i..i prefer to use the classroom which is the only thing that I can use because we don't have resources up to so far. Accommodation is not there.	Poor contextual knowledge - resources
		M: Yah most of them, their mother tongue that I used to this learning area in English where in there is a need for me to explain in their mother tongue, then I use the language. **M:** (in Sepedi) Biosphere is where we see animals and people living together like in the universe where we are, meaning without plants there wont be animals and without animals there cannot be plants.	Language differentiation

B. Instructional strategies

THEME	CATEGORIES	DATA	CODING
Instructional strategies	Teaching route	**M:** In a system there is an input, a process and an output. When we talk about the input, we are talking about the source of something, for example we know that on earth there is a sun. Are we together. So the energy is known as the output. The energy from the sun is the form of radiant energy. So for the biosphere to exist it means plants must get energy from the sun, and this plants must get water from the soil which is from the hydrosphere. **R:** Okay. That is why you were repeating the content- **M:** That is why I was repeating the content, I wanted them to understand….understand that content	Traditional/rote learning/ teacher-centred method
	Epistemological perspective	**R:** Okay. Okay. Then according to you, in what way should knowledge be attained? How do you believe eh… learners should know or gain knowledge? In what way? **M:** Yah sometimes when I go to class, for them to gain knowledge, eh I let them to listen attentively. So, where they don't understand, then I give them a chance to…to indicate section where they did not understand that very well. **M:** We are talking about the envelope that covers the… surface of the earth. Is that understandable?	subjectivity

		LS: Yes! (in a recital manner) **M:** The space where a mixture of gases. A space where there are so many gases, carbon dioxide and many others. Is that understandable? **LS:** Yes! (in a recital manner)	
		M: Sometimes I use the question and answer method, eh narrative method, eh this are the..the..the strategies that I can use because up to so far as I have indicated earlier, because of running short of eh resources such as eh apparatus, then that is where I use this kind of… **M:** A system is a set of interconnected parts (reading from his notes). Remember we talk of the four spheres of the earth, that we have just mentioned here. They say for them to make a system, they must work together. In other words if one system is not okay that means other system here are not going to be..in other words they are going to be affected. **R:** Okay. You spent most of the time in the class talking whiles learners were listening. Why..why was that? **M:** Yah I have realised that these learners as I have asked some questions before. I have realised that	Irrelevant teaching methods for science /Lecture method

		they know some of the aspects. Some of the aspects for example that one of layers of the earth as well as the spheres so as an educator as I was having the knowledge, that is why I was trying to give them the knowledge of how these spheres of the earth are related. Because they..they they knew only the layers of the atmosphere as well as the..i mean the layers of the earth as well as..other factors that as I was talking I wanted them to listen and know how they are related.	

THEME	CATEGORIES	DATA	CODING
Classroom interactions and discourse	Type of discourse Patterns of discourse Communicative approach	**M:** No I used to…I involve them **M:** Yes I give them a chance to...to say whatever they know **M:** Sometimes learners understand very well when they…when their peers explain something. Rather than when I explain it in the class. **M**: If there is no biosphere what do you think is going to happen? If there is no biosphere. What do you think will happen? (before learners could respond) it means there will be no life. It means there will be no life. Because is here (pointing to the biosphere written on the board). Is that understandable?	Dialogic authoritative

	R: Okay. You spent most of the time in the class talking whiles learners were listening. Why..why was that?	IRF IRF
	P: Yah I have realised that these learners as I have asked some questions before. I have realised that they know some of the aspects. Some of the aspects for example that one of layers of the earth as well as the spheres so as an educator as I was having the knowledge, that is why I wad trying to give them the knowledge of how these spheres of the earth are related. Because they..they they knew only the layers of the atmosphere as well as the..i mean the layers of the earth as well as..other factors that as I was talking I wanted them to listen and know how they are related.	
	M: ah actually, when I introduce my lesson, as I have indicated, im going to ask them questions based on what they have already learned (initiation). Thereafter, then im going to help them, If they don't give positive answers (response), then from there im going to get into the matter (feedback). Explain and after that, pose questions to them, thereafter they answer if they don't answer I help them so that they can come in their right direction.	
	M: So what is another sphere of the earth? What is another sphere of the earth? (initiation) Yah! (pointing at a learner).	

	L: Atmosphere! (response) **M:** Yes, we have got the atmosphere, are we together. (feedback) **M:** If there is no biosphere what do you think is going to happen? If there is no biosphere. What do you think will happen? (before learners could respond) it means there will be no life. It means there will be no life. Because is here (pointing to the biosphere written on the board). Is that understandable?	Authoritative/non-interactive

Key

•	**Data from interviews**
	Data from observations

4.4.2 Discussions

4.4.2.1. Teacher knowledge

Mr M`s SMK was irrelevant in most cases during his teaching.

> ***Mr M: When these spheres (pointing at the lithosphere, atmosphere and hydrosphere) interact with one another, they are going to make the biosphere***

According to Rohaan et al (2012), SMK deals with the understanding of themes and topics that need to be imparted to the learners, which was not the case with Mr M. The CAPS document states clearly the content that need to be taught in the topic, which is how the spheres interact with another and how they interact with the biosphere (DBE 2011a). The educator chose only to focus on the latter which is the interaction between the three spheres and the biosphere and nothing was said about the interaction between the spheres themselves. It was therefore clear that the educator did not employ the NS CAPS document as a point of reference.

Furthermore, Mr M` s lesson was characterised by a lot of misconceptions.

> ***Mr M:And again we have got four spheres of earth, what are those?***
> ***Yes! (pointing at a learner)***
> ***Learner : Hemisphere!***

Even though Mr M managed to do away with the above misconception, he himself created a lot of misconceptions. He at one stage referred to the lithosphere as the solid part of earth. He was correct since the lithosphere is dominated by soil and rocks which are solid, however, he could have created a misconception that all object which are in solid forms like ice water and living organisms, are a component of the lithosphere. When asked what he meant by his statement during post-observation interviews, Mr M indicated that even though living organisms are solids, they are part of the lithosphere. That in itself creates another misconception that all living organisms are found in the lithosphere. These misunderstandings could have blocked learners' effective learning of science (Burgoon et.al 2010).

Moreover, his failure to explain clearly the relationship between the hydrosphere and lithosphere could have learners thinking that the two is one and the same.

> ***Mr M: ……..this plants must get water from the soil which is from the hydrosphere.***

Furthermore, Mr M`s failure to utilise the CAPS documents resulted in him teaching a lot of content which was irrelevant.

Mr M: In other planets we don`t have the lithosphere, we don`t have the atmosphere, we don't have the hydrosphere

That in itself could have led to misconceptions in class as according Roseshine (2012), the misconceptions can arise in class, if a teacher gives learners a lot of content at once during a lesson.

Moreover, even though Mr M revisited relevant prior knowledge, it was insufficient. According to (DBE 2011a), the educator should revisit the content from Grade 7 Social Sciences in which he could be able to demonstrate through drawing and labelling, the concentric layers of the earth. It was however not the case with Mr M.

Mr M: So now I want you to…I want us to go back. We know that in Grade 7 we learnt about the earth which is one of the coordinates of the world. Are we together. So what are the… what are the structure… what is the structure or what are the layers of the earth? What are the layers of the earth?

Further to that, revisiting the correct and relevant prior knowledge could have helped learners to connect the dots and enjoy the comfort of effective learning. That notion was substantiated by Mesa et.al (2014) who indicate that checking on learners` prior knowledge, allows them to match the previous knowledge with their new emerging learning

Mr M failed to create relevant and realistic setting (Nieman & Monyai 2006) for the topic which could have been easily achieved had he chose to utilise outdoor teaching, allowing learners to have direct and first hand learning. This is so since the spheres of earth consist of the atmosphere (layer of gases), the hydrosphere (water in all forms), the lithosphere (soil and rocks), the biosphere (living things) which their components were outside the classroom. However, Mr M lacked awareness of such resources and claimed there were no resources which forced him to teach in the classroom.

Mr M: Yah. Because of a large number of learners that we are having, i..i prefer to use the classroom which is the only thing that I can use because we don't have resources up to so far. Accommodation is not there.

Moreover, Mr M was not goal orientated (Starkey 2012). This was due to his lack of awareness of specific aims that pertains to Natural Sciences curriculum. According to the NS CAPS document, there are three specific aims that the

curriculum intends to achieve: Specific aim 1 - 'Doing Science' , Specific aim 2 - 'knowing the subject content and making connections', Specific aim 3 - 'understanding the use of science'. Mr M was however not conversant with any when asked about them during the interview.

> ***Mr M:Eh specific aims sometimes when we teach learners, we….want them to…to.. to know something for example, if you want them to know more about the..the importance of…of the…of the hydrosphere, how they must gentle the sources of water. So that is one of the aims that I used to tell learners when I'm in class.***

He however during the lesson focused on achieving specific aim 2 – knowing science. He did not create room for specific aim 1 and 3. Moreover, Mr M lacked knowledge of the assessment strategies that pertains to the NS curriculum. In fact, he seemed to be confusing them with teaching strategies when asked during the interview. When asked why he did not administer even a single task in the form of classwork, he indicated that the assessment that he gave was verbal and not written. This was a downside of his teaching since giving a classwork could have allowed him to diagnose the learner`s understanding and any misconceptions.

Furthermore, Mr M relied on dusters, chalks and notes. He did not bring any other additional teaching aids to class to authenticate his teaching. The educator indicating the issue of being under resourced as a reason for lack of teaching aids. This was in contrast with DBE (2011a) which indicates effectively that in the absence of teaching resources, the educator should "improvise".

The educator`s class was dominated by English language even though he in some instances used Sepedi to explain some concepts and relationships. This could have been a downside to his teaching since the language of teaching and learning is English. Moreover, using Sepedi which some of the English words are not available in their vocabulary could have led to an incorrect translation in the learners` minds.

> ***Mr M: (in Sepedi) biosphere is where you see animals and people live together in the world just like as we are.***

It is clear from Mr M`s utterances that his explanation in Sepedi could have best been explained in English. Moreover, his explanation could have created misconceptions in the learners` minds that people (human beings) are not animals.

Table 4.7. A summary of MR M` s teacher knowledge

Content knowledge	Irrelevant content
	Poor SMK
Teacher`s student understanding knowledge	Irrelevant utilisation of prior knowledge
	Learners` and teacher`s misconceptions
	difficulties
Contextual knowledge	Poor knowledge of context on dimensions
	Poor knowledge of context on resources

4.4.2.2 Instructional strategies

Mr M`s teaching was totally teacher-centred (Boumová 2008) in that in most cases he gave the learners minimal time to be involved in their learning (Kaddoura 2011). Further to that, he spent a lot of time reading his own notes and explaining the concepts to the learners in a repeatable manner. He indicated that he wanted learners to understand the content even though his approach was in contrast with the principles of CAPS, which discourages "rote and uncritical" approach to learning (DBE 2011a). It therefore became clear that the educator wanted learners to memorise the concepts as much as they could, consequently creating "shallow, surface thinking" whereby learners would not properly understand the content (Kaddoura 2011).

Furthermore, the educator was not well conversant with relevant teaching strategies for teaching science. In fact, Mr M relied on instructional strategies which do not promote active and critical learning as outlined in the CAPS NS curriculum (DBE 2011a).

> ***Mr M: Sometimes I use the question and answer method, eh narrative method, eh this are the..the..the strategies that I can use because up to so far as I have indicated earlier, because of running short of eh resources such as eh apparatus, then that is where I use this kind of…***

Moreover, even though the educator employed more than one teaching strategies, the said strategies did not afford learners room to utilize their individual style of learning (Bennett 2007). This was so because learners ultimately did not engage in group work, individual work or even allowed room to move when learning (Nieman & Monyai 2006).

Further to that, even though Mr M indicated that he would be drawing on the board to illustrate to the learners how the spheres interact, which would have been good, he however, relied on giving examples to discuss the concepts he

was teaching. Even though it was not an entirely bad approach, it did not give rise to activities wherein learners would draw, label, write, model, investigate, discuss, name, sequence, dissect, and research (DBE 2011a).

> ***Mr M: For example, last time I was here in class, we spoke about systems of the body. Remember we talked about the skeletal systems, we talk about digestive system. We talked of the reproductive system. All these systems work together so that our bodies can live or reproduce themselves, are we together. But here when we talk of the system (pointing on the board), we are talking about lithosphere, we are talking about the…hydrosphere, we are talking about the atmosphere, as well as the biosphere.***

On the other side, the educator indicated that he chose to use examples instead of illustrations or both due to a lack of resources. It was a downside of his teaching since he had enough resources like chalks, chalkboard and dusters which he could have improvised (DBE 2011a) and used to draw and indicate the interactions between the spheres of earth.

Table 4.8. A summary of Mr M` s Instructional strategies

Teaching approach	Rote learning/ teacher-centred
Instructional method	Lecture method
	Question and answer
Explanatory framework	Examples
Epistemological perspectives	Subjectivity

4.4.2.3 Classroom discourse and interactions

Mr M`s discourse was dialogic in that in most cases he never gave the learners time to respond to questions he was asking. For instance, he would ask learners questions and after realising that they are struggling to respond, give a full answer himself.

> ***Mr M: If there is no biosphere what do you think is going to happen? If there is no biosphere. What do you think will happen? (before learners could respond) It means there will be no life. It means there will be……. no life. Because is here (pointing to the biosphere written on the board). Is that understandable?***

The educator was therefore the most dominant voice in class and did not allow his learners to be full participants of their learning and consequently restricting combination and consideration of ideas (Scott et al 2006). Moreover, his approach was non directional (Mortimer & Scott 2003) as his goal was obviously to transmit definite details to the obedient acceptors (Tytler & Aranda 2015).

> **Mr M: …. other factors that as I was talking I wanted them to listen and know how they are related.**

Hence, his discourse was authoritative. Furthermore, Mr M did not give room for interactions since as was indicated above, he was the dominant voice in class. Moreover, his approach did not trigger learners` deeper thinking, consequently failing to form a correlation between them (Lemke 1990 in Smart & Marshall 2012), which in this case was the relationship between the spheres of earth. Therefore, Mr M`s class was characterised by the authoritative/non-interactive communicative approach (Scott et al 2006).

Furthermore, the educator `s patterns of discourse were IRF (Molinari et al 2013). This was so since the educator at a number of stages in his class would ask a question, wait for learners` responses and ultimately give feedback by either dismissing or agreeing with the response (Molinari et al 2013).

> ***MR M: So what is another sphere of the earth? What is another sphere of the earth? (initiation) Yah!(pointing at a learner).***
> ***Learner: Atmosphere! (response)***
> ***Mr M: Yes, we have got the atmosphere, are we together? (Feedback)***

Table 4.9 A summary of Mr M` s Classroom discourse and interactions

Type of discourse	Authoritative discourse
Patterns of discourse	IRF
Communicative approach	authoritative/non-interactive

4.4.3. Findings

i. Wrong playing field

The educator taught the lesson in the classroom even though it would have been better to teach the themes outdoors. This was so because spheres like atmosphere, which deals with a layer of a gas; lithosphere, which include soil and rocks; and hydrosphere which deals with water in all forms (Bester et al 2013: 202), could have been better taught outside the classroom, in the school yard or on the soccer playing field. This was going

to have a good effect on learning since the educator could have indicated to the learners, things like the soil, the rock, rivers, clouds which would be visible to the learners, consequently creating "real world environment" (Nieman & Monyai 2006:8).

The educator however, did not take the learners to the outdoors citing lack of resources and overcrowding as reasons.

> ***Mr M: Yah. Because of a large number of learners that we are having, i..i prefer to use the classroom which is the only thing that I can use because we don't have resources up to so far. Accommodation is not there.***

Outdoor teaching does not rely on the size of learners and it is very clear that the educator did not have that in mind when planning his teaching. Moreover, the NS CAPS document stipulates very well that in cases where resources are insufficient, the educator should contrive (DBE 2011a).

ii. Irrelevant gears applied

Mr M taught the topic spheres of earth in a way which is alien to science. This is so since the educator used the lecture method, which minimally involve learners. Further, the lecture method did not support inquiry which allows learners to be "objective thinkers" as stipulated in the NS CAPS document (DBE 2011a). Instead, learners were left with no choice but listening to the educator delivering his 'speech' (Kaddoura 2011).

Moreover, even though the educator varied his strategies when teaching by also employing the question and answer method, the methods applied were not upholding the aims of NS CAPS curriculum (DBE 2011a). For instance, the curriculum aimed amongst others, at producing learners that "identify and solve problem, make decisions through critical and creative thinking"; work co-operatively in teams; collect, analyse, organise, and critically evaluate data"; and become "effective communicators".

The educator could have achieved the above mentioned aims had he opted to utilise the drawing and labelling of earth`s spheres to indicate the interactions that take place between the spheres. He however, kept on repeating and emphasising the themes he was teaching, with a clear intention of feeding the learners with information in a way that they will not forget. That was a downside of his teaching, since he ultimately created facile and narrow thinking in learners (Kaddoura 2011).

iii. One-way traffic

Mr M`s lesson was totally teacher centred (Boumová 2008). This was so since the teacher allowed minimal interaction with the learners through the question and answer method and spent a lot of time reading his notes to the learners, hence found to be failing to accommodate "higher order skills such as application in analysis" (Cashin 1985 in Nouri 2016).

Moreover, the educator was at a particular stage, found to be enjoying telling learners the themes of his lessons than allowing them to be involved after asking them a question.

> ***Mr M: If there is no biosphere what do you think is going to happen? If there is no biosphere. What do you think will happen?***
> ***(before learners could respond) it means there will be no life. It means there will be….. no life. Because is here (pointing to the biosphere written on the board). Is that understandable?***

That indicated a dictatorship approach were learning went in one way and that is the way of the teacher who was the authority in the class.

iv. Contaminated lesson

Mr M`S lesson was fully characterised by irrelevant content, indicating a disorganisation of knowledge from the teacher. According to Shulman (1986), content knowledge is "the amount and organisation of knowledge per se in the mind of the teacher". However, it was never the case with Mr M who moved from here to there in his articulation. Moreover, teaching learners a lot of content at once which was also irrelevant could have created a lot of misconceptions (Rosenshine 2012). Furthermore, Mr M created misconceptions himself in class during his articulation, by referring to the lithosphere as the solid part of the earth even though we know the solid phase is also present in other spheres. Further to that, the educator went on probing questions on learners with content which was irrelevant to the topic of the day.

> ***Mr M: in which part of the earth or in which part of the world do we find water which is a solid. Yah! (pointing at the learner).***
> ***Learner: around the poles.***

Mr M: Yes, it is found around the poles are we together
Learners: Yes!
Mr M: remember we have the Northern and Southern poles.

v. Relevant, but incomplete file of previous records picked

Mr M`s revisited relevant knowledge as was required. According to the NS CAPS document, the educator when teaching the topic spheres of earth should revisit the Grade 7 social sciences` topic of concentric layers of earth (DBE 2011a). However, the NS CAPS document goes further to say the educator should be able to demonstrate the concentric layers of the earth through drawing and labelling (DBE 2011a), which was not the case in Mr M`s class.

vi. Poor curriculum saliency

There is a vast evidence that the educator did not recognise the NS CAPS document as a point of reference when approaching his lesson in class. This was evident initially when the educator chose not to revisit the prior knowledge as indicated on (v) above, and as was required by the NS CAPS document. Furthermore, the educator `s lesson was not aimed at achieving the three specific aims as outlined in the NS CAPS document. This was first visible when firstly the educator showed his lack of awareness and knowledge of the three specific aims during the interviews, and secondly, did not employ instructional strategies which could have helped in achieving the three specific aims.

Moreover, the educator did not apply the written assessment in class, despite him telling learners to go and write as a homework, the exercise that appears in a textbook. This was due to his poor knowledge on assessment strategies for NS as was evident in the interviews.

Mr M: Yah the assessment strategies that sometimes I'm used to employ, eh can be any question and answer method, telling method, and sometimes I'm used to apply the….the…the…the practicals where I am going to pose questions to learners so that they can give us…they can come up with some solutions regarding the…the..the spheres of…of the earth.

Furthermore, assessing learners in class could have allowed the educator to observe how much they had learnt, enabling him to diagnose the problems and misconceptions learners had with the topic.

4.5. CONCLUSION

This chapter presented, discussed and made findings from the data of the three cases identified to answer the research questions. The cases (participants) were exposed to the same questions and same observation protocols and taught the same topic. Moreover, the cases were interviewed and observed separately to elicit more insight in their classroom practices. The three cases were given the pseudonyms Mr P, Mr JB and Mr M and are from Schools A, B, and C. Furthermore, it is only the elements that were presented that assisted in answering the research question.

CHAPTER 5

5.1. INTRODUCTION

This chapter presents the summary of findings. It further answers the research questions, presents the contributions and shortcomings of the study. The study finally recommends further research.

5.2. RESEARCH QUESTIONS

This study was undertaken to unpack teaching difficulties in the topic of the Planet, Earth and Beyond strand of Natural science. The focus was on the teacher knowledge, instructional strategies, and interactions and discourse.
The study was guided by the following research question:

What are the teaching difficulties of Planet, Earth and Beyond strand?

The question led to the following sub-questions:

a. **What is the nature of the teachers` knowledge in the Planet, Earth and Beyond strand?**

b. **What is the nature of the teachers` instructional strategies in the Planet, Earth and Beyond strand?**

c. **What is the nature of teachers` classroom interactions and discourse in the Planet, Earth and Beyond strand?**

Below I answer the research questions per case:

5.2.1 What is the nature of the teachers` knowledge in the content of Planet, Earth and Beyond?

Case 1 (Mr P)
The study has revealed that Mr P` s content knowledge was disorganised as he was found to be teaching irrelevant content. Moreover, he had a poor SMK as he was evidently unaware of what needs to be taught. As such the educator revisited irrelevant prior knowledge and this could have created a lot of misconceptions in his class.
Moreover, the educator demonstrated poor contextual knowledge in many aspects. For instance, he did not know where a topic of this nature can be taught, opting to use a resource-less classroom. He was not aware of specific aims that

needed to be achieved in a science classroom. Therefore, the educator demonstrated poor teacher knowledge on the Planet, Earth and Beyond strand.

Case 2 (Mr JB)

The study has shown Mr JB`s content knowledge to be well organised and accompanied by sufficient SMK. This was so since the educator followed the content as was required by the NS CAPS document hence having awareness of what needed to be taught. However, Mr JB included some content in his lesson which were irrelevant for the topic and hence could give birth to misconceptions despite himself being aware of misconceptions learners had in class. The study also revealed that Mr JB revisited irrelevant prior knowledge to the topic spheres of earth despite showing awareness of the knowledge to be revisited during interviews.

Mr JB also had poor contextual knowledge on where the topic needed to be taught as he chose to teach it in class as compared to outdoors. Furthermore, despite showing good knowledge of three NS specific aims, he only employed two of the three specific aims in class leaving out the “doing science”.

Therefore the Mr P` s teacher knowledge was poor.

Case 3 (Mr M)

The study has revealed that Mr M`s knowledge of content was disorderly, irrelevant and hence could create misconceptions. Furthermore, even though the educator showed ability to deal with misconceptions in some instances in class where he effectively corrected a learner`s incorrect response, he was found to be creating some misconceptions himself in his articulations in class. Moreover, teaching irrelevant content indicated the teacher`s poor SMK. Further to that, the prior knowledge revisited by the educator was relevant, and helped connect what the learners learnt from previous grades to the new knowledge. However, the best could have been achieved had he asked the learners to draw the concentric layers of the earth as indicated by the CAPS document.

The educator had poor contextual knowledge on the place for teaching the topic having taught the topic in class. He indicated lack of accommodation and safety of learners if taught outside the classroom. The educator also lacked knowledge on the NS three specific aims as he showed no clue of what they are during interviews even though he achieved only specific aim 2 – knowing science, and hence was not goal oriented. Mr M also had poor assessment strategies since he did not assess learners through a classwork but through a homework. He acknowledged his lack of written assessment in class and indicated that he relied on verbal assessment.

Therefore, Mr M`s nature of knowledge was very poor.

5.2.2 What is the nature of the teachers` instructional strategies in the Planet, Earth and Beyond strand?

Case 1 (Mr P)

The study revealed Mr P` s poor awareness of relevant teaching strategies for teaching science. Mr P mentioned and utilised lecture and, question and answer method which were teacher centred and promoted rote and uncritical learning. Moreover, the educator relied on giving examples which were irrelevant and did not assist in promoting understanding from learners. Furthermore, allowing learners to demonstrate or illustrate their understanding through relevant teaching aids could have helped in achieving practicality of the lesson.

Case 2 (Mr JB)

The study revealed that Mr JB`s instructional strategies were generally learner centred. This was easily achieved by an educator through pairing learners when giving them a task. He indicated that he wanted them to learn not only from books and the teacher, but from one another hence employing collaborative learning. Moreover, the educator employed classwork as an activity in class. Further to that, the educator employed discussions in class in the form of question and answer method and hence his epistemological perspectives were socially and culturally embedded. The educator employed analogies in class in which he illustrated accurately to the learners through drawings, how the three spheres – the lithosphere, the atmosphere, and the hydrosphere interact with one another and with the biosphere.

Furthermore, the usage of different strategies: the question and answer method, discussion and collaboration method, and demonstration methods assisted in accommodating learning differences.

Case 3 (Mr M)

It was further revealed by the study that Mr M `s approach in class was totally teacher centred as he was the dominant participant of the lesson. This was so since he kept on reading and repeating content from the notes he prepared and hence created rote and disordered learning that promoted memorising of content. This notion was confirmed when he was asked on his choice for this approach, where he indicated his intention for learners to understand the content, even though over repeating the content could go beyond understanding, leading to cramming. Therefore, the educator`s epistemological perspectives were subjective.

Moreover, the methods he employed in his class were alien to science. The educator opted to use lecture and question and answer methods. When asked concerning his choice for such methods, the educator indicated he was giving them knowledge and wanted them to listen. His approach failed to promote active learning as required by the NS CAPS. Despite his indication for his preference for the usage of analogies and illustrations, the educator only employed

examples in his class. Moreover, the methods employed by the educator did not accommodate learning differences since they did not involve inquiry and collaborative learning.

5.2.3 What is the nature of teachers` classroom interactions and discourse in the Planet, Earth and Beyond strand?

Case 1 (Mr P)

The study revealed that the discourse in Mr P`s class is authoritative since the educator was dominant voice in class. He even indicated during post observation interviews that he believes in that approach despite initially indicating he prefers dialogic discourse. Moreover, interactions in his class was minimal as he spent most of the time narrating to the learners, hence his communicative approach was authoritative/non-interactive. It was further revealed that Mr P employed the IRF, open chain and non-triadic patterns in his class.

Case 2 (MR JB)

The study showed the nature of discourses in Mr JB`s class to be dialogic. That was revealed not only through the interviews, where the educator indicated his belief for engagements between him and the learners and amongst learners themselves, but was also evident in his lesson wherein he kept asking and engaging with learners in a way that ignited their cognitive skills. Consequently, the communicative approach in his class was dialogic/interactive.

Further to that, his lesson was characterised by the IRF and non-triadic patterns wherein he probed questions to the learners, with learners responding and him giving feedback to the learners. They were also instances were leaners responding to questions in a chain order, hence yielding non-triadic patterns.

Case 3 (Mr M)

The educator was the dominant voice in his class, despite initially indicating he will involve learners in their learning and therefore his class was authoritative. As he indicated in his post interviews, he wanted the learners to listen to the knowledge he had, consequently minimising their interactions with him. He spent the most dominant part of his lesson reading and repeating notes, and hence the communicative approach in his class was authoritative/non-interactive. Moreover, his lesson followed the IRF patterns wherein he asked a question, learners responded followed by the educator giving the correct feedback to the learners.

Here below I present the answer to the main research question per case.

5.2.4 What are the teaching difficulties of Planet, Earth and beyond strand?

Case 1 (Mr P)

Mr P` s class was highly characterised by content which was insignificant and irrelevant. For instance, the educator was found to be teaching about the emergence of education and the people who founded it – the Greeks. Furthermore, in addition to the misconceptions which were evident in his class, he created misconceptions himself by his articulation of a lot of content which was off from the focus of the topic. Moreover, his content knowledge was disordered as he would move back and forth with no particular order in his articulations. Further to that, the educator focused and emphasised on content with which he failed to achieve meaningful learning. This was so since he was at one particular point teaching about the shape of the earth at which when asked about it, he indicated he wanted learners to understand the meaning of the word sphere which meant 'round' shape. Furthermore, the educator did not revisit the relevant prior knowledge since he focused on the learners` knowledge of all planets of the universe instead of the concentric layers of the earth as was outlined in the CAPS NS document. That was a downside of his teaching since he failed to connect the learners` preceding knowledge with their existent knowledge.

The study also found that Mr P did not create authentic settings for science teaching as he chose to teach the topic in the classroom with only a duster and chalks. He did not use outdoor teaching or even bring relevant teaching aids like stones, rocks, charts and models, despite having initially indicated his will to bring them to class, consequently failing to create legit scenery. Furthermore, the educator was goal astray as he did not only demonstrate a lack of knowledge of the three specific aims for NS during interviews, but failed to achieve them in class. This was so since he did not administer any written work nor engage in practical work.

Mr P`s teaching in class was teacher centred and focused on feeding learners with information, consequently creating passive and shallow thinkers in learners. Moreover, the teaching strategies that were employed being the lecture and question and answer were alien to science and did not advance active and critical learning. In the process the teacher relied on reciting and repeating lesson concepts. He indicated that during his training his was taught that approach and believed in it. This proved clearly the teacher`s poor curriculum saliency. Moreover, his class was anti-constructivist as it did not advance PBL in the form of written work despite initially indicating he would be grouping learners. That as a consequence restricted collaboration between learners and ultimately prevented learning from taking place within the social plane. Furthermore, the educator did not employ a number of strategies that accommodate learning differences, depriving learners a room for diversity as a result.

The educator was the dominant player in class, depriving learners room to fully enjoy their own game. Instead of being the referee to the learners who were the players, he decided not only to be the player and but a dominant player. He was a dictator who wanted learners to follow where he would point them. As such his class was dominantly characterised by an authoritative/non-interactive classroom discourse despite indicating he would employ dialogic discourse. For example, at one instance he asked learners a question on the dominant gas, before learners could respond he quickly gave them the answer. He did not engage with the learners' cognitive thoughts, consequently becoming a barrier to learning himself.

Case 2 (Mr JB)

The study found Mr JB`s content knowledge to be organised as he taught the spheres in an ordered manner, by indicating effectively how the lithosphere, the atmosphere, the hydrosphere interacts with one another and with the biosphere. Moreover, Mr JB indicated sufficient SMK as he taught learners the themes that were relevant and required by the NS CAPS document, despite off ramping in some instances where in he was teaching about the composition of the atmosphere and the dominance of the Nitrogen. That approach of teaching irrelevant content created misconceptions, despite him being certain he did away with some misconception. Moreover, the educator revisited irrelevant prior knowledge, choosing to focus on the gases learned from Grade 8 instead the drawing of earth`s concentric layers they learnt in Grade 7 social sciences as was prescribed by the NS CAPS document.

The educator also had a poor contextual knowledge in terms of a place of teaching and learning. The educator chose to teach the topic in the classroom, disregarding the laboratory and outdoor teaching which could have created realistic settings for learning. Further to that, the educator had a good understanding of the NS three specific aims. Even though he applied two of them in class, leaving out the 'doing science' one and indicating he could not apply it since he failed to do the practical.

The study also indicated the educator`s lesson to be learner centred. That was so since the methods he employed were more collaborative and lead to team learning. The educator indicated that the rationale for teaming up the learners was to allow them to learn from one another. This approach upheld the NS CAPS principles since it promoted active and critical learning. Moreover, collaborative learning has the ability to lift learners` spirits and interests in their learning. Further to that his employment of both collaborative learning and classroom discussions accommodated learners` different learning styles. Furthermore, the educators utilised analogies wherein he drew and illustrated effectively how the spheres of the earth interact with one another.

Mr JB`s class was characterised by the dialogic discourse which he indicated during the interviews and was evident in class wherein he involved learners effectively in their learning. Further to that, the teacher did not just accept responses from learners but allowed to dig deeper into their thinking. For instance, when he asked learners to name different forms of water, one learner mentioned solid where the educator intervened by asking the learner to name the solid water, with the learner indicating it as ice. Therefore, the interactions in Mr JB`s class was not one dimensional and consequently gave rise to the dialogic/interactive communicative approach. Moreover, the study also found his discourse patterns to be both IRF and non-triadic

Case 3 (Mr M)

The study found Mr M to be having insufficient SMK in that he was found to be emphasising to the learners that other planets do not have lithosphere, atmosphere and hydrosphere. That in itself created a lot of misconceptions even though he showed awareness of the misconceptions by dealing with them in class when one learner gave a wrong response which could have sounded correct to many. For instance, one learner though one of the spheres of earth is the hemisphere. Moreover, his content knowledge lacked organisation as he was at one point telling learners that the spheres of earth – the lithosphere, the hydrosphere, and the atmosphere created the biosphere. On the positive, the educator revisited relevant knowledge, that of the layers of the earth, consequently connecting previous knowledge with the incoming one from learners as he alluded during post observation interviews. However more could have been attained if he channelled learners in a way in which they could draw the concentric layers of the earth as recommended by the NS CAPS document. The educator had a poor contextual knowledge with regard to the specific aims and the assessment strategies that pertains to the NS curriculum. This was evident during interviews and in class, and he did not even give written work, despite indicating he relied on verbal assessment in class. Hence Mr M was goal disoriented. Moreover, teaching learners the topic of spheres of earth in class and not in laboratory and/or outdoor deprived learners first hand authentic learning. He indicated though lack of resources and lack of accommodation (laboratory) as reasons for going to class even though the NS CAPS document specifies effectively the need to improvise. Moreover, the language of teaching and learning is English, so mixing it with Sepedi in class could have a downside of his teaching.

The study also revealed the approach followed by Mr M as a teacher centred method which promoted rote and uncritical learning. He did that by not affording learners to be fully involved in their learning, instead he kept on reading and repeating notes over and over again, with an intention to feed learners with information. That approach together with the teaching strategies he employed – the lecture and question and answer method created passive thinking learners

and did not support active learning. Moreover, the said strategies did not accommodate different learning styles due to their inability to create collaborative learning and allowing learners space to move around. Furthermore, the educator did not employ illustrations in class and relied on examples, citing lack of resources for his choice. This approach was a draw back since he could have improvised by drawing on the board the spheres and indicate how they interact. Mr M did not involve learners as he indicated in interviews, instead in some instances he would ask learners a question, and without waiting for their responses give answers himself. His approach was non-directional as he was evidently focused on feeding learners with information failing to elicit learners' deeper thinking and forming connection between ideas. Hence, his discourse was authoritative accompanied by the authoritative/non-interactive communicative approach in class. in addition, the patterns in his class were IRF.

5.3 MAIN CONTRIBUTIONS OF THE STUDY

The CPDF played a crucial role in the study. The idea behind the framework was that the teacher`s Natural Science content knowledge, PCK and contextual knowledge will allow him/her the leverage of choosing instructional strategies that are relevant to the PEB topic in Natural Sciences class. The approach chosen which include traditional/non-traditional methods, epistemological perspectives and explanatory frameworks will give rise to a choice on types of discourses- authoritative and/0r dialogic discourses plus the patterns of discourses. The most interesting part is that if the types of discourses the teacher chose are not effective, the teacher can always go back to the instructional strategies 'bag' to pick another approach which can yield efficient discourses and interactions. In other words, moving between these areas would be involuntary (Mudau 2016). However, the main purpose of this study was to unpack teaching difficulties in NS class for the topic Spheres of Earth, with the main focus on teacher knowledge, instructional strategies, and classroom discourse and interactions. It only utilised the CPDF for the themes mentioned and did not necessarily focus on the sequence of the occurrence of the themes.

Furthermore, a number of studies have been undertaken on classroom discourses and interactions. For example, a study by Julie and Jeff (2013) indicated a direct correlation between the classroom discourse and student`s cognitive level. Another study by Navas (2013) found the student-lecturer interaction to be triggered by the language proficiency even though learners felt that the approach used by lecturers as more important. Even though such study were undertaken, none according to the researcher knowledge looked at the interactions and discourse from the NS PEB strand`s perspective.

Findings from the present study had revealed that NS educators do carry misconceptions to class while some add to those misconceptions by teaching too much content which is irrelevant. That in itself indicates poor SMK the educators possess. Some educators` content was disorganised and lacked direction as they moved back and forth in their articulation. Their contextual knowledge left much to be desired. For instance, the topic such as the spheres of earth, which could have been taught effectively outdoors and/or in the laboratory was taught in the classroom with insufficient teaching aids. Further to that, some educators had little knowledge on specific aims and assessment strategies to be employed in an NS class. Moreover, the study has been able to reveal that apart from one, educators have difficulties in the choosing the relevant approaches, relevant instructional strategies which should have supported active learning and constructivism. Furthermore, educators still see themselves as the authorities in class and hence apply a one-way approach which stands in the way of collaborative learning and engagement.

The study has therefore been able to expose the difficulties that teachers have when teaching the spheres of earth topic of the NS. It has also been able to add to previous knowledge base in that no study of this nature in the context of the spheres of earth topic has been undertaken and as such it leads way for further research and for curriculum planners to plan their curriculum effectively with the difficulties that are discovered in mind.

5.4. IMPLICATIONS FOR FURTHER RESEARCH

- The study has been able to effectively discover the nature of the teacher knowledge, instructional strategies, and classroom discourse and interactions in NS PEB strand class with the topic spheres of earth, but it did not study the sequence at which the above themes occur in class as structured by the CPDF.

- The study successfully discovered the teaching difficulties in topic - spheres of earth. However, it could do the same for the rest of the PEB strand, which further research can achieve.

- Teaching practice is very broad. This study only focused on teacher knowledge, instructional strategies, and classroom discourse and interactions. Further research should diagnose the teaching from other perspectives.

- The study was also confined to the Sekgosese East circuit, and it could not be undertaken for the rest of the district of Mopani or even Limpopo Province, something which is open for further research.

- Most educators did not agree to participate, depriving the researcher to discover the difficulties from gender`s perspective.

- The study could also assist curriculum planners, educators and all stakeholders if it could be extended to other subjects like Mathematics, Life Sciences, Geography, and Technology.

5.5. SHORTCOMINGS OF THE STUDY

- The study was only limited to the schools and NS educators in the Sekgosese East circuit and therefore cannot be generalised to the whole population as representing the Mopani district, the Limpopo province or the national population in general.

- The classroom observations were done in class where learners were also part of, but only information from teaching practice was noted, which could have been interesting if difficulties were also discovered from learners. However, the scope of the current study restricted the researcher to educators` occurrences.

- Moreover, this study being a case study meant lack of generalisation, however, it was chosen due its ability to allow the researcher to get to the gist of the “case in depth”, and its spontaneous environments, with focus on its “complexity and context” (Punch & Oancea 2014: 148), consequently explaining “what it is like” to teach Natural sciences in the context of Spheres of Earth (Bertram & Christiansen 2014: 42). Moreover, the educator was guided by the sampling strategies as it is reported in the methodology chapter.

5.6. RECOMMENDATIONS

The study recommends the following:

- Educators should be trained on how to implement active and critical learning in order to do away with rote learning.

- Educators should be empowered with knowledge on NS specific aims and assessment strategies.
- Departmental heads, SMT, subject advisor should engage in regular class visits in NS educators` classes, reviewing the lesson plans that educators should have prepared.

- Schools should provide educators with CAPS relevant documents.

- The DoE should provide more education to educators on the importance of following the curriculum as prescribed in the CAPS document.

- The department should provide educators with relevant teaching aids and practical apparatus and in the absence advice educators on how to improvise. That in itself will help in keeping science as the doing subject.

- The subject advisors should assist educators in identifying misconceptions.

5.7. CONCLUSION

This chapter presented the summary of findings. Further, research questions were answered, followed by the presentation of the contributions and shortcomings of the study. The study finally recommended further research and directives to the Department of Education.

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APPENDICES
APPENDIX A: OBSERVATION PROTOCOL

Research topic: Teaching difficulties in Natural Sciences in Sekgosese East Circuit in the Limpopo province.

Grade 9 Natural Science **Pseudonym: …….**
Name of observer: Nkanyani T.E **Duration: 60 min**

Teaching difficulties have proven to be a problematic issue faced by educators. Furthermore, research has shown that most educator show a poor content knowledge in maths and science. It was for that reason that this study was undertaken to uncover difficulties teachers face when facilitating learning in Natural Sciences, by focusing on teacher knowledge, instructional strategies, and classroom interactions and discourses as they are indicated in the CPDF.

Date/Time Area Observed	Descriptive Field of observed activities	Reflective notes
1. Constructivism		
a. Social interactions	How learning occurred from the social context	
b. Active learning perspective	How did teaching address the individual learning‘s perspective.	
c. Prior knowledge	Did the educator(s) give room for learners` prior knowledge	
2. Teacher Knowledge		
a. Subject Matter Knowledge (SMK)	Knowledge on the nature of science (NOS), specific aims, and how misconceptions are addressed	
b. Pedagogical Content Knowledge (PCK)	How teaching takes place, through the use of analogies, examples, and illustrations; ability to observe if learning has been achieved; which language is dominant	
c. Contextual Knowledge	Knowledge about where science learning should occur	
3. Instructional Strategies		
a. Teaching Route	Whether active or rote learning was used	

b. Epistemological beliefs/perspective	A believe about how knowledge should be attained	
c. Explanatory Frameworks	Analogies, metaphors, examples, axioms, and concepts when teaching the PEB strand	
d. Active learning teaching strategies ❖ Scientific inquiry	Which active learning strategies where employed (Problem based learning- PBL, research projects etc) Whether scientific inquiry occurred in class	
e. Differentiation of Strategies that addresses learning differences	Learners learn differently and hence requires a teacher to apply a variety of strategies	
4. Classroom Discourse and Interactions		
a. Types of classroom discourse	Dialogic/authoritative discourse	
b. Authoritative discourse	Was the teacher the only authority in the direction of the class	
c. Dialogic discourse	Was there an exchange of language between the teacher and the learners and between the learners themselves	
d. Interanimation of ideas		
I. Low level interanimation II. High level interanimation	Different ideas were made on the social plane, for example teacher listing student ideas Different ideas were explored and by comparing, contrasting, developing	
e. Sequences of discourses	Monologic, co-constructive, dialogic, or/and scaffolding	
f. Communicative approach	How the teachers communicated with learners: Dialogic-	

	Authoritative/interactive-noninteractive	
g. Patterns of discourse	IRF/IRE	
I. Chain patterns	Open/closed chain patterns – I-R-P-R-P-R/I-R-P-R-P-R-E	
II. Non-triadic patterns	I-Rs1-Rs2-Rs3-Rs4-Rsn, with Rsn representing a specific learner	

APPENDIX B
INTERVIEW PROTOCOL

A. EDUCATIONAL BACKGROUND

1. Please tells me about your teaching career, where you were trained and for how many years?
2. Up to which level did you receive training? Diploma, degree, honours, masters etc
3. How many years have you been teaching, and out of those how many have you been teaching Natural Sciences?
4. Please outline your involvement in science projects, be it science expos or any other science related projects or competitions?

B. TEACHING DIFFICULTIES

TEACHER KNOWLEDGE

5. How is active learning and social interactions occurring in your class? **[constructivism]**
6. What challenges do you face when teaching the topic to the learners? **[teaching difficulties]**
7. How do you address learning differences in class? **[differential learning]**
8. Explain to us the Planet, Earth and Beyond strand in the Natural Sciences? **[SMK]**
9. Please outline the specific aims of Natural Sciences and the different assessment strategies, and the ones you would employ when teaching the topic: Spheres of Earth? **[SMK]**
10. What misconceptions do you know of that is associated with the topic: Spheres of Earth? **[SMK; PCK]**
11. Please tell us how would you teach the Grade 9 learners the topic – Spheres of Earth? **[PCK]**
12. What analogies, examples, and illustrations would you employ in teaching the topic? **[PCK] [EXPLANATORY FRAMEWORKS]**
13. How do you therefore know when learners have understood the content you are teaching? **[PCK]**
14. Where would teaching of the topic take place? In the classroom, library, laboratory, outdoor or any other area? **[CONTEXTUAL KNOWLEDGE]**
15. Which language is dominant in your class? **[PCK]**

INSTRUCTIONAL STRATEGIES

16. Please make mention of the teaching strategies that you know of? **[INSTRUCTIONAL STRATEGIES]**
17. Which strategy would you use to teach the topic: Spheres of Earth? **[INSTRUCTION STRATEGIES]**
18. According to you, in what way should knowledge be attained. **[EPISTOMOLOGICAL BELIEFS]**

CLASSROOM DISCOURSE AND INTERACTIONS

19. Please mention and describe the type of discourses that you know of? **[TEACHER QUESTIONING]**
20. Which of the discourses is dominant in your class? **[CLASSROOM DISCOURSE]**
21. What difficulty of questions do you normally use in your classroom? Easy, moderate or difficult questions? **[TEACHER QUESTIONING]**
22. How are leaners ideas attended to in your class? By writing them on the board or by reflecting on them while comparing? **[interanimation of ideas]**
23. **What is the sequence of discourses that take place in your class? [DIALOGIC, MONOLOGIC, CO-CONSTRUCTIVE SEQUENCES, SCAFFOLDING]**
24. **Briefly explain the communication that take place in your class? [communicative approach]**
25. **Please explain the sequence at which you introduce the lesson, how your learner reacts and finally how you conclude the theme you would be explaining? [PATTERNS OF DISCOURSE]**

C. LESSON REFLECTION

26. What do you perceive as good elements from your lesson?
27. What from your lesson did you find difficult to achieve?
28. How do u think the lesson could be improved if there is any room for that?

APPENDIX C

LETTERS REQUESTING PERMISSION TO CODUCT RESEARCH

Request for permission to conduct research at three Secondary School in the Sekgosese East Circuits.

The Head of Department
Limpopo Department of Education
Private Bag X9489
POLOKWANE
0700

Title: Teaching difficulties of Natural Sciences educators in the Planet, Earth and Beyond strand in the Sekgosese East circuit of Limpopo

Dear Sir/Madam

I, Tebogo Edwin Nkanyani, am doing research with Prof AV Mudau, a senior lecturer in the Department of science and technology education towards an M Ed degree at the University of South Africa. We are inviting three of your secondary schools in the above-mentioned circuit, to participate in a study entitled: Teaching difficulties of Natural Sciences educators in the Planet, Earth and Beyond strand in the Sekgosese East circuit of Limpopo Province, South Africa.

The aim of the study is to unpack teaching difficulties in the Natural Sciences classroom when teaching the topic of planet, Earth and Beyond.
The schools have been chosen because of their closer proximity and accessibility to the researcher. The study will entail interviewing the Natural Sciences teachers of the three schools, prior and after teaching, and also in observations of their teaching.
In line with upholding research ethics, the confidentiality and anonymity of participants will be considered. It should also be indicated that participation is voluntary – meaning that the participant can agree or disagree to participate and if they agree they have a right to withdraw whenever the feel like doing so.
The benefits of this study are helping Natural sciences teachers together with the policy makers in identifying difficulties in teaching. Moreover, the feedback procedure will entail giving you both the hard and soft copy of the final report.

Yours sincerely

…….
TE Nkanyani

LETTERS REQUESTING PERMISSION TO CODUCT RESEARCH

Request for permission to conduct research at Mahudu Secondary School

The Principal
Mahudu Secondary School
P.O Box 91
Soetfontein
0913

Title: Teaching difficulties of Natural Sciences educators in the Planet, Earth and Beyond strand in the Sekgosese East circuit of Limpopo

Dear Sir/Madam
I, Tebogo Edwin Nkanyani, am doing research with Prof AV Mudau, a senior lecturer in the Department of science and technology education towards an M Ed degree at the University of South Africa. We are inviting your school through its Natural Sciences teacher to participate in a study entitled: Teaching difficulties of Natural Sciences educators in the Planet, Earth and Beyond strand in the Sekgosese East circuit of Limpopo .

The aim of the study is to unpack teaching difficulties in the Natural Sciences classroom when teaching the topic of planet, Earth and Beyond.
Your school has been chosen because of its closer proximity and accessibility to the researcher. The study will entail interviewing your Natural Sciences teacher prior and after teaching, and also observations of his/her teaching.
The benefits of this study are helping your teacher, together with other Natural sciences teachers in identifying difficulties in teaching and to education principals who are responsible for policy and programs.
Feedback procedure will entail giving you both the hard and soft copy of the final report.

Yours sincerely
…….
TE Nkanyani
CS1 Educator

APPENDIX D

PARTICIPANT INFORMATION SHEET

21 January 2017

Title: **Teaching Difficulties of Natural Sciences educators in the Planet, Earth and Beyond strand in the Sekgosese East circuit of Limpopo**.

Dear Prospective Participant

My name is Edwin Tebogo Nkanyani and I am doing research with Awelani Victor Mudau, a senior lecturer in the Department of science and technology education towards an M Ed degree at the University of South Africa. We are inviting you to participate in a study entitled: Teaching Difficulties of Natural Sciences educators in the Planet, Earth and Beyond strand in the Sekgosese East circuit of Limpopo. I am conducting this research to find out and unpack teaching difficulties in the topic of the Planet, Earth and Beyond strand of Natural science.

I received your contacts from the natural sciences workshop attendees' records and you were chosen based on your teaching experience and your availability and accessibility in terms of the distance between my location and your place of work. Moreover, apart from you are other two participants from other school who will be participating individual and separate from your participation.

The study involves *interviews which will audiotaped and observation which will be recorded on field notes and a video camera.* Interview questions will be based on your experience in teaching the subject, how you teach the Planet, Earth and Beyond topic, the instructional strategies you would employ, and the type of discourses present in your class. The interviews will take 2 hours while observation will take the whole class period.

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

Your participation in the study will benefit you personally and the whole education fraternity in getting to the gist of teaching difficulties and assist in equipping teachers with effective directives through recommendations.

Moreover, you have the right to insist that your name should not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research OR your name will not be recorded anywhere and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

Only me and my supervisor will have access to data and no one else. Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet of my office for future research or academic purposes; electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. After the period the hard copies will be shredded whereas soft data will be permanently deleted.

This study has received written approval from the Research Ethics Review Committee of the *CEDU REC,* Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

If you would like to be informed of the final research findings, please contact Tebogo Edwin Nkanyani on 0764013824 or email on tebzana7@gmail.com. Should you require any further information or want to contact the researcher about any aspect of this study, please contact 0764013824, tebzana7@gmail.com.

Should you have concerns about the way in which the research has been conducted, you may contact Prof AV Mudau on mudauav@unisa.ac.za.

Alternatively, contact the research ethics chairperson of the CEDU REC, Dr Madaleen Claasen on mcdtc@natactive.co.za.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.

…….

Nkanyani T.E

……

CONSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the interview and video recording of the observations.

I have received a signed copy of the informed consent agreement.

……. ……..……

Participant Name & Surname (Please print) **Signature & Date**

…… ……

Researcher's Name & Surname (Please print) **Signature & Date**

APPENDIX E
CASE 1 INTERVIEW TRANSCRIPTS

PRE-OBSERVATION INTERVIEWS

RESEACHER:

Thank you very much Mr P--- for availing yourself, for this….. interview. As I have indicated to you er… as it is outlined in the letter what it is all about. Now we are going straight to the first question. Can you please tell me about your teaching career, the way you received training…and up to which level did you receive that training?

PARTICIPANT (P):

My qualifications are as follows: i…studied for teaching…..during the former…..Lebowa government…er… at this institution, Sekgosese college of education. I furthered my studies doing ACE with University of Limpopo. I did… Postgraduate Diploma…with Regenesis…I am now busy with… University of Pretoria doing B.Ed honours.

R:

Ok. Thank you. Err. How many years have you been teaching and out of those years, how many have you been teaching Natural Sciences? How many have you been teaching in totality? And out of those how many have been teaching Natural sciences?

P:

Err.. the past 24 years… I taught..Natural Science…for more than..yah…6 years. I don't know because more than 6 years.

R:

Ok. Allright. Then are you including also General Science.

P:

Natural Science only. With regard to General Science it means.. lets just say yah 10 years. Yah. During that time I was teaching only Physical Science.

R:

OK. Uhmm. Can you please outline to us….. your involvement in science projects? Be it the science expos or any other related errr projects or competitions that are science related. How were you involved?

P:

Ehhh, …… because I was involved 10 years back. Because from 2007 up to now I have never been involved in this. But before 2007, we were always…. Umm….entering competitions. The so called science fairs. People inventing their own things..yah…

R:

Alright. Now can you please explain to us, what do you understand about active learning and social interactions. And how does active learning and social interactions take place in your Natural Sciences class when you teach the topic Spheres of Earth?

P:

Maybe… I can tell that with active learning… maybe learners at that the time they are too much involved. It's.. learner centred. Ehh with this social maybe… even if they are active…they are involved..maybe there is some debate with social…according to my understanding… uhmm

R:

So..ok then.. how do they engage with each other in class..

P:
Eh ….sometimes I group them.. and tell them that after they must give me a feedback. How they….Maybe they were doing the research…maybe amongs the groups…each group must…..maybe select one.. to represent… them.
R:
OK. What challenges do you face when you teach Natural Science? Ehh. During this topic of spheres of earth. What challenges do you normally face.
P:
Eh nowadays the problem is one.. you find that learners are no longer researching…they rely too much on googling. And then…If you tell them to read. They will tell you maybe…I am wasting their time. That`s why even when questions come…they get a prob..maybe they find a problem to answer them.
R:
But in class which problems do you face?
P:
Face!? …… you find that…. learners are coming from secondary..that is a problem because…. people are afraid to name it. You find that… in a classroom…instead of being two way interaction. You find that is a one way. You are the only one giving them information.
R:
OK sir. Uhmmmm…. How do you address learning differences.. in class? in that learners would learners would learn differently.
P:
Ehhhh… because I was taught… during that time… long time. The… I was taught about this principles… eh we have got a principle of individualisation. Ehh. Totalisation and differentiation. Therefore I..i must be able to differentiate learners who are able and those who are not able so that I can attend them individually.
R:
Explain to us. Ehh. What the Planet, Earth and Beyond strand is all about in the Natural Sciences?
P:
That's the…because… eh..if you are human being.. you must be conversant with what is happening around you. We are in the planet earth..what ever happens on this earth…we must know. We must be able to know. So that we can predict…lets say for instance, what ever happens today, you must be able to predict for tomorrow.
R:
Eh. What misconceptions do you know of that are ascociated with this topic: spheres of earth. The misconceptions ?like the wrong beliefs…the…ehhh the untruths…
P:
Ehhh. Misconceptions…myself I do understand because even I was like them before. Neh! That the planet is always on the.. the move. Neh!. But we are always on the earth we don't see it moving. But… The science say the earth is always what…. on the move…its rotating. That was my misconception.

R:
Then what misconceptions do learners have.. do you sometimes meet in you class?
P:
Uhmmm. sometimes when i..when you tell them neh…because i..i was once..told that.. the earth is so fast… even now if I tell learners that, when maybe you can take the fastest car on this earth and when you compare this car with the earth.. the earth is faster than that car. Neh! Learners don't believe.. yah.
R:
Uhmmm. Can please tell us…. how you teach….. the Grade 9 learners the topic Spheres of Earth? How would you teach them if you had teach them now? Where would you start?
P:
Uhmmm. What im going to start… lets say for instance..the first.. im going to ask this question. How many planets are in this?..how many planets are found in the universe? Be in the universe.. amongst those planets, which planet.. is eh what… maybe which planet is there…maybe there is life on them. Lets say for instance…like mercury is there any life on the mercury whatever? They must tell us. From there I will go on.
R:
So what examples, analogies, or illustrations would you use when you teach this topic?
P:
When teaching this to- ….-pic. I compare it with….maybe when doing chemistry. In chemistry we have got the so called the atoms, uhmmm, you basic unit of matter. That… when you study this planet earth, you must compare it with what? The earth because atoms consist of all electrons and electrons are found around the what? ….atoms. and around the nucleus. And are always in what? In motion. Even the planet is like what? The…the electrons, is always what? On the move around the..the sun.
R:
Then how do you therefore know when learners have understood that content that you have been teaching. What is it that you…
P:
To see wether they have understood. I will maybe some will ask questions. Once learners ask questions, it means.. they are in the what? In the row to understanding. Or maybe when I ask them questions, when they answer me… I will see that they….they do understand.
R:
Uhmmm, where would teaching of this topic take place. Would it be in classroom? would it be in the library? The laboratory? Outdoors or any other area? Where will it be?-
P:
I can tell you its everywhere, because… it's a natural thing. In the classroom, there are some things that you can take and show them
R:
Uhmmm, which language is dominant in your class?
P:

You know the medium of instruction is English. But Sepedi… they are used to it.

R:

But which one dominates….. amongst those languages? Which one is used more frequently/

P:

Ahhh they are used to Sepedi.

R:

Please indicate ehhh,…the teaching strategies that you know of…and the ones that you will use to teach….. the topic spheres of earth?

P:

Ehhh…during our time because edu-education keeps on changing. During our time we used…now you say strategies. During our time we taught with… methods of teaching. Neh!! Now you come up with strategies. During our time… we have got the telling method, question and answer method, nowadays we use, I will just mix them.

R:

So which strategies will you use when you teach spheres of Earth?

P:

Eh,, as I indicate there are many strategies. Question and answer, telling method, and then…. I forgot. But the situation will control me what to use.

R:

Uhmmm, according to you in what way should knowledge be attained? How knowledge should be achieved?

P:

Ehhhh…..knowledge! the more you interact with people, the more you read books, is then that you-you are going to.. to gain knowledge or achieve what you want.

R:

Please mention and describe the types of discourses that you know of?

P:

Discourse in the classroom? One of it is got maybe….you find that… you teach learners of different ages…and maybe the one that is older! Sometimes won`t feel safe in front of young learners. If he is asked questions he/she is asked a question… maybe he is unable to…to answer. Maybe he thinks maybe learners will laugh at… maybe at that particular person.

R:

So which-which of those discourses will…is dominant in you class. which one do you..eh…do you frequently use in your class.

P:

Eish…children of nowadays…their problem is one. Ehh..if maybe teacher answers eh…maybe…ask a question. Maybe one learner…makes a mistake in answering that question. Instead of helping them, those who know, they will laugh. That is the problem… of nowadays. They don't help each other.

R:

Ok, so when we talk about discourses we will talking about…authoritative, or dialogic? Authoritative is that is based on you, dialogic is your engagement with the learners. So I want to know which

one is dominant in your class? between authoritative and..and dialogic? Between the two which one is more dominant.

P:

Too much I use dialogic,.that is why I want someone.. that maybe the period ends,…… someone-everyone must feel free

R:

Ehhhh, what difficulty of questions do you normally use in your class? do you use easy questioning, moderate or difficult ones?

P:

I prefer the…the difficult ones so that when they are unable to answer,. Once I tell them answers…… they will be able to, maybe to-to go on researching.

R:

How are learner ideas attended in class? do you attend to them by writing them on the board,or by reflecting on them while you are comparing them? How do reflect on those learners` ideas……. when you are teaching?

P:

Sometimes I write them on the board,…….but too much talking.

R:

What is the sequence of discourse that takes place in your class, is it dialogic, monologic, co-constructive sequence or scaffolding. Which sequence, which one start and is followed by which one.

P:

Eh from monologic, to dialogic.

R:

Can you please explain the communication,….that takes place in your class? how your learners communicate with each other and how they communicate with you?

P:

Maybe, lets say for instance, everyone is given a permission to.. talk, once he/she is raising to show me that he wants to…..talk.

R:

Can you please explain the sequence at which…… you introduce the lesson, how your learners react and finally how you conclude….. the topic that you will be explaining.

P:

First I go to the them by asking questions,to..to see their understanding of what im going to..to teach, once…they show that they don't understand or do understand..maybe I will go to..the main topic…explaining. At the end I will ask question wether they..to see wether they understood or not.

R:

Eh Mr P thanks very much for..availing yourself for…eh, eh…this pre-observation interviews. We are now going to class for observations, then when we are coming back from class, that is when we will do the..post-observation interviews. Thanks very much.

POST-OBSERVATION INTERVIEWS

R:

Thanks very much Mr P for a wonderful.. lesson. We are now going to look at the lesson reflection. The first question on the post-observation

249	interview is: what do you perceive as good elements from your lesson?
250	What do you see as good elements from your lesson?
251	**P:**
252	The good element.. is that.. when busy teaching, if you don't see your
253	learners responding is not good, but if you see one-maybe learners
254	responding what you are doing is a good thing.
255	RESEARCHER: So in other words, you-you think you have achieved
256	that-
257	**P:**
258	Yah! Sometimes you teach until the end of the… lesson without any
259	learner asking questions.
260	**R:**
261	Ok, what from your lesson did you find difficult to-to achive?
262	**P:**
263	I don't see any. I think I achieved what I was doing.
264	**R:**
265	How do you think the lesson could be improved, if there is any room for
266	that?
267	**Mr P:** eh! The lesson can be improved,…by giving..learners works or
268	maybe class activity… to see….wether what was done,… was done in a
269	proper way or not.
	R:
	Thanks very much, that brings us to the end of the interviews. I really appreciate it. Thanks very much.

APPENDIX F
CASE 2 INTERVIEWS TRANSCRIPT

PRE-OBSERVATION INTERVIEWS

RESEARCHER (R)
Mr JB, thank you… for availing yourself for the study.
PARTICIPANT/RESPONDENT (P)
Ok, You are welcome.
R
Yah as you can see we are going to start with interviews. This is the pre-observation interviews, then after observing you teaching I`m going to come back with post-observation interviews.
P
Ok
R
Thank you very much. The first question eh..can you please tell us about your teaching career, where you were trained and for how many years and up to which level were you trained?-
P
Ohkay!!! Eh….i was trained as a teacher from Hillside teachers` college, in Zimbabwe. So…after that I taught for almost..eh 5 years and I went back to University. I obtained my Bachelor of Education there, that was in Zimbabwe. Then I left Zimbabwe I came to South Africa in 2008. Since then I have been grade 8, grade 9, grade 10, grade 11, grade 12 sciences. So I can say I have experience of teaching for about 22 years.
R:
Okay, so in other words which le-..up to which level have you…have you received training?
P:
Training is up to-up to Bachelor of Education. first degree.
R:
Oh so it`s only Bachelor of Education? no honours? ..you don't have honours, master?
P:
Honours, masters is in a different field.
R:
Okay, okay. So up to Bachelor`s degree?
P:
Yes
R:
Okay
P:
Then, you also indicated the number of years in totality, how many years have been teaching,? and the how many have you been teaching Natural Sciences?
R:
Eh, I`ve been teaching for 22 years. Then in Natural Science,….if I say Natural Science, I see it as Physics, chemistry, and Biology. And I can say i`ve been teaching for 22 years. It`s only the naming of saying

Natural Sciences. In Zimbabwe we don't call it Natural Sciences, we just call it science. It's the same concepts

P:

Eh! can you please outline your…. involvement in science projects, be it your science expos or any other science related projects.

P:

Yes. Before I came to South Africa I was involved in what we call,. Collaborative projects in science. Where we used internet to go over.. to discussion forums with other countries, using learners-learners would interact with other learners from other countries like Nigeria, eh Mexico, USA, France I remember when we were involved in such programmes. Then when I came here to South Africa I also got involved in the Eskom…. Projects.

R:

Eskom Science Expos?

P:

Yes. Science Expos. Yes- where participating with certain group of learners. Last year they went up to is it district level only. And this year I hope they will get beyond that.

R:

Oh-kay. The next question… how is active learning and social interactions occurring in your class?

P:

Active learning?! Normally my teaching is child centred. I do most of the teaching via learner interaction. Learner-to-learner, learner-to-teacher, leaner-to-environment.

R:

Okay!

P:

Yes. That`s…the interaction.

The social part?! Normally I try to take teaching into the society. We maybe in class but will be talking what is happening outside in the society. So that`s how I take it as what? The society or social interactions. I make the learner interact with the day-to-day living…. Life.

R:

So but then how do learners interact among themselves?

P:

Learners…! Will be working in groups. I normally give them work in groups in the form of questions. They may ask each other. They may ask the book. As a class, we discuss the work together as class discussion. To find out if there are other learners who are left behind, or other learners who have missed the point.

R:

What challenges do you normally face when you teach the topic to the learners, Spheres of earth?

P:

Spheres of Earth? Yah learners lack imagination, because that one is an abstract concept. You will have to imagine things which you are not seeing. Are they really there? Do I have a picture in the mind of what they are saying? Of course I may get it from the book. But myself do I

imagine…those things being there? So lack of imagination among learners is…something which is lacking and to assist that area normally I use a lot of pictures, I use lot of videos, and sometimes I use lot of eh what I can say work from the internets, the websites.

R:

Okay. How do you address learning differences in class?

P:

Yes! There are fast learners, they are people who are average, and those whom we can say they are slow in learning. So normally I pace… my lesson… in such a way that the fast learners will end up assisting the slow learners.

R:

Can you explain to us what the Planet, Earth and Beyond is all about?

P:

That one is about systems. You know systems eh eh a whole which is made of parts. The parts interact together to form on thing. So when we say the earth, we are not talking of the soil. We are not talking of……the trees. We are not talking of.. the nor the water. But we are talking of different things which are working together to bring one thing we refer to as earth. So in short I can say earth is made up of systems which are the pot of water, air, the soil. These things work together to support each other to sustain life.

R:

Okay.

R:

Uhmmm, can you please outline the specific aims of Natural Sciences and the different assessment strategies and the ones that you will employ when you teach the topic Spheres of Earth?

P:

Yah in Science you know. The learner must be able to perform scientific I can say eh eh..experiments in short. A learner must develop the skill, we call them scientific skills, be able to carry out the research, trying to solve the social problem, through carrying out experiments. Another one is a learner must be able to understand the environment in which he is leaving. And that`s more of understanding and knowledge. Then a learner must be able also to apply… the knowledge… to the day to day living. I can say those are the three areas where we talk of the skills of doing science, the skills of understanding what really is happening in science or in life. Then after getting knowledge, are you able to apply it to day to day living.

R:

Okay thanks for that. Uhmmm, what misconceptions do you know of that is associated with the topic spheres of earth?

P:

Yah some learners you know they take earth as one thing this one and it's a misconception. Some will also think the earth is like… a disc. It's a (inaudible). Yet the earth is round spherical. And in trying to remove that misconception, i.. try.. to bring even a ball when I am introducing the topic of… universe-remember the universe, that`s when we talk of planets and all those things, before we come to the earth. Normally

some would think air is..is not part of the earth. Some would think water is not part of the earth. Because there is that misconception to say this is the earth the soil. Yet the earth is.. a complex of things. (there is laughter in the room)

R:

Can you please tells us how you would teach the Grade 9 learners the topic Spheres of Earth, putting into consideration, the analogies, the examples and illustrations that you would employ?

P:

Yes, my approach normally is through question and answer. I would present learners with eh what I call.. lesson activities. They are going to work on those activities using textbook because nowadays our teaching is more of textbook based. Is no longer that OBE. So I would give them a set of questions..and they would go a the textbook, try to link the question to the textbook. As they are going over the textbook there will be learning so many things, but myself I would direct them to what I want via the questions, then after that, the questions would involve even drawings. So during drawing you know they will try to get that skill of knowing what really is happening. How are these things going to interact? Why are they interacting this way? After that, we now discuss as a class, to find out really, did they get what I want them to get?

R:

How do you therefore know when the learners have understood the contents of what you were teaching?

P:

Ys that`s the most important part. After that, I have to give them what I call eh..diagnostic test. Normally I give it after the lesson-sometimes after later not immediately after. I give them time to forget (laughs).

R:

Okay. Okay. (laughs)

P:

Then I can give them sort of a test to find out really did they understand and this test may have simple questions and applications.

R:

Allright, where would the teaching of this topic take place? Would it be in the classroom? or the library,laboratory, outdoor-

P:

It`s in the classroom.

R:

It will be in the classroom? Okay thanks for that.

R:

Which language is normally dominant in your class?

P:

English

R:

English? Okay.

R:

Please make mention of the teaching strategies that you know of? And the ones that you would employ when the topic Spheres of Earth?

P:

Yah there`s demonstration teaching, there`s experiment, then there`s discussion. So in Spheres of Earth I cannot I will carry out an experiment, I cannot I will demonstrate but we will be discussing what really is an Earth?, What do we now about earth? What are we going to learn about earth? How…are we going to learn about it?

R:

Okay.

R:

According to you in what way should Knowledge be attained?

P:

Knowledge should be attained through collaboration. A person should interact either with another person, and in that way we say we are not..collecting knowledge but we are building knowledge we should build knowledge through collaboration-we collaborate with the environment. What really is happening, why is it happening like this, you ask you friend..how do you see it?

R:

Okay, thanks for that.

R:

Uhmmm. Can you please make mention and describe the discourses that you know of-classroom discourses?

P:

Classroom discourses? The…

R:

Yah the discourses. You have your dialogic, or authoritative discourses-and which ones do you use? The one that is dominant in class.

P:

Normally I prefer the one where we….have a dialogue, I don't prefer where we…..just…. learners receiving, receiving. I must also learn from learners. Because when i`m teaching normally im carrying a research (He laughs)

R:

Okay (laughs)

What difficulty of questioning do you normally use in your class? do use moderate, or difficult or easy-

P:

Most of it is moderate.

R:

Okay!

P:

Easy to cater for those ones who are weak. Then moderate…the weaker ones will also face challenges then those who are fast, I give them the difficult ones. Just the few, majority of the questions will just be moderate.

R:

How are learners` ideas attended to in class? do you attend to them by writing them on the board? Or do you reflect on them while you are comparing ideas?

P:

Eh!..in most cases,….. I… reflect or talk through the ideas. But as a summary, I have to put them on the board, so that others may also see and some may copy and keep them as a record.

R:

Okay

P:

Eh! but in most cases as we are discussing a new idea may come up. I do illustrate on the board, yes as we are discussing, but I have to put them as a summary at the end.

R:

What is the sequences of discourses that takes place in your class? you will have monologic, dialogic, then you have co-constructive then scaffolding. Whch sequence do you normally use?

P:

Yah! I mean when I introduce the class topic I mean some will say mono, but in most cases I want it to be a dialogue type. So I can just say it's a mono, dialogue. It will be just interchanging. But majority of it is dialogue.

R:

Okay.

Can you please briefly explain the communication that takes place in your class?

P:

Communications? Yes. Those….eh! how can I put them? We you know can see that a learner…eh…is not paying attention. To me is communication. And I have to make that learner pay attention, through talking. (laughs). So there are those facial expression, there are those you know eh, remind us, (laughing) probing, even picking a learner who is not paying attention and say hey! Can you say something about this and this. We want to bring them into interactions in class.

R:

Can you please explain the sequence at which you teach the lesson, the way the learners react and finally how you conclude the what you want them to understand.

P:

Yes. When I introduce my lesson, normally I enjoy…. posing questions to learners. Why do they want to create a problem to the learners? So that during the lesson you will be trying to solve the problem created. So my introduction normally is about questions I may-I say topics but I start with questions. Questions may be written, questions may be by word of mouth, so normally will learners will now work on questions as we go. How do the learn?.. how do the work with the questions? They will be using their textbooks. So its question, textbook, question, textbook and they do it normally in pairs, or in threes. That`s peer-to-peer. They will be sharing ideas. After that, I have to…. group the whole class now as one thing. It now goes step by step, question by question. How did you see this one? How did you answer it? Can you come and draw the diagram if it was a diagram? Just trying to check really if they were working. Some of them you know, they are just passengers (laughs). To avoid that we want to see everyone doing something.

R:

Okay. No thanks very much eh.. for your time. We will now go to the class where classroom observation will take place, then we will have to come back for the post observation interviews.

P:

Thank you very much!

R:

Thank you very much.

POST-OBSERVATION INTERVIEW

R:

Thank you very much sir for availing yourself for…. This post-observation interviews, that are emanating from the class that you taught on the topic spheres of earth. The first question is you decided to teach the topic in class and not in the laboratory or even outdoors. What was the reason behind that approach?

P:

Doing it in class you know there's this chalkboard I wanted to illustrate using diagram, in a lab (laboratory) we don't have eh..chalkboard, outside I don't have that platform where I can illustrate using the chalkboard. That was the main reason of using the classroom.

R:

Okay, oh thank you. Then you started the lesson with a task. What was the purpose of that task? What did you want to achieve?

P:

With the task I wanted to..to find out the prior knowledge. You know when you are teaching learners sometimes they got their own knowledge. So you should first of all identify what do they have about this area. And from there you develop new knowledge linked to prior knowledge. So the task was to find out the prior knowledge so that I can find out how I can link the new knowledge to the old knowledge.

R:

Okay!! Then what prior knowledge did you revisit?

P:

Yah prior the knowledge which I wanted to find out is that do they know what earth is like. Do they know the shape of the earth? Do they know the relationship of the earth and the sun? Do they know the relationship of the earth and the other spheres? So I wanted to find out where are they exactly so that when I tell them about the other spheres then it becomes very smooth.

R:

Okay! Then in your pre-observation interviews you mentioned all the three specific aims. Did you address all of them, and how did you address them?

P:

The…I cannot say all of them but the two eh….eh the last two or first two. Because I did not do the one for skills and I did it partially, theoretically but partially. The others is about the knowledge, knowing how, what the spheres are like, how are they linked and how can we apply them you know in life? I did address those ones, so I can say in short I addressed mainly two, knowledge and application. That one of skills we did not carry out practical experiments.

R:
Okay! So how did you apply them in real life? The second one you are referring to- applying them in real life.
P:
To apply in real life is like learners now know what an earth is like, then the spheres they now know that they live inside the spheres eh I was trying to link it to what they do everyday life.
R:
Okay thank you sir. And then when you where teaching them you grouped them in pairs, when you give them a task, why! What was the purpose of that approach?
P:
Yah sometimes you don't learn from the book or the teacher. You also learn from your friends. Other friends you know they are learning faster, so as they are learning they also teach others, so its more of peer teaching. Yah developing kno…knowledge from your friends. Knowledge doesn't just come from the book or from the teacher but is even from your friends you learn new things.
R:
So you wanted them to learn from one another, so in other words that was cooperative learning.
P:
Yes, that was cooperative learning.
R:
Okay. Then how did you deal with the misconceptions if ever there were there that you came across in class or if didn't deal with them how will you deal with them in future?
P:
Yah the misconceptions were on the relationship of earth and sun. So… to move or reduce misconceptions asked them to draw diagrams which will show how they are thinking. And when I say how they are thinking I can correct you with its wrong. So more is more of developing what we call the pictorial diagram or mind eh! With the picture in mind so that they know exactly what they want to see? Is it the real thing that they are seeing? What they hope to see is it the real thing they are seeing? From the diagram I think we can tell that.
R:
Okay. Okay. So your class was dominated by discussions. What was the significance of that approach?
P:
Yah cooperation normally there's what we call collaborative learning. Yah when you are learning you are building knowledge. And you can build it through discussions. Yes not just by reading. Cause when you read sometimes you will have a certain perception of things which may be wrong. But if you are talking to a friend then a friend can give you the other side , then you know you build knowledge from those discussions.
R:

396	Then what-when you were busy discussing with them, where did you
397	find learners finding it difficult for them to discuss and how did you
398	intervene?
399	**P:**
400	Yah especially when there is new knowledge which is coming which is
401	not part of their everyday life, sometimes you have to explain using the
402	examples, uhmmm like the earth, eh is roundish but sometimes they
403	don't think is roundish because they see it as a flat layer. Eh that is.. to
404	them is new knowledge. So you have to tell them no is like this and this
405	because of this. So through discussions, you will end up understanding
406	it and through diagrams, through illustrations, and through
407	collaboration with friends the end up with certain knowledge of the
408	spheres of the earth.

APPENDIX G
CASE 3 INTERVIEW TRANSCRIPT

Interview transcripts case2

Pre-observation interviews

Researcher:

Mr…thanks very much for availing yourself for this.. eh!Interview. Can you please tell us about your teaching career, where you received training, and for how many years?

Participant:

Eh! I! received my training at Sekgosese secondary school, for SPTD. Eh majored in Mathe..matics, Biology, Physical Sciences and English.

Researcher: okay

Participant:

And I started to study this in 1993.

Researcher:

so it was Sekgosese secondary or Sekgosese college -

Participant:

No it was Sekgosese college of education

Researcher:

Then up to which level. Did you do diploma, degree, honours… which level did you reach?

Participant:

After I obtained my…. My diploma. Then I went on and studied with University of South Africa. And I specialised in Natural sciences, Advanced Certificate in Education.

Researcher:

Okay! Thanks

And then how many years have you been teaching, then out of those years how many have you been teaching Natural Sciences?

Participant:

Now it is…….six years and some months. But what I know I got six years teaching the subject

Researcher:

Then in general, teaching, generally how many years-

Participant:

Yes, i.,I started to teach in 2003. But before 2003 I volunteered as an educator at some secondary school, in 1999

Researcher:

Okay. Thank you very much .

Can you please outline your involvement in science projects, be it the science expos or any other science related projects and competitions.

Participant:

Yah I immediately when I was employed at…. Secondary school. I am the one who was leading this eh..projects.

This one of science expo and many others. And most of the learners whom I tried to guide them in this kind of projects eh managed to participate at circuit level, district level, provincial level as well as national. And I have got one of my learner who is conducting,

eh who is leading this kind of projects nationwide and is one of my products. Even now here where I'm working I'm helping learners to come up with their projects.

Researcher:

Thanks very much. This is interesting, it's very interesting.

How do you manage active learning and social interactions in your class, when you teach Natural Sciences?

Participant:

Yah in most cases, let me say because the nature of our school at which I am now, I used to go to other schools. For example where there are some topics that need apparatus, teaching aids such as apparatus, chemicals and so on. So I go there eh and ask for them so that when I go to class they must help me in teaching the learning area. So and learners are very much interested, especially when you go to class, having some teaching aids.

Researcher:

Okay!

Participant:

Yah!

Researcher:

And then what challenges do you face when you teach Natural Sciences, especially the topic spheres of earth?

Participant:

Yah…the problem with the spheres of the earth, the challenge that I usually have here at school, is eh the problem is teaching aids, for example charts and so on. So sometimes I used to improvise by making some brochure and so on so that when I go class, then that learners must…be able to understand me very well because I got those teaching aids and paste them on the board . Challenges that I'm facing is that one of teaching aids. Because our school is not well resourced.

Researcher:

So how do you then address the learning differences in class? You see we have leaners who are slow, some are fast, some are moderate. How do you the address those differences.

Participant:

Actually, these kind of learners are there but when I come across that kind of problem where maybe some are slow learners, and so on, then I used to give myself time with them, so that I can teach them , so that they can understand this very well, so that they can be at the same level with other learners who are well gifted.

Researcher:

Okay. Can you explain to us what you understand about Planet, Earth and Beyond strand?

Participant:

Yah. When we talk of Planet, Earth and Beyond strand, here we are going to talk about, the earth in detail. We know that earth is one….earth is one of the planets, so …there are four….the planet earth consist of four spheres. Yes. The first one we have got the atmosphere, which consists of different gases such as carbon dioxide,

oxygen and many other gases. And again we have got the lithosphere, so the lithosphere, this is the solid part of the earth. Referring to the rocks, soil and other types of rocks. Again we have got eh, the hydrosphere. When we talk of the hydrosphere, we are talking about the..the…the water part of the earth, especially oceans, and know that water exists in different forms, in gaseous form, solid form, as well as eh..eh….eh…luquid form. And again we have got the….we have got the…the…the bisosphere. The biosphere that is … where different living organisms live together, …. Depending on other…eh….spheres of the earth such as water, lithosphere as well as hydrosphere, as you know that animals for them to live, they have to respire and for them to respire, they must, they must undergo the gaseous exchange which is known as respiration. Receives oxygen from the air, and they release carbon dioxide and other gases into the air which is known as the atmosphere. And this little organisms we know of plants and animals, eh animals depend on lithosphere for….for theirhabitat. And plants and living organisms they grow on soil and get water from…the soil so that life can go on.

R:

Okay thank you very much.

So having said that, we are talking about Natural Sciences, and Natural Sciences has got its own specific aims, and also assessment strategies. Can you please tell us the specific aims of Natural Sciences and the ones that you would, I mean assessment strategies that you would employ in the topic, spheres of earth?

P:

Yah the assessment strategies that sometimes I'm used to employ, eh can be any question and answer method, telling method, and sometimes I'm used to apply the….the…the…the practicals where I am going to pose questions to learners so that they can give us…they can come up with some solutions regarding the…the..the spheres of…of the earth.

R:

Okay. Then what about the specific aims?

P:

Eh specific aims sometimes when we teach learners, we….want them to…to.. to know something for example, if you want them to know more about the..the importance of…of the…of the hydrosphere, how they must gentle the sources of water. So that is one of the aims that I used to tell learners when I'm in class.

R:

Okay. What misconceptions do you know of that is associated with the topic Spheres of Earth? The misconceptions.

P:

Sometimes, learners they do not understand the difference between the atmosphere and the lithosphere. Sometimes when you ask them questions based on the lithosphere, they will give you answers which are from the…the…the hydrosphere. So they don't know the difference between these sphere of earth.

R:

Please tell us how you would teach the grade 9 learners spheres of earth. How would start teaching them.

P:

Yah actually when I teach them, we know that….this…planet, Earth and Beyond stretch from primary level, I mean for example in grade 7, sometimes when I go to grade 9 I ask them questions about the…the…the parts of the earth. Parts of the earth, I know that sometimes they can tell me about which we know as the lithosphere, they can tell us about the mars parts which is known as the hydrosphere. As well as the ….the….the air which is known as the..the atmosphere. And from there I'm going to ask them to give layers of the earth. What I know sometimes they can tell me of the crust. They can tell me of the core as well as the mantle. So that is where I am going to lay some basics to check as to whether they know something about this.

R:

Okay! So, what examples, analogies or illustrations that you would employ in teaching the topic? What analogies or example or eh illustrations would you employ when you will be teaching this topic?

P

Sometimes, the illustrations that I use when I am in the class, is to draw some pictures on the board. To show them the…how the…the…the spheres of the earth are.

R

Okay. Then how would you therefore know when learners have understood the topic that you are teaching?

P

Sometimes I with ask them where there is a problem. If they indicate then, that's where I am going to pose questions to them. And when they answer them correctly, that is where it will give me an indication that I was in the right track.

R

Okay. Then where would…where would you teach this topic? It might be the classroom, the library, the laboratory, outdoor or any other area.

P

Yah. Because of a large number of learners that we are having, i..i prefer to use the classroom which is the only thing that I can use because we don't have resources up to so far. Accommodation is not there.

R

Okay. Then which language is dominant in your class?

P

Yah most of them, their mother tongue that I used to this learning area in English where in there is a need for me to explain in their mother tongue, then I use the language.

R

Can you please make mention of the teaching strategies that you know of, and the ones that you would use to teach the topic Spheres of Earth?

P

Sometimes I use the question and answer method, eh narrative method, eh this are the..the..the strategies that I can use because up to so far as I have indicated earlier, because of running short of eh resources such as eh apparatus, then that is where I use this kind of…

R

Okay. Okay. Then according to you, in what way should knowledge be attained? How do you believe eh… learners should know or gain knowledge? In what way?

P

Yah sometimes when I go to class, for them to gain knowledge, eh I let them to listen attentively. So where they don't understand, then I give them a chance to…to indicate section where they did not understand that very well.

R

Okay. Uhmmm… can you please mention the types of discourse that is dominant in your class. Eh discourse we are talking about authoritative, and also dialogic discourse. I..i think you understand the two.

P

The…the discourse sometimes the disturbances or---

R

No discourse as in when you are teaching, sometimes authoritative is when you are the only who is talking in class-

P

No I used to…I involve them

R

You involve them..

P

Yes

R

So that is dialogic. You involve the learners

P

Yes I give them a chance to..to say what ever they know

R

Okay,

P

So that they can help me to explain some of the concepts when we are in the class so that this learners can understand very well.

R

Okay

P

Sometimes learners understand very well when they…when their peers explain something. Rather than when I explain it in the class.

R

Okay. Thank you.

R

Then what difficulty of questions do you normally use in your class? Do you use easy, moderate or difficult questions.

P

Yah. I use moderate, so that they can … they can cover all...all kinds of learners. We know that we have got slow learners, moderate and the less gifted one. So the questions must cover them all. But sometimes I used questions of high level, so that they must sharpen their minds.

R

And then uhmmm. How are the learners idea attended to in your class? Do you attend to them by writing them on the board?, or do you just discuss them amongst yourself and your learners when you compare those ideas.

P

Sometimes I write them on the board and give them a chance to… say something.

R

Okay. And then what is the sequence of the discourse that takes place in your class? We have dialogic, we have got monologic, we have co-constructive. Do you start with dialogic and then you go to monologic or do you start with monologic and then you go to dialogic?

P

I start with monologic I sometimes give questions to them, so that they can answer. And there after, then I proceed monologic, and from there then I come to dialogic.

R

Okay-okay.

Can you…please tell us about the communications that takes place in your class, uhmmm how do you communicate with the learners?

P

Actually when I'm in the class, i…I …I make sure that I am friendly, so that they can be free, for…for learning. So that they mustn't feel threatened when im in the class.

R

Please explain the sequence at which you introduce the lessons, and how your learners react and finally how you conclude the theme that you are teaching?

P

Yah actually, when I introduce my lesson, as I have indicated, im going to ask them questions based on what they have already learned. Thereafter, then im going to help them, If they don't give positive answers, then from there im going to get into the matter. Explain and after that, pose questions to them, thereafter they answer if they don't answer I help them so that they can come in their right direction.

R

No sir, thanks very much. This brings us to the end of the first part of the interviews which is pre-observation. Now we are going to class we are going see you teach and then after observing you teaching we are going to come back with the last part of lesson reflection we reflect on the lesson.

Thank you very much

POST OBSERVATION INTERVIEW

R

Thank you very much sir for a wonderful lesson, now we are going to conclude our interviews with the post-observation interviews. There are just a few questions that I just want to ask you. What do you perceive as good elements from your lesson? What do you see as good elements from your lesson like the positives from your lesson.

P

Yah what I observed while teaching is that learners were very much positive, the…the…the..they managed to..to reveal what they have learnt in some previous days, as they were participating , listening and they were able to answer questions positively even though their voice was not strong. But I managed to see that they are able to..to..to respond to questions, that's an indication that they were listening to me and I presented the lesson very well.

R:

Okay. You decided to tea..teach the topic eh in the class and not in the laboratory or not even outdoors. What was the reason behind that?

P:

Yah one of the reason for going to class is because we…I don't have eh we don't have eh what we call the laboratory. And eh the surroundings around here is not safe for..for one to go outside with the learners to go and teach. That is why I decided to go to class. That is where I have realised that when I am in the class then we are going to talk together, so that we can understand what we are learning about.

R:

What misconceptions did you come across in your class and how did you address them?

P:

So I have realised that eh.. learners did not differentiate between eh the…layers of the earth and the layers of the..atmosphere. I mean the layers of the..the..they did not understand, in other words I can say they..they they did not differentiate between layers of the… earth., as well as different layers of…of the of the what we call…of the atmosphere and less of the earth's crust. So they were just mixing them. So , that is why I have indicated that we have got four layers of the earth or spheres. When we talk of the layers here im talking about the spheres as well as the layers of the atmosphere..of the..of the earth. For example where we talk of the earth's crust, eh talk of the mantle, the inner core, and the..the outer core, such things, so learners came into realisation that we have got four layers ..of four spheres of the atmosphere as well as different layers of the..of the earth. So that is why I talked about spheres of the atmosphere which are the lithosphere, hydrosphere, eh the biosphere as well as the …the atmosphere.

R:

Okay. And then you said the lithosphere is the solid part of the earth, what were you implying?

P:

So when we talk of the solid part of the earth here, we are talking about…we are talking about the..the..the soil, talking about the rocks, and other layers of the earth which are in the form of the solid.

R:
Okay. And then when you were referring to the solid part you were reffering only to the lithosphere, the rocks and the soil-
P:
The rocks, the soil…those are the parts because this other..for example this other living organisms even though they are solid, but they are found on the ..the…the depend on the lithosphere for…for growing such as plants, they grow..they grow on lithosphere.
R:
Okay thank you. Then what prior knowledge did you revisit and what was the reason for your choice?
P:
Yes, the prior knowledge that I have revisited is that one of eh asking learners to give layers of the earth as well as the spheres of the earth. The reason for that I just wanted to check as to whether, they still remember what they taught in the previous grades so that I can link that with the..the the interaction of these four spheres of the earth, so that they know that these spheres of the earth, they are eh..eh they act together so that they can form a system wherein we have got the living organisms and many other things where in this different spheres of the earth we know that we have got eh what we call we have got this eh, the output, the input as well as the..the process.
R:
Okay. Now what was the most difficult thing to achieve when you were teaching?
P:
Yah the difficult thing to achieve during my teaching as I have indicated earlier, is that one where we find that these learners….they did not know that if one of the spheres is..is..is interupted, the other spheres are also going to be affected. So I just wanted them to know that all these spheres of the earth, they interact together so that the..the system can..can take place.
R:
Okay. Uhmm Natural Sciences has got three specific aims, that is doing science, knowing science and applying science. Which ones did you attend to in your class and how did you attend to them?
P:
Yah because I was teaching in the class, in other words as we just talking, is that one of knowing science how it works. So that is why I decided to go to class so that I can achieve that aim of knowing that eh Natural Sciences is one of the science subjects and most of the things that are happening on earth applies to…apply to science.
R:
Okay. So you only attended to the skill of knowing science?
P:
Yes knowing science, eh and how to..to relate things. The relationship between different eh factors that are found on the earth.
R:
Okay like when you are talking about the biosphere and the-
P:

The lithosphere, and all those things . You know that as long as they will be able to know the..the relationship between the biotic factors as well as non biotic factors.

R:

Okay. Uhmmmm you did not assess the learners during the lesson. What was the reason behind that?

P:

Yah I..i have assessed them but assessment was verbal. It was verbal because I was asking questions. Even though I did not give them the formal …writing assessment in the class but I have assessed them by verbal questioning eh so..so that I can check as to whether they understand what I was ..i was teaching about.

R:

Okay. You spent most of the time in the class talking whiles learners were listening. Why..why was that?

P:

Yah I have realised that these learners as I have asked some questions before. I have realised that they know some of the aspects. Some of the aspects for example that one of layers of the earth as well as the spheres so as an educator as I was having the knowledge, that is why I was trying to give them the knowledge of how these spheres of the earth are related. Because they..they they knew only the layers of the atmosphere as well as the..i mean the layers of the earth as well as..other factors that as I was talking I wanted them to listen and know how they are related.

R:

Okay. That is why you were repeating the content-

P:

That is why I was repeating the content, I wanted them to understand….understand that content.

R:

Okay. So in the pre-observation interviews before we went for the observations, you said you are going to use illustrations in class but you did not use illustrations you used examples. What was the reason for that change of approach?

P:

Yah I have realised that I don't have some…some resources such as eh teaching aids or learning aids, that is why I decided to give examples because the..the..the they are very much acquainted to some of the examples that…I used to..to give to them.

R:

Okay. Thank you very much that brings to the end of this post-observation interviews. We appreciate it.

P:

Okay.

R

Okay thank you

Then from your lesson what did you find difficult to achieve?

P

Yah what I have realised is that, most of them, they don't….they don't , actually they do not eh eh find the difference between the lithosphere and other layers and they do not know the layer in which , which is known as the layer of life, where living organisms are interacting together. So that is what i…I have learnt

R

So how are you going to help them to…to get past that difficulty?

P

For them to know that sections very well, I'm going to give them a lot of work and after I have given them a lot of work then I'm going to mark them together with the learners. We are going to give answers together. In other words, we are going to give memorandum being together. So that they see where they went wrong.

R

Okay thank you.

Then okay yah that was my last question. How do you think lesson could be improved if there is any room for that?

P

Yah. For me, to improve the lesson, so it I must, even myself I have to get most times, do preparations and try to accommodate learners of different IQs so that the might be accommodated.

R

Fair enough. Eh sir thank you very much for your time, I really appreciate it.

P

Okay thanks very much.

APPENDIX H
OBSERVATION PROTOCOL CASE1

(0-5 min)

The class was well organised with desks well packed. It was also clean and not over crowded. The teacher started by asking the learners to name the planets they know. The learners raised the hands high with the teacher pointing them to respond. The learners started mentioning the planets with the teacher writing them on the board. The learners mentioned Neptune, Mercury, Earth, Jupiter, Venus, Mars, Uranus, Surtum in that order. The teacher indicated to the learners that "amongst these, in some life exists, while in some life doesn't exist". He therefore asked them where they think life existed amongst those planets. The learners responded by picking earth. The teacher asked them if its only earth where there is life. Some learners said yes while some were not responding. The teacher said "its okay, it's the way you were taught". Another learner then raised a hand and picked planet mars. The teacher asked the learner if he believed or heard or knew about his answer. The learner indicated that he heard. The teacher then asked the learners to tell him anything about earth. One learner raised his hand and said earth is a planet which has only one move. The teacher concurred with the learner. The teacher then wrote on the board the question on how is the earth. He sustained his question by asking from the shape, how is the earth? One learner raised their hand and said it is round. The teacher emphasised and said the earth is round in shape with most learners joining him in agreement and reciting that statement. The teacher then reminded the learners about what he taught them with the emergence of education. He asked them where did education start. Learners did not respond. He then indicated that education was started by the first civilised people, the Greeks. He also indicated that in science, Greek words are used. Something that is round shaped is called a sphere and because our earth is round shaped is a sphere (again reciting the answer with the learners). He said all planets which are spherical are round in shape. He continued by saying in some planets there is no life but because in planet earth there is life then it called a biosphere.

(6-10 min)

He said the earth has got features. He emphasised to them while writing on the board that earth has features. He asked a question as an example that if he wants of a person what can the learners tell him? Learners did not respond. He responded and said one of the features of a person is horns. He then said the features of a person is when you have two legs, two hands. He came back to the question on the features of the earth and learners started responding. One learner raised her hand and said water. The teacher wrote the answer on the board. The next learner listed air with the teacher again writing the answer on the board. The third learner indicated soil. The teacher corrected her while writing on the board and said that she should say land which include soil and rocks. He then said in the water, in the air, in the land life is there then that I why they are collectively called biosphere because the biosphere consist of water, air and land. He

then asked the learners where they are found. He quickly said to the learners that they are found inside the water. Learners agreed. He again made them to self - correct their statement by indicating they are found on land. He then asked them what they call the biosphere inside water. One learner raised her hand and said hydrosphere. The teacher agreed and emphasised on the answer by reciting with the learners while writing on the board. He then asked the learners and what about this (referring to air). One learner raised her hand and said atmosphere. He wrote the answer on the board while reciting with the learners. He then said what about this one, the last one (referring to the land). One last learner responded and said lithosphere. Again the educator wrote the answer on the board while reciting with learners. He now indicated to the learners that the lithosphere work as a system. He asked the learners what can tell about the word "system". He asked the learners if it is the first time they come across the word. One learner raised his hand and he said system is two or more parts working together. The teacher agreed on the answer by repeating the answer in a recital manner with the learners. He gave an example of South African government as a system, because there are many departments which work as a system. He reemphasised his statement by giving examples from the Department of education, and other departments work as systems. He continued by saying even the hydrosphere, the atmosphere, and the lithosphere work as systems, they work together to sustain life.

(11-15 min)

He asked learners to define the word sustain. No learner responded. He continued by giving examples like we eat to sustain life, we work together sustain life, South African government is doing everything, everyday to sustain life, to keep things alive. He therefore defined the word sustain and said it`s about keeping the organisms alive. He therefore asked the learners to define for him the atmosphere. One learner said it's the thin layer that covers the air. The educator agreed and reemphasised by repeating the learner's definition and added it is the layer of air of air that covers the earth. He went back to issue of the spheres working as a system. He gave his own example with water and said water is everywhere. He continued and said on land (pointing to the board and reciting with learners). He again said water evaporates and goes to air (pointing to the board and reciting with learners). He said condensation takes place up there (pointing above) and that when precipitation takes place, the water comes down again, and that is a cycle. He told the learners that the water which was used by Biblical Moses and Jesus is the same water that is used today. He emphasised the statement and indicated that that is the water cycle. He then explained the different stages of the water cycle starting with evaporation going up (pointing up) , condensation, and then precipitation coming down (pointing down), It's a cycle. He then said the hydrosphere, atmosphere, and lithosphere work as a system. He therefore pointed at the air(atmosphere) written on the board and said the air comes to animals and plants. He continued by saying the air comes from atmosphere to the animals and plants and the animals

takes the air to the atmosphere. The teacher paused his lesson and asked for questions from learners. Learners never got a chance to ask since the teacher quickly went back to his lesson pointing straight on the atmosphere from the board. He said there is a certain gas on the atmosphere which cost too more percentage than any other gas. He asked the learners what that gas is. Learners did not respond (they were not given a chance) since the teacher quickly asked them what air is. No learner responded.

(16-22 min)

He then said I am telling you for the last time. He then wrote on the board and said in a recital manner that air is a mixture of gases. He repeated reciting the statement with the learners. He started asking them about the names of gases. He pointed one student who said carbon dioxide. He pointed the next one who said Nitrogen. Another one said oxygen. The last one said Argon much to the teacher's surprise who repeated the name with a question and exclamation tone. The teacher then mentioned his own example of methane. He then asked the learners which amongst those gases is having more percentage than other gases? He asked them to raise their hands and say it. Within 3 seconds when no learner responded, he was quickly back to teaching and wrote on the board at the same time reciting that Nitrogen is having 78 % while other gases share only 22 %. He went back to Nitrogen's 78 % and said it is an approximate value and that it can be 77 % or 79 % and that 22 % is shared by other gases. He then asked if learners have questions. One learner raised his hand and questioned about Argon that the teacher dismissed as a gas. The teacher then confirmed that Argon is a gas since it belongs to a group of noble gases and that the learner who previously named it as a gas was correct. One learner asked in Sepedi about where Nitrogen is coming from. The teacher responded while writing on the board that this one (pointing to Nitrogen) is found in the atmosphere. He further said for it to move from the atmosphere to reach human beings is a long process. And continued by saying Oxygen and carbon dioxide are always with us (referring to him and learners) and that animals exchange these gases with plants and Nitrogen is not exchanged. He continued by saying Nitrogen is found in the atmosphere and in order to get three processes must be followed. He continued by saying he wishes the can be thunderstorm every day and repeat that notion in Sepedi and said when there is lightning, nitrogen is received from the atmosphere. He mentioned the next method called the Haber process which he said was too expensive and the learners will learn more about it in Grade 12. He mentioned the third method that Nitrogen will be found from some plant' s roots after getting from the atmosphere. He asked for questions from learners and the was no question. He thanked every learner and concluded his lesson.

APPENDIX I
OBSERVATION PROTOCOL CASE 2

(0-5 min)

The class was organised with desks in order. The class also had a black board, chalks and dusters. The educator indicated to the learners that they must be sited in pairs. Learners moved and rearranged themselves to sit in pairs. The educator started issuing learners in their pairs copies from a text book. The copies were carrying theory of the topic spheres of earth. The educator then issued the pairs of learners with empty papers to write on. Then he wrote on the board questions he wanted his learners to respond to. The questions asked were: 1. Name the parts of earth interacting with each? 2. Give the name of four spheres interacting on earth? 3. Draw the diagram showing the spheres of the earth interacting? 4. Describe interactions between – lithosphere and hydrosphere, atmosphere and hydrosphere, and atmosphere and lithosphere? He then asked them to write in their pairs and finish within 10 minutes.

(6-10 min)

Mr JB started checking learners` work as they were writing and discussing in their pairs. He told them to rely on their friends if they get confused by the questions and should not keep quiet as if they are writing a test. He also told them not to copy the questions from the board as they appear on the pamphlet he has given them. He continued to move around checking learner pairs working. The educator wrote on the board: The earth. The educator told them they can answer the questions up to number 3 and should not worry about the fourth question. He continued to move around the class and indicated that he notices that some learner pairs are already on question no 3. He moved around and re-emphasised his earlier utterances that learners should talk to each other and not behave like they are in an exam room. Learners now started to come out of their shells and started talking to one another. The teacher meanwhile was busy assisting another pair in interpreting the questions. And then as he was busy moving around, he realised that one learner was still on question number 1. He mentioned it to the whole class that someone is still on question number one while another learner is on question number 4.

(11-15)

The learners continued with the task meanwhile the educator was moving around, checking. The educator then asked them to finish up their work. After some time, he indicated to them that their time was up. The educator then asked the learners to discuss the work with him. He reminded them that the discussion for the day is going to be based on the earth. He asked the learners what an earth is. One learner raised a hand and said it is a planet where people live. The educator concurred with the learner by repeating the learner`s response. He went back to the questions on the board and asked learners to respond to the first question which required them to name the parts of earth interacting with one another. One learner raised her hand and said spheres. The teacher accepted and repeated the

response the learner gave. He went to the board and wrote the answer while reciting. He came back to the learners and told them the earth is a planet and the planet is having spheres which interacting. The educator then told the learners it is time to know about the aforementioned spheres which are interacting. Learners rose their hands in numbers to give the responses. The first learner was pointed and mentioned atmosphere. The educator wrote the answer on the board while repeating the response in recital manner. The second learner was pointed and said biosphere. The teacher wrote the answer on the board. The third learner pointed mentioned the hydrosphere which the educator confirmed and wrote on the board. The educator then indicated the similarity in the answers given that they all end with the suffix -sphere. The fourth learner then responded by mentioning the lithosphere which the educator affirmed to and wrote on the board while reciting the word lithosphere. He again indicated the suffix sphere and indicated all responses that were just written on the board are parts of the earth which are interacting, meaning they share something with each other.

(16-20 min)

Mr JB then moved to the third question. He asked for anyone from the learners who can come and draw a diagram which will show the interactions. He sustained his question by asking about how the spheres share, how they interact. He took the instruction further by indicating the learners must respond in the form of the diagram by using the remaining space on the board. Majority of the learners showed more eagerness to come to the front of the class and draw as they raised their hands in large numbers. One learner who the educator chose came to the front and draw three circles which intersected at one point. He labelled the first circle as the atmosphere, the second circle as the lithosphere, the third circle as the hydrosphere and where the atmosphere intersected with the lithosphere as the biosphere. The educator then intervened. He asked the learners about what is drawn on the board and that according to the diagram, the biosphere is between the atmosphere and lithosphere. Some learners started to raise their hands in order to correct. The educator then recognised one learner whose hand was up and asked him to come to forth. The learner drew the three circle same as the latter colleague of his, labelled the three spheres the same way the first learner did except that the biosphere was now allocated to circle which formed an intersection of the three spheres. The educator then went to the board and started comparing the two diagrams. He indicated that the first diagram has the first circle as the atmosphere which was the case with the second diagram. The first and second diagrams having the second and third circles allocated the lithosphere and hydrosphere respectively. He then indicated that in the first diagram the biosphere forms the intersection between the atmosphere and lithosphere leaving a gap in an intersection circle of the three spheres whereas in the second diagram the opposite is true. The educator then indicated that the

second diagram implies that in atmosphere there is biosphere, in lithosphere there is biosphere and same applies to the hydrosphere which has the biosphere.

(21-25 min)

The educator then indicated through the intersection spaces available that they imply that there is an interaction between atmosphere and lithosphere, between lithosphere and hydrosphere, and between atmosphere and hydrosphere. He said those spaces are called interactions. He then indicated to the learners that it is time to go to the last part which asks learners to explain the interactions of the spheres. One learner was pointed and responded by indicating that the lithosphere and hydrosphere interact when water is absorbed by the soil and takes it to sea. The educator repeated the word lithosphere, hydrosphere. Then educator then said before getting to the details of interactions, he wants to know something from them. He asked them about the composition of the atmosphere. One learner responded by saying a layer of gases around earth. The educator asked the learner to repeat his response which he did. The educator then wrote the response on the board. He eventually asked the learners to indicate the type of gases they have learned from grade 8. One learner raised a hand and mentioned oxygen. Another learner said sodium which the teacher quickly dismissed. Another learner raised a hand and said carbon dioxide which the teacher agreed to. He therefore them on the board. He then said there is another one which is in larger quantity at about 78 %. He indicated oxygen is 21 % while carbon dioxide is 0.03 %. One learner said photosynthesis which the educator quickly dismissed and indicated photosynthesis is a process and not a gas. He then told the learners the gas he was asking them about is nitrogen, while writing on the board. He then asked the learners about the contents of the biosphere. One learner raised his hand and said all animals and plants. The educator amplified the response by writing on the board that it carries living things. He turned to the learners and said living things are animals and plants.

The educator then asked his learners to tell him about what is found in the hydrosphere. Learners raised their hands and one learner who was pointed by the teacher said water in all forms. The educator wrote the response on the board and said it is water in all forms. The teacher therefore asked learners to give him the forms of water. One learner raised her hand and said air which the educator dismissed. He then gave his own example and wrote liquid, indicating that that is the form that learners and everyone is using every day. He asked them to give their own examples which one learner responded by saying solid. The educator therefore asked for name given to solid water which one learner responded by saying ice. The educator then wrote the response on the board. Mr JB asked for another form of water from the learners of which one learner mentioned gas. He then asked the learners to name the water which is found in the form of a gas. One learner responded by saying water vapour which the teacher wrote on the board.

(26-30 min)

Mr JB the indicated that what is given there are the forms of water. He said liquid is found in dams, seas and rivers. He also talked about ice but did not go further with his discussion. He then said the last one is lithosphere. He asked learners to indicate to him the composition of the lithosphere which one learner said soil and rocks. The educator agreed, wrote the response on the board and said that is where they are standing. The educator moved back to the issue of interaction and intended to explain the interaction between the lithosphere and hydrosphere. He asked the learner who initially gave the response about the said interaction and the learner responded by saying the lithosphere interacts with hydrosphere when water is pushing the soil. Mr JB concurred with the learner and said the water after raining will flow on top of the soil and push the soil to another area. The educator then moved to the interaction between the atmosphere and hydrosphere. One learner raised a hand and said the hydrosphere and interact with the atmosphere when water evaporates and forms the water vapour. The teacher then explained that the in the atmosphere (pointing on the board) there are gases and in hydrosphere (pointing to the board) there are many forms of water and one of them is water vapour which is a gas. He continued his explanation saying water from the river from the liquid to the gas and during the change it will move from the ground to the atmosphere. Then the educator then moved to the interaction between the atmosphere and lithosphere. One learner raised a hand and said the atmosphere interacts with the lithosphere when the gases erupts. The educator tried the learner`s explanation and gave an example of volcanic eruptions. That in the ground there is molten rocks, the rocks move from the ground and shoots straight into the atmosphere. And in that way the lithosphere interacts with the atmosphere.

(31-35 min)

Mr JB indicated that he is moving to the summary of what he has been teaching. The educator then erased the board and drew a circle while explaining to the learners that the shape of the earth is like a ball (with gestures showing a round object). He then inserted continent Africa in that map and indicated where South Africa would be and said that is where they are. He therefore inserted other remaining continents. He said what he has drawn there is the earth and all the remaining spaces between the continents is occupied by water because on either sides of individual continents there is an ocean and that is part of the hydrosphere (pointing on the board where he wrote the hydrosphere). He further said around the earth (making another circle around the initial circle) there is the atmosphere (pointing to the where he wrote atmosphere on the board). He further explained that everyone is on top of the earth but inside the atmosphere. He then said water which is in the north and south pole are in the form of ice while the water which is in the middle is in the form of liquid. He continued explaining that during hot days the water in the middle of the earth will evaporate by becoming the

water vapour and move to the atmosphere and in that way the atmosphere interacts with hydrosphere. The educator then told the learners that when there is rain the water will come from the atmosphere, seep into the ground and flow in the river, the water flowing in the river will be carrying soil particles from one place to another and in that way the hydrosphere will be interacting with the lithosphere. The educator then moved to the biosphere. He told the learners that they are the people, they are the living things, they live on plants, the animals and plants. He therefore asked the learners how animals and plants interact. He then said when it is hot and learners go and bath, they interact with the hydrosphere.

(36-39 min)

He told them that the earth is made of three basic spheres. He further indicated that they (him and learners) are inside the air and breath it. And that fish lives in water. He then again did a summary and indicated that when the liquid change to gas it will go into the atmosphere (pointing on the board) and when the water in the atmosphere changes to rain it will go into the hydrosphere (pointing on the board). He explained more and said the biosphere get water from the hydrosphere, get oxygen from the atmosphere and plough on the land (pointing on the lithosphere from the board). The educator then told the learners that earth is not the soil but it is everything in it and around it. He reemphasised the statement and further said around it implies the air. He therefore asked for questions from learners and before they could ask he started talking about people who go to the moon and asked the learners if those people are inside or outside. The learners collectively shouted the word ‘outside’. He therefore asked the learners how those people (who go to the moon) survive. One learner said the wear something (making gestures about something which is worn or carried) while another learner was said the wear something that carries gas. The educator concurred with them and said they carry the atmosphere (pointing to the board where he wrote atmosphere and laughing). The teacher then thanked the learners and told them to ask any question while at the same promising to give them homework. He told them to go and write activity two from the pamphlets he has given them. He said he is giving them the task in order to check their understanding and later on he will give them a test. He thanked them once more.

APPENDIX J:
OBSERVATION PROTOCOL CASE 3

(0-5 MIN)

The classroom (mobile classroom) was untidy, having no door, very small. The learners were sited on their desks in an unordered manner. There were also a lot of noise coming from the nearby class. The educator greeted the learners and reminded them that he is their teacher. The educator then told the learners that the last section of the year is the planet, Earth and Beyond and reminded them that the topic is not new since the learnt about from grades 6, 7 and 8. He then took the learners back to what was learned in grade 7 about the earth being a coordinate of the earth. He therefore asked the learners to mention the layers of the earth that they are in the know of. One learner raised her hand and mentioned crust which the educator agreed with. The next learner who was recognised mentioned the inner core with the educator agreeing to the response. Another learner mentioned the outer core while the last learner indicated the mantle. The educator then told the learners that there are four spheres of earth which he asked them to mention. One learner rose and mentioned hemisphere. The educator then asked other learners if the response correct. Most learners said yes which the educator dismissed. One learner recognised rose and mentioned the atmosphere which the educator agreed to. The educator then asked the learners to explain what an atmosphere is. Before waiting for the response, he quickly switched to explaining to the learners what an atmosphere is. He told them it is an envelope that covers the surface of the earth. He continued explaining saying it is a space where there are different gases, mentioning carbon dioxide as his example. He asked learners if they are still with him. He then asked them to mention other gases. One learner recognised mentioned the hydrosphere which the educator concurred to. He asked learners what they knew about the hydrosphere. He hinted the word hydro- to the learners while at the same time writing it on the board. He then asked the learners what hydro- stands for. One learner responded by saying water which the educator concurred with and repeated the word in a recital manner. He then told the learners that when talking about the hydrosphere they are simply referring to water mass on earth. He therefore asked learners to mention other spheres. Another mentioned the biosphere which the educator agreed with. The educator then a asked the learners what a biosphere is. He asked the learners to raise their voices when they respond. A learner responded but was inaudible. The educator then indicated that a biosphere is where living organisms live together and interact with one another on their habitat. He asked learners to mention another sphere. One learner raised her hand and mentioned the lithosphere with the educator concurring with.

(6-10 min)

The educator then indicated to the learners that the lithosphere is the solid part of the earth, referring to the earth-est ground and rocks

that are found there. He reminded his learners that what he just taught in lower grades. The educator then introduced the lesson and indicated to the learners that the topic is the earth spheres work as a system while writing on the board. The educator told the learners that a system is when different parts of the earth are interacting with one another so that they can sustain life. He gave an example by referring to previous lessons where he taught them about the system of the body. He continued by reminding the learners about the skeletal system, digestive system, and reproductive system. He reiterated that the systems he mentioned work together so that bodies can live or reproduce themselves. He then checked with learners if they are still with him. The educator then went back to his topic indicating that when the systems he is referring to the lithosphere, hydrosphere, atmosphere as well as the biosphere and that all those spheres work together so that they can be known as a system. He reemphasised that the working together of the four spheres is known as the system. The educator then read his notes to the learners and said a system is a set of interconnected parts. He then went back to spheres of earth and said for all those spheres to make a system they must work together meaning if one system does work properly that will make other systems also not to work properly and be affected. He checked with learners if they understood and they said yes. The educator continued and indicated that the systems must have input, process, as well as output, while writing the statement on the board.

(11-15 min)

He gave the sun as an example of the input and energy as an output, and said plants need energy from the sun to survive and also water from the hydrosphere. The educator further indicated that the hydrosphere is most important. He continued and said the energy from the sun is called radiant energy and is also known as the output. The educator then told the learners that for biosphere to exist, plants must get energy from the sun and get water from the soil which is the hydrosphere which is important. He further indicated that the lithosphere is also important.

The educator continued reading from his notes that there are outputs process and also an input process and that if one part of the system is affected, the other parts will be affected meaning that if the hydrosphere is disturbed, then the lithosphere will also be affected, the atmosphere is also going to be disturbed. He continued to give more reasons that plants and animals use energy from the sun to make their own food. He checked with learners if they understood. He continued his statement and said when plants and animals use energy from the sun they are going to produce carbon dioxide which is going to be released in the air and animals are going to obtain oxygen from the air. He continued his statement and said animals are going to release carbon dioxide in the air which plants will absorb and obtain oxygen from the air which plants will released. The educator continued and said the lithosphere helps the plants to grow very well and the atmosphere supplies the plants with carbon

dioxide. He asked the learners if they are still with him and told them the water which is known as the hydrosphere is going to be used by plants in the process of photosynthesis. The educator then told his learners that if they were listening they would know that there is water from hydrosphere, there is carbon dioxide from atmosphere, there are plants which live on soil which represents the lithosphere. He repeated his statements while writing on the board. He then wrote the biosphere and said the biosphere is when plants are interacting with another. The teacher asked the learners if they are still with him and said it is known that animals eat plants to survive to absorb the food substances from the plants. He continued by saying that the said plants live on lithosphere, get carbon dioxide from the atmosphere, and they get water from the hydrosphere. He indicated that when the spheres he pointed at on the board interacted with one another they will make the biosphere. He then said the biosphere is when living organisms interact with one another and the environment. He told the that without the three spheres (lithosphere, hydrosphere and atmosphere) plants and animals will not exist.

(16-20 min)

The educator pointed to the biosphere on the board and said it is a place where living organisms come together. He repeated the statement in Sepedi and said biosphere is where we see animals and people living together like in the universe where we are, meaning without plants there won`t be animals and without animals there cannot be plants. The educator continued and said the organisms live together because they depend on the interactions of the different spheres. He asked the learners if they are still together with him. The educator indicated that in other planets there is no lithosphere meaning no land, there is also no atmosphere meaning no carbon dioxide , and that makes planet earth important. The educator then asked the learners to mention four layers of earth. The first learner mentioned the lithosphere which the educator concurred with. He then asked the learners to mention the different parts of the lithosphere. One learner said plants which the educator dismissed. Another said rocks which the educator concurred with. The other learner mentioned soil which the educator agreeing with. The educator then asked the learners to mention the other sphere which one learner mentioned atmosphere with the concurring with. The educator then told the learners that the atmosphere consists of different gases. He asked the learners to mention them. One learner mentioned carbon dioxide which the agreed with. He then asked learners to mention living organisms using carbon dioxide in order to sustain life. A learner raised her hand and said plants which the educator agreed with. The educator then asked learners to mention other gases found in the atmosphere. One learner after being recognised mentioned oxygen which the educator concurred with. The educator then asked the learners to mention the organisms which uses oxygen after obtaining it from the atmosphere. One learner mentioned human beings. The educator concurred with her

and indicated that human beings are example of animals. He then told the learners that the atmosphere is important because it living organisms get Oxygen from it. He asked learners to mention another layer of earth. One learner raised her hand and was inaudible. He asked her to repeat the response. The learner responded and mentioned the hydrosphere which the educator agreed to. He then asked learners to explain what the word hydro meant. One learner mentioned water which the educator concurred with. He therefore reminded learners that a large amount of earth is covered by water. The educator asked learners to mention sources of water on earth. He gave more hint and asked where water is found on earth. One learner mentioned the river with the teacher agreeing with. The other learner mentioned oceans with the educator sustaining the response. The third learner mentioned seas with the educator asked agreeing to and mention rivers and lakes as his examples.

(21-25 min)

The educator said the places mentioned are places where water is found and are known as the lithosphere. The educator then asked the learners to give different forms of water. One learner mentioned liquid which the educator agreed with by repeating the response. The educator continued by telling the learners that the water that human beings use is in the form of liquid. Another learner mentioned solid which the educator concurred with. The educator then asked the learners where solid water can be found. A learner raised his hand and said in ice. The educator sustained the response by saying water is found in ice. He then asked the learners if they are still with him. The educator asked the learners to mention the part of earth where ice water is found. One learner said around the poles with the teacher agreeing to. He reminded the learners that there is a Northern pole and Southern pole and mentioned that the water which is found on the poles is the form of solid. The educator then asked the learners to mention another form of water. Another learner mentioned gas with the educator sustaining the response. The educator then asked the learners to give examples of water which is in the form of a gas. Within some few seconds before learners could respond the educator started a scenario about exhaling on the window pale and observing some sort of a mist. He asked learners to name that type of gas they would observe on the window pale after exhaling. One learner raised his hand and said water vapour with the educator agreeing to by repeating the response. The educator went back to his notes and read them again that the four spheres interact with one another to sustain life. He explained the meaning of the statement and said without the lithosphere there will be no life since plants will not have a place to grow. He asked learners if the understand him before he told them there will also be no place to build houses and that makes the lithosphere important. He then turned his focus to the atmosphere while pointing on the board. He said without the atmosphere there won't be gases available and that will be problematic since the gas that humans take in will not be available. He again turned on to the hydrosphere and

said without water our body will not undergo processes such as digestion and that makes the hydrosphere important. The educator then told the learners while pointing to the board that all said spheres interact together to sustain life and their interaction is known as the system. He emphasised his statement by saying they are called a system because the spheres act together so that life known as the biosphere can exist on earth . The educator went back to his notes and said the process in the earth system consists of the four spheres which are the ones he wrote board (pointing on them).

(26-30 min)

He continued and repeated his statement that the interaction that takes place on earth takes because there are four spheres which together form a system. The educator then asked for questions from learners. He continued in Sepedi and requested to be asked a question. With no learner asking questions, he asked them a question himself. He asked them what was going to happen if there was no hydrosphere. He asked the question many times until one learner responded but was inaudible. The educator repeated her response and the response was that the animals are going to die as their bodies will dehydrate. The educator continued and said the plants will also die since they will not be able to absorb water from the soil. The educator continued explaining that when one sphere stops operating, the others will be affected meaning without hydrosphere there will not be biosphere hence no life. He asked the learners what will happen to living organisms being plants and animals if there is no atmosphere. He then asked what will happen to the animals. When no learner responded the educator reminded them that the atmosphere contains gases before going back to the question asking the learners what will happen to the earth if there is no atmosphere. One learner responded by saying animals will suffocate since they will not be getting oxygen and ultimately die. The educator then asked learners to explain how the absence of the atmosphere will affect plants. No learner responded even after the educator repeated the question a couple of times. The educator then responded and said since there will be no carbon dioxide in the atmosphere, plants will not manufacturer their own food through photosynthesis and will die.

(31 – 34 min)

He asked the learners what will happen if there is no biosphere. Before learners could respond he told them that the implications of the biosphere's absence, is that there will not be life. The educator then explained in Sepedi the interaction of spheres and consequences of their absence. He requested for learners` questions which did not come. The educator then instructed the learners to go and write work from a textbook as a homework. The questions asked as they appear from the textbook were: 1. Briefly describe how the biosphere can be harmed by the choices people make? 2. Give one example of each of the following: a. How people can disturb the balance between the biosphere and the atmosphere? b. How people can disturb the balance between the

atmosphere and the hydrosphere? The educator concluded the lesson.

APPENDIX K:
DETAILED ANALYSIS SYSTEM (DAS)

THEME	CATEGORY	CHARACTERISTICS	
Teacher knowledge	Content knowledge	Lithosphere, atmosphere, hydrosphere, biosphere, interactions between the sphere	
	Students understanding	Prior knowledge	
		linguistic abilities misconception	
		difficulties	
	Context knowledge	Resources	
		Curriculum	
		Policies	
	Teaching route	Language and culture	
Instructional strategies		Traditional teaching/rote learning	
		Non-traditional teaching/ active and critical learning	
	Epistemological perspective	Empirical and/or tentative	
		Observation and/or inference	
		Subjectivity and/or creativity	
		Social and cultural embeddedness	
		Theories and laws	
	Teaching methods	Lecture,	
		Demonstration,	
		Question and answer	
	Explanatory framework	Examples	
		Analogies	
		Metaphors	
		Axioms	
Classroom interactions and discourse	Type of discourse	Dialogic	
		Authoritative	
		reflective	
	Patterns of discourse	Initiation, response and feedback (IRF)	
		Open chain patterns	Non-triadic/closed patterns
	Communicative approach	Dialogic/interactive	
		Dialogic/non-interactive	
		Authoritative/interactive	
		Authoritative/non/interactive	

APPENDIX L:
LANGUAGE EDIT CERTIFICATE

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Dear Sir/Madam

This serves to certify that the dissertation "TEACHING DIFFICULTIES OF NATURAL SCIENCES EDUCATORS IN THE PLANET, EARTH AND BEYOND STRAND IN THE SEKGOSESE EAST CIRCUIT OF LIMPOPO" submitted at the University of South Africa, College of Education by candidate Tebogo Edwin Nkanyani of student number **44616732** was edited by us, and found to be examinable for the purpose of awarding the degree MASTER OF EDUCATION WITH SPECIALISATION IN NATURAL SCIENCES EDUCATION.

Kind Regards

Dr MA Mafukata

APPENDIX M:
PERMISSION TO CONDUCT RESEARCH.PDF

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PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

Enq: MashimbyeTS
Tel: 0716793339

SEKGOSESE EAST CIRCUIT
HOUSE NO. 483
SENWAMOKGOPE TOWNSHIP
10 January 2017

TO WHON IT MAY CONCERN

PERMISSION TO CONDUCT STUDY/ RESEARCH: NKANYANI TE

This is to certify that the above mentioned educator has been given permission to conduct study/research among the learners and educators within the Sekgosese East circuit.

The circuit wishes to request the schools to give him permission to interact with the relevant stakeholders at schools without compromising learning and teaching.

The circuit wishes the researcher good luck in his endeavor to complete his research.

Yours faithfully

CIRCUIT MANAGER

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10 JAN 2017
SEKGOSESE EAST CIRCUIT
DEPARTMENT OF EDUCATION

SEKGOSESE EAST CIRCUIT
P.O.BOX 136 MOOKETSI Tel: 015 8740032/ FAX: 0158742121
"Working together we can do more in providing quality education"
Education is a Pre-condition for development

APPENDIX N:
TURNITIN

Teaching difficulties of Natural Sciences educators in the Planet earth and beyond strand in the Sekgosese East circuit of Limpopo

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