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A case study of South African township teachers' use of pedagogical content knowledge.

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Chapter 4

4. Development and Presentation of Core and Papers

4.1 Introduction

From the field notes that were collected, three kinds of artifacts were developed from the data, that is, dialogues between teachers and learners and also Professional and Pedagogical Representations (PaPe-Rs) and Content Representation (CoRe).

The chapter describes firstly what PaPe-Rs and CoRes are in detail, and gives a brief account of how PaPe-Rs were created and the details of PaPeRs of two teachers. This will be followed by presentation of a CoRe and two PaPe-Rs that were developed.

The CoRes and PaPe-Rs are presented in this chapter without comments as portrayals of PCK which are analysed in chapter 5. Raw data was constructed by transcribing audio recordings enhanced by field notes that were taken during classroom observation. From those notes, dialogue between learners and their teacher was developed (See appendix 3). In Ms Simelane's case, apart from transcripts and her reflections were also used to construct a dialogue between her and her grade 12 learners.

When transcription was completed, teachers were given transcripts to check whether the content was correctly captured. After teachers agreed

and confirmed, PaPeRs were created by using information obtained from the transcripts and interviews. In the following paragraphs CoRes and PaPeRs are presented.

4.2 Description of Models used for Analysing Data

The data, which were collected by observing lesson presentations of science teachers when presenting their lessons on the mole, was captured and portrayed using Content Representation (CoRe) and the Professional and Pedagogical experience Repertoire (PaP-eR) (Loughran et al., 2004). In conjunction with this method, a model called "categories of description of the mole concept model" was used to categorise the teachers' understanding of content (Strömdahl et al., 1994 and Tulberg et al., 1994). In this chapter I shall be focusing on the PaP-eRs and CoRe. The Stromdahl et al. and Tulberg et al.'s models will be discussed in greater detail in the next chapter.

The use of CoRes and PaP-eRs were developed by Loughran et al. (2006) in an attempt to uncover, articulate, document, capture and portray teachers' PCK. The authors believe this will create genuine opportunities for sharing the knowledge within the professional community in ways that are meaningful, useful and available for teachers, education specialist and science education researchers.

I chose the above two analysis methods because there are common features showing a correlation of some kind with certain aspects of

participants that Loughran et al. (2006), Tulberg et al. (1994), Stromdahl et al. (1994) and the ones that are involved in my study. In particular, all studies involved investigating content knowledge. In addition in all these studies:

- The authors were either investigating or portraying PCK of the Science teachers
- The participants are science teachers
- The participants are high school teachers teaching at secondary level
- The content of interest in all these studies is chemistry (although, in my study the content is specifically on the mole Loughran et al. portrayed teachers' PCK on the particulate nature of matter). When interacting with Loughran and his group, they indicated that they have created CoRes and PaPe-Rs for physics, earth science and biology content (Loughran et al., 2006).
- The studies of Tulberg et al. (1994) and Stromdahl et al. (1994) are exploring the concept of the mole. In my study, I intended to find out how teachers translate their understanding of this concept into their classroom practice.

Loughran et al. (2004) stated that if a representation of PCK is to help teachers recognise, articulate and develop their understanding of that content, then it must be based on an understanding of what content the teacher knows (and has come to understand) to purposefully shape the pedagogy and the associated approach to pupils learning. This statement

applies to content knowledge (CK) of teachers and this is what Tullberg et al. (2004) do.

Before I apply this method to analyse the data I collected I shall briefly explain the tool. The method used by Loughran et al. (2004) comprises two important elements of PCK, namely, science content knowledge and teaching practice. The CoRe is linked to the particular science topic whilst PaP-eR is linked to the teaching practice (Loughran et al., 2004: 41). The following paragraphs provide a brief description of what the CoRe and PaPeRs is about. In addition, the CoRe and PaPe-Rs that were developed from data collected are presented later.

4.2.1 Content Representation (CoRe)

According to Loughran et al. (2004) the CoRe is about representing the teachers' understanding of PCK, that is, the different knowledge (aspects) that teachers consider when preparing and presenting a particular content in their field of teaching (in Loughran et al.'s s case the content was on particulate nature of matter). The knowledge includes

- excluding certain knowledge which is associated with the content
- the reasons behind including the knowledge that "expert" teachers think is important to be presented in conjunction with the particular knowledge
- the misconceptions or alternative ideas associated with the concept
- the idea in which the knowledge will be presented to learners
- innovative ideas of testing for understanding the content

- the explanations use and the framing of sentences or ideas to suit the age and the background of learners.

A teacher will be able to consider all the above aspects (and other aspects which she/he will think is relevant to consider in order to reach learners' understanding) only if the teacher has a reasonable understanding of the content she/he will present. According to Loughran et al. (2004: 376) teachers' understanding of particular aspects of PCK will be revealed by an ability to ask and give answers to the following prompts

1. *What do I intend the students to learn about this idea?*
2. *Why it is important for students to know this?*
3. *What else do I know about this idea (that I do not intend my students to know yet)?*
4. *Difficulties/ limitations that are connected with teaching this idea*
5. *Knowledge about students' thinking which influences my teaching of this idea?*
6. *What other facts that influence my teaching of this idea?*
7. *What teaching procedures (and particular reasons of using these to engage with this idea)?*
8. *specific ways of ascertaining students' understanding or confusion around these ideas (include likely the range of ideas)*

Excluding question number 8 which is described in Loughran et al. (2006) ,this study will concentrate on the first 7 questions only. Loughran et al. (2004) developed the above questions 1 to 7, to suit an Australian/

developed world context. To me it does not imply that I needed to use exactly wording of the questions as indicated above. Loughran et al. (2005) confirms that the CoRe should not be viewed as static or as the only/best/correct representation of that content.

Each teacher is unique and dynamic in his/her practice therefore these questions can be rephrased differently depending on the aspects that an teacher thinks are important for that time and the order in which questions are listed is not necessarily fixed because the manner in which individual teachers conceptualise the content is different but equally valid.

Because participants in this research were not used to reflecting on their practice the above questions were not actually used but rather as guiding categories when collecting data I have rephrased these questions to suit the context of participants' understanding of their practice. The above questions were used directly when analysing data from the interviews and observations.

In Loughran et al.'s study, the CoRes were assembled as a synthesis of expert practices gathered in workshops. I was trying to portray responses from individual participants who were not expert teachers (at the time of collecting data). However, after I had constructed the CoRe, teachers were revisited with the questions from Loughran et al.'s CoRe to verify the correctness of statements in the CoRe of the study. From the data collected during both interviews and observations the CoRe and after

consultation with participants of the study, the following CoRe was constructed (See Table 4.1).

The CoRe below includes responses (from an interview) not only from the participants of the study but also responses that were given by a well recognised Science education lecturer who has done an intensive study on the mole in Sweden. Because the expect is used to reflect on his practises and has conducted extensive study on the mole and on teaching strategies that can be employed, the expert was requested to respond to the seven questions in Loughran et al. (2004). This was done in order to compare his responses with teachers at high school and also to get views from an "expert". The responses were not put in the developed CoRe of this study but they will be used in the following chapter when the results are discussed. The information from the CoRe was also helpful in developing PaPeRs. Analysis of the CoRe will be done in chapter 5.

Table 4.1: The CoRe of the teachers

Questions	Mr Xaba	Ms Simelane
1. What you intend the students to learn about this idea?	-The mole is equal to the number of atoms, the smallest particles of matter. -To know the definition of mole in their textbook	• Definition of a mole as written in the textbook • the importance of understanding this mole in chemistry and • use the formula to calculate the number of moles. • use the formula to calculate then Avogadro's number
2. Why is it important for students know this	Makes calculating very huge number of small things like atoms of any matter easier	• To be able to distinguish quantities • The mole is related to many topics taught at Grade 11 and 12 • They need to know amount of substances to

		form products • Mole is one of the 7 basic SI units we use in Physical Science
3. What else do you know about this idea (that you do not intend student to know yet)	Avogadro's number. He knew about it in the interview but did not use it in class)	• The history of mole ("it confused me for years)
4. Difficulties/ limitations connected with teaching this idea	• Difficulties in understanding the Periodic Table. • Lack of knowledge of the symbols of elements • Poor background in chemistry • Use atomic number and mass number interchangeably • Difficulties with calculation of molar mass • Algebraic difficulties, e.g. changing the subject of the formula	• Lack of knowledge of symbols of elements and chemical formula • Atomic number vs. mass number • Difficulties encountered in determining molar mass (MM) of elements/compounds • Poor background in chemistry • They do no know the correct chemical formulas of compounds • They cannot balance simple chemical equations • Learners confuse a mole with mass , volume and in some case with density • Their understanding of the word "number vs. quantity"
5. Knowledge about students' thinking which influences your teaching of this idea	-Maturity of students -General background knowledge	
6. Other factors that influence your teaching of this idea	❖ Responsibility by learner to do their task honestly (maturity) ❖ Chemistry background- understanding all the basic concepts such as the atoms, atomic mass relative (molar mass) mass number, isotopes etc. the concept of mass as should be understood in the concept	• Just joined the school and lacks specifics of knowledge of learners background • Learners' first group from new junior secondary curriculum • Learners were struggling with earlier tasks • Learners can do tasks on their own
7.Teaching procedure (and particular reasons for using	• Doing calculations of different types, practice makes perfect	• Started by explaining the mole by using

these to engage with this ideas)	• search for exercises from different chemistry books • do number of problems on the chalkboard • give them more homework	analogy of dozens, counting and weighing different coins, peanuts, biscuits and rice grains • Give calculation activities that create understanding but also application questions involving quantity and menu

4.2.2 Professional and Pedagogical experience Repertoires (PaPe-Rs)

According to Loughran et al. (2004), a PaP-eR is like a window into a teaching /learning situation wherein it is the content that shapes the pedagogy. The PaPe-Rs are about teaching which contextualise the content, in so doing helping to illustrate so, certain aspects of PCK.

PaP-eRs are linked to CoRe and they bring to life the aspects of PCK, which inform effective classroom teaching. They help to connect the practice seen with the understanding of that particular content. This statement suggests that one PaP-eR alone is not sufficient to show the complexity of the knowledge around particular content. Loughran et al. (2004) recommends that a collection of PaP-eRs attached to different areas of the CoRe is crucial in highlighting some of the different blends of elements that jointly are indicative of PCK in that content area.

The links made by teachers illuminate the decisions underpinning the teacher's actions intended to the help the learners better understand the content.

PaPe-Rs are developed from detailed descriptions of individual teachers' actions and or as a result of discussions about situations/ ideas/issues pertaining to the CoRe, as well as classroom observations. PaPe-Rs are developed through interaction of the prompts, questions, issues and difficulties that influence the particular approach to teaching that content to which the PaP-eR is tied and reflects the richness of the teacher's understanding of science teaching and learning in that field.

Loughran et al. (2004) further say that the construction of a CoRe and the associated PaP-eRs allow a way of addressing the problems of capturing and portraying PCK that have continually confounded previous research. They recommend that PaP-eRs do not need to carry the more comprehensive knowledge informing the practice being illustrated that makes such accounts too cumbersome to be engaging or useful to other teacher.

Since PaP-eRs are engaged in portraying teachers' illustrations of the elements of PCK they should not be restricted to a particular format or style. They can have a variety of formats (such as interview, observer's voice, journals, window into a lesson, students' voice and actions, annoted resources etc) in order for the reader to be able to identify with the situation and as a results of particular framing of content, context or pedagogy to draw meaning from it.

As indicated before that the difference between Loughran et al.'s (2004) teachers and those who participated in this study is that they are not idealised expert teachers and they have little teaching experience.

Important to note is that participants of this study do not reflect on their classroom practice, and thus PaPe-Rs that were developed for these teachers were for non expert teachers. It is also important to note that for the purpose of this study only one PaPe9R per teacher was created. These PaPe-Rs are not based on big ideas but PaPe-9Rs were interpreted as detailed cases of what teachers do in their practice when preparing and presenting lessons. PaPe-Rs assist in analysing data that was collected because appropriate for organising all the data which was collected and present it in an organised systematic way. In the following sections Both Mr Xaba and Ms Simelane's PaPe-Rs are presented.

4.3 Presentation of Professional and Pedagogical Representations (Pape-Rs)

From this part onwards, PaPe-Rs of two teachers are presented. These papers were developed from the data that was collected from interviews and observations. A PaPe-R that explains the proceedings during Mr Xaba's lesson presentation will be presented firstly. This will be followed by a PaPe-R that will also outline events as they unfold during Ms. Simelane lesson on the mole.

The following is a paper that explains and describes Mr Xaba's lesson on the mole concept.

4.3.1 A PaPe-R on Mr Xaba's lesson presentation of the mole

Mr Xaba is a Physical Science teacher at a school in Eastern part of Gauteng. He has just obtained a B. Ed degree in one of the local universities in Gauteng

4.3.1.1 Mr Xaba's framing in the interview – the content

"I explain what a mole is in terms of a heap or pile of something. There is definition in their textbooks, it is a long one but they must know it because they chose to do Physical Science. This definition was written by the authors and professors and the textbooks are supplied by the Department of Education so they must learn what is inside. You see the examiners use these textbooks to set questions if they know the definition they will pass at the end of the year

These learners dodge classes and when they are in class they do not listen and do not finish their task. There are problems when you teach this concept. These learners have difficulties in understanding the Periodic Table I have given them the table long time ago in fact I gave them at the beginning of this year.

They cannot use the periodic table in the class, they do not know the symbols of elements they confuse the symbols and elements, for example they associated the symbol P with potassium, S with sodium. This problem becomes more difficult if the substance is a compound. I think this is a result of lower class teachers concentrating more on Physics aspects than Chemistry and by so doing leaving learners without a good background of chemistry concepts.

Also the atomic number and mass number is used interchangeably by teachers such that learners end up not knowing which is which. The other

problem when teaching the mole is that molar mass calculations are difficult to be handled by learners for example molar mass (MM) of CO_2 the possible answers you will find are

MM CO_2

- = (12 + 16) x 2 or
- = (12+16) + (12 +16) or
- = C + O which is 12 =16 and not consider the small 2 or
- = C + O + 2 (i.e. 12 + 16 +2)

They also have problems in mass calculation exercises. You see, that is maths and physics problems because such problems they involve changing the subject of the formula which is basically mathematics. If they cannot change the subject of the formula then the moles - mass problems will be difficult. I think teacher should explain the Periodic Table to learners in detail and make a clear differentiation between atoms and elements. If they understand that then it will be easy for them to understand that a mole is the amount of atoms or anything in a substance and this substances are small particle like for example C is made up of small particles.

I search for many exercises from different chemistry books and I do lots of problems on the chalkboard and show them how to go about doing them and I also give them homework to practice what we were doing in class. Learners who give themselves time to the exercises do not normally encounter any difficulties. When you practice a lot you do not forget that it stays in your mind for a very long time."

4.3.1.2 Mr Xaba's framing in the classroom – the "heap" idea and calculation problems

Mr. Xaba started the lesson by handing out the pamphlet with a drawing of an apple showing the macroscopic level of the particle which consists of a bite of that apple. According to this diagram matter is composed of atoms, which in turn are made from quarks and electrons. This string theory demonstrates that all such particles are actually tiny loops of vibrating string (See figure 4.1)

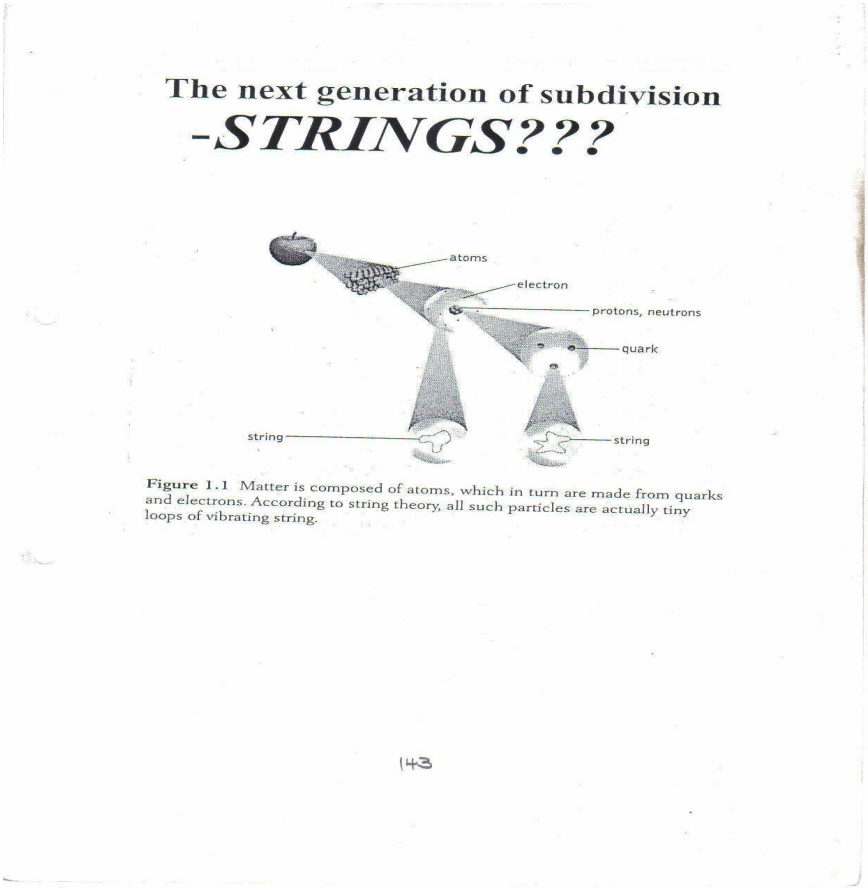

Figure 4.1 handout presented to learners by Mr Xaba (Adopted from Greene, 1999).

He also mentioned most basic scientific concepts and the famous scientists that are associated with each concept on the pamphlet. For example he associated Mendeleev with the Periodic Table of the elements and the mole with Avogadro. He then posed a question to learners which sought to know "how do they explain atoms?"

Learners responded by saying that it is the smallest particle of matter and this explanation was accepted by the teacher. He then introduced a mole by writing the word 'mole' on the board and explained that mole is the Latin word meaning "heap" or "pile'. He said that a mole means "many things put together" and that the unit for mole is molar. He further described that the mole is equal to the number of atoms, the smallest particles of matter.

He demonstrated using soft white chalk in his hands that it is made of small particles. He then pointed that there were too many small particles in any object and they cannot be counted one by one. At this point he explained that the problem is that we want the solution very soon. Because the results are needed then we will not finish within a short time. So moles are used to calculate them. He proceeds thus:

"Let us calculate the number of moles."

At this stage he introduced a formula

$$\frac{\text{Mass}}{\text{Molar mass}} = \text{Moles}$$

and he showed 3 equations where all the quantities in a formula are made to be the subject of the formula. He told learners the unit of moles to be 'gram per moles'.

He showed learners how to move from grams to moles by manipulating with the above formula to get

$$\frac{\text{Mass}}{\text{Molar mass}} = \text{Moles}$$

It seems their response prompted him to show them how to get the molar mass number on the periodic table. He told them that "molar mass (MM) is obtained on the periodic table for all elements by finding a certain number which he explained quickly but seemingly learners had an idea of the position of that number on the periodic table.

He took out the copy of the Periodic table showing that on each block of the Periodic Table the number on the top left is the atomic number and the number on the bottom is the molar mass. The MM for the element Hydrogen is quoted as 1, 00797 g/mol which was used as an example to demonstrate that the number is rounded. He then did a couple of examples on finding the MM of different elements from the Periodic Table and made learners aware not to forget to include the units 'g/mol'.

One of the examples he chose was Carbon (C), which has an MM of 12 g/mol. "In case you are given 8 g of C then 8 g of C must be converted to number of moles." This he said you to know molar mass of carbon. You then decide which conversion you will use is it g/mol or mol/g. In this case 8g will mean we use mol/g

"8g x 1 mol = 8 mol

then

$$\frac{8g}{1} \times \frac{1mol}{12g} = \frac{8mol}{12g}$$

= Use your calculator 0,6 mol or 0,7 mol"

More examples were done on the board using the same approach. After those exercises learners were given a tasks to do these included the following problems:

Find the number of moles in:

1. 40g of Oxygen gas
2. 0,45g of Cl.
3. What mass of lead in grams is equivalent to 2, 5 mol of lead (Pb)?
4. What amount of tin (Sn), in moles is represented by 36, 5 g?

The teacher went to sit at the back and joined one learner. They worked together for the rest of the period. Because they did not finish they had to complete the task as homework.

This brings us to the end of PaPe-R explaining what happened in Mr Xaba's class. The discussion from this point onwards will be presenting the second PaPe-R as indicated above.

4.3.2 A PaPe-R on Ms Simelane's lesson presentation of the mole

The following is PaPe-R that explains Ms Simelane's attempt to use models to make learners understand the concept of mole.

Ms Simelane is a Physical Science teacher in a township of the Eastern part of Gauteng. At the time of data collection, she was then studying for a Science Education degree at the honours level and it seemed that what she is learning from the course was interesting for her teaching practice because she was new in the current school but she was committed to try and apply new approaches. In fact these approaches are important to her practice because they help her in her to attempt create learners conceptual understanding of the mole.

4.3.2.1 Ms Simelane's framing in the interview – the content

"At grade 12 I expect that these learners should know about the mole from last year but you know our learners and for those who are repeating it might be worse so I am not assuming anything. I am going to teach them everything that will be of use for grade 12. That will include the basic concepts in chemistry such as atom, nucleons, elements, mass number, atomic mass, relative atomic mass you see that stuff.

I believe it is only after this stuff is well understood that I can start with the explanation of the mole. A mole is a very difficult concept to understand even now I am not sure if I understand it so well. It took me more that ten years to be confident and you added a little more fear during the workshop but at least I have a clear understanding now so it is more difficult for learners. A mole to me is a counting unit it is just a number and in their textbooks it is explained as a quantity of matter containing exactly the same number of elementary particles of which it is a knowledge I also use. When teaching about the mole I consider what a mole is, the

importance of understanding the mole in chemistry and then I use the formula to calculate the number of moles. This if followed by the Avogadro's number. I start by explaining the mole by using an example of a dozen of different things which I see around whether in a classroom or outside and even in the laboratory. You see they confuse a mole with mass, volume and in some cases with density and all this is stuff they should know from standard 6 (Grade 8). It is OK that they know or have ideas about these but it is a problem when they use this knowledge now. Then I explain where the number $6{,}022 \times 10^{23}$ comes from, but very briefly.

As an introduction to the mole I also use money coins as my teaching they like money so they tend to be attentive when you use money and I also use triple beam balance. I use 20 x 5 cents coins and 20 x 10 cent coins. You see it is important it shows that the "quantity' of coins is the same but the mass of the different coins is different *(I use the this word "quantity' from the beginning and I explain what it means to them and instead of using the word "number" because it is used in their textbooks and our children have language problem*). So then it means even elements can contain the same number of particles but are different in mass. This is revision work, they are in grade 12 but they do not know about the mole. The other day I started with them on the mole, it was difficult it was like it is for the first time they were taught this concept so I have decided that I shall teach it as though they were never introduced to it. The point is, if I pretend I do not see this problem they won't understand the other chapters that I still have to teach and that will affect the results and my reputation as a Head of Department in a school, currently known as subject specialist (HOD). You

see I have to help them. You see the mole is important for many chapters to come i.e. redox reactions, acids and base analysis, chemical equilibrium constant. It is a lot to risk for.

The kinds of activities that I give to learners to create understanding are mainly calculations I want them to master calculation on the mole because we will use the moles when we do the equilibrium rates and K_c. If they cannot balance the equations they are out they will not get those correctly especially for explaining the Le Chatelier's principle am preparing them for those section of the syllabus."

4.3.2.2 Ms Simelane' framing in the Classroom- "a dozen analogy"

She started the lesson by reminding them that the previous day they were talking about atomic mass, nucleons and mass number, relative atomic masses. She then asked questions like "What is atomic number?" and accepted the ideas from the learners that it is the number of protons in a substance. She went further to ask "what is atomic mass?" and she accepted the idea that it is the number of protons and neutrons together. She then asked "what is the relative formula or molecular mass? The accepted idea was that it is the total number of protons in a substance same as atom mass relative to a particular substance. Molecular mass is the same as atomic mass relative to the substance's mass which means molecular.

At this point she asked what learners think the mole is. She old them that "It is a counting unit of any thing" She further told them why is it

important in chemistry. She reminded the class that the mole is used in topics such as gases, counting number of moles, chemical equations, acids and bases, organic chemistry. In fact she said the mole is important because if for example you are preparing nitric acid in industry you don't want to prepare something that you will not use, you need to know exactly the amount you will use. Another example was for baking a cake, the amount of flour and baking powder to use. If you put more baking powder than flour, the cake won't come out well. You need to know amount of substances to form products. She also told learners that the mole is also listed as one of the seven basic SI units in their textbooks.

After this period she used the analogy of a dozen. She asked learners how many objects will make a dozen and confirmed with the learners that the big number is 12. She gave learners a selection of substances such as biscuits, peanuts and rice grains to work with. So there were 12 biscuits, peanuts, rice grains and they all counted each pile of the same substances and they confirmed that in each group there are 12 objects which make a dozen of whatever substance. She then weighed a pile of each substance. The mass of each dozen was weighed and recorded on a table at the chalkboard and they were shown to be different. She alerted learners to note that masses of 12 peanut beans and 12 rice grains are not the same but there are the same numbers of objects in each case. She then related this to the piles of c sulphur and magnesium which were on the table in front. She told them that they are different size of piles but the number of moles in each pile is the same. The number of moles does not mean mass of a substance. So 1 mol of substance is called molar mass and to get

number of moles of a substance depends on whether the substance is an element or a compound. The molar mass of an element equals the molar mass number that appears on the Periodic table of element, and she gave an example of carbon to illustrate her point. She said that mass number (when rounded to the nearest whole number) of C equals 12 and the units are g/mol so its molar mass is 12 g/ mol. She indicated that normally a short hand MM is used for molar mass like for example MM (S) means molar mass of sulphur and equals 32 g/mol. 1 mol of each substance S equals to 1 mass of S. She then did an example of MM ($CaCO_3$) and explained that in this case (a compound) add different molar masses that makes the compound $CaCO_3$, that is, 40 (for calcium) + 12 (for one carbon) + (16 x3) (for 3 oxygens) =100 g/mol. She explained that there are three (3) oxygen atoms that constitute this compound and that explains why 16 x 3 in the case of oxygen. She then continued and related MM to the peanuts on the table. She said however the problem they were facing then is that twelve (12) peanuts were weighed using a scale and obtained mass of 8.9g but the mole refers to number of particles in a substance. For example, in the case of piles on the table we need to find out how many particles were there in each pile of the substances that were weighed.

For Avogadro's number she explained briefly that scientists determined that the quantity of particles in each pile is 6, 02 $x10^{23}$. This is a very big number and she wrote it down on the board without using scientific notation i.e. 602000000000000000000000). From here she gave learners a number of exercises that needed learners to do calculation of the mole using the formula

Number of moles = mass of a substance_____.

Molar mass of a substance

For the remaining minutes learners engaged in exercises that needed them to do calculations. This brings us to the end of the lessons on the mole by Ms Simelane. However, after she was concerned about how the lessons went. In her reflection she said "

> ……. ***I must say that I was panicking a lot****. I wrote the following concepts on the board atomic number, mass number, relative atomic mass and relative molecular mass and asked learners to give the definitions.* ***Learners gave different answers but were not sure about relative molecular mass. So I gave them the answer*** *and proceed with the lesson.* ***I was disappointed with the way I preceded with the lesson because I was suppose to make the learners understand relative molecular mass and atomic number using either an analogy or thorough explanation****.*
>
> …….. ……
>
> **I jumped straight to calculations. It was difficult for me to link the analogy to the formula. I could have used the analogy to link the concept to the formula. For example to calculate the number of rice in 500g packets,** *the tempo of the lesson was fast; it wasn't appropriate for achieving the objectives. So I realized that next I must slow down for the learners to grasp and for me to remember every point that needs to be emphasized. I must also encourage learners to use their initiative to answer question than to follow me all the time. And for a better presentation it is important to write down every point that needs to be visited in order.*

4.4 Concluding Remarks

In this chapter Loughran et al.'s (2004) model that was used to analyse data that was described. The description of the model was followed by capturing and portrayal of collected data by using CoRes and PaPe-Rs. The next chapter will provide a discussion of issues that arises from CoRes and PaPe-Rs that were developed in this chapter.