Investigating Bachelor of Education Second Year University students' difficulties with non-technical words presented in the science context

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ABSTRACT

The language issues in South Africa recently made headlines where inclusive education in respective mother tongues has been the outcry. South Africa has been a democratic state for more than 20 years and still such language inequalities are most prevalent. The issue of language redress to accommodate the country's educational needs and demographics remains a big concern even at University levels. The focus of this study was to investigate the challenges, concerns, familiarity and understandings of the difficulties that non-technical terms presented to B.Ed. second year University students. This case study explored whether issues with non-technical terms' science contextual meanings and familiarity in science related fields of study were still persistent at University level.

The study was conducted at an English medium South African University, with student demographics coming from mostly urban settings with mixed home language backgrounds where English was highly spoken in school. The data collected in this case study was derived from University students' responses on a questionnaire to predetermined questions that focused on non-technical terms' meanings followed by a semi-structured group interview. The findings in the interview with participants gave an indication to their contextual familiarity and understanding of non-technical terms' science context meanings, with the aim to improving teaching and learning of physical sciences in schools as a preparatory measure for further University studying.

Similar to the findings from studies with South African teachers and Grade 12 learners' (see Oyoo, 2016, in press; Oyoo & Semeon, 2015) which revealed that South African school learners encountered difficulties with non-technical terms presented in the science context, this study revealed that South African University students' also experience difficulty with non-technical terms' science context meanings. The main sources of difficulty identified in the study were attributed to the South African language and historical background which contributes to poor vocabulary. Students' lacked the exposure, and contextual familiarity to the language that these meanings are embedded in. This led to students' inability to differentiate between non-technical terms' specific scientific context meaning from terms' everyday meaning. The lowered exposure to these terms' actual contextual use inside and outside classroom conversations is a factor that needs to be countered. Students' acknowledged that explicit meaning of non-technical terms' science context meanings should have been made when learning science at school. School science instruction needs to pay special attention to details on the context of the word in use as a preparatory measure for University. This claim is more on the fact that, participants acknowledged that familiarity is the major factor to their difficulty based on their different lived experiences.

DECLARATION

I declare that this research report, titled

'Investigating B.Ed., Second Year University students' difficulties with non-technical words presented in the science context'

is my own work and that all sources I have used have been indicated and acknowledged as per University standards by means of a complete reference list.

This research report is being submitted in partial fulfilment of the degree of Master of Science (Science Education) at the University of the Witwatersrand, Johannesburg, South Africa.

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CHAPTER 1: BACKGROUND TO THE STUDY

1.0 Introduction

1.1 Problem Statement and Rationale of the study

South Africa is over twenty years into its democracy, yet the issue of access to quality education and the shortage of skills debate remains a huge challenge to our economy. The country's economy depends on the skilled middle class with expertise in Science, Mathematics and Technology. Sadly, the number of student enrolments in these fields of study is not conducive to meet the challenges of the economy. South African Grade 12 learners enrol at University to study science, a level higher than the attained level that they had at school. University instruction is different compared to that at school where teachers would improvise on the learners' sense making process by often seeking examples from their native cultural environments to simplify scientific processes (Rollnick, 2000; Probyn, 2005).

Breier and Erasmus (2009) highlighted that economical analysts had indicated that one of the major contributors to the shortage of relevant skills in the country is attributed to low number of students admitted at tertiary institutions to pursue science related fields of study. Nonetheless, the South African Higher Education Act No.101 of 1997 (Government Gazette, 1997) retained the responsibility and accountability for the selection of high school students for higher education at institutional level (Skelly, 2007). It also stated that admission policies must provide for appropriate measures to redress past inequalities and may not unfairly discriminate in any way (Department of Education, 1997). In this view, South African higher education has made notable progress in the past twenty years in terms of widening educational access to school leavers.

Wilson-Strydom (2015) points out that African students accounted for 42.5 % of enrolment in 2004 and this proportion grew to 70.1 % in 2013.Yet approximately 30 % of students drop out of University in their first year, and about 55 % of all students never graduate. As powerful as these numbers are, still it doesn't pin point the problems to the lowered University enrolments and student difficulties.

Ramnarain and Molefe (2012) argue that one of the contributing factors to student difficulties at university could be attributed to the lack of readiness in high school learners to pursue science related programmes at a higher institution. Another issue is that at school level, all the high-stake National Senior Certificate (NSC) examinations are taken in only English or

Afrikaans, meaning the language of assessment is minimised to only two languages while the rest of the South African official languages are rendered unimportant to English and Afrikaans.

The Minister of Education, Angie Motshekga was presented with a review of the implementation of the National Curriculum Statement (NCS) in 2009 with emphasis on the importance of English as a First Additional Language (Maher, 2011). The report also stated that “crucial attention needs to be paid to issues of language, in particular First Additional Language English, which remains a strong predictor of student success at school” (Department of Education, 2009, p. 41). Many students from South Africa are not English speaking, but are required to know English in order to master educational concepts and to engage meaningfully in the information age on a global stage (Department of Education, 2009). Language and its terminology is an issue in everyday speech, be it in the classroom or in day to day form of communications amongst learners. In each school subject, the communication barrier between the learner and teacher should be top priority to ensure a continuous display of quality in performance on learner scores. In some instances, teachers resort to other methods such as code switching to provide further clarity at school level (Probyn, 2005; Bilgin & Rahimi, 2013). This is the first stage in teacher to learner interaction to convey meaningful messages to each other.

As a result of apartheid in South Africa, the education system faced many difficulties with regard to language of instruction in educational institutions (Barkhuizen & Gough, 1996)**.** The consequence of these previous unequal and unfair education systems is that there is now an ongoing cycle of under preparedness among previously disadvantaged groups of students (Archer, 2010). Therefore, as students’ progress through their primary, secondary schooling and into tertiary, they battle to use a cognitively challenging vocabulary to learn and express themselves, hindering their performance and ability to study. Clearly the role and nature of language in South Africa as it affects learning in science classrooms is an overlooked problem.

Most of the Language in Science Education research conducted have pointed difficulty to general English language proficiency as a major contributor to student difficulties in science. However Oyoo (2007) argues that the prominent issue that is overlooked is the nature and structure of the science register. The studies conducted in Africa by Oyoo (2007, 2012, 2004) have pointed that familiarity and contextual proficiency of everyday used non-technical terms bearing a different science context meaning seems to be the major difficulty in science classroom discourses.

This study on students' difficulties was conducted at an English medium South African University, with student demographics coming from mostly urban settings. This study has investigated whether issues with non-technical terms' science contextual meanings and familiarity in science related fields of study are still persistent at University level. This study also investigated the other science language contextual factors which can be interpreted as possible indicators to students' level of preparedness in science and science related University studying.

1.2 Aims and Objectives of the study

The objective of this study is to investigate the language difficulties via an exploration of the challenges, concerns, familiarity and understandings that contribute to the difficulties that non-technical terms present to University student teachers of physical sciences. This is with the aim to improving teaching and learning of physical sciences in schools as a preparatory measure for further University studying. The underlying aim of this is to bring to light the level of South African students' preparedness in the language for science learning at University. This study will be advancing on the findings from studies conducted in South Africa over the past 5 years, where instructional language use, familiarity and the understanding of non-technical terms in the science classroom were investigated amongst teachers and Grade 12 learners (see Oyoo, 2016, in press; Oyoo & Semeon, 2015).

In this study, the difficulties that students encountered with non-technical terms will be an indicator that the reported problem is prevailing at University level. Therefore, the following research questions were posed:

1. Are there any indicators in the students' selection of items that indicates language difficulty with non-technical terms science context meanings?
2. What are the explanations or reasons for the difficulties that students encountered with non-technical terms?

1.3 Background of the study

Science Achievements in South Africa

Over the past decade statistical data especially between 2008 and 2015 revealed a flux in the quality of science results between males and female learners leaving high school. Table 1.1 summarises the noticeable fluctuating Mathematics and Physical Sciences subject achievements between 2008 and 2015 compiled from the (Department of Basic Education ,2008,2010, 2012, 2014), and Department of Basic Education 2015 Technical report.

Table 1.1: Mathematics and Physical Sciences subject achievements of 2008 – 2015

Year	% Mathematics	% Physical Sciences	Overall % Pass Rate	% Bachelor's Passes
2008	45	55	62.6	20.1
2009	46	37	60.7	19.0
2010	47.4	47.8	67.8	23.5
2011	46.3	53.4	70.2	24.3
2012	54.0	61.3	73.9	26.6
2013	59.1	67.4	78.2	30.6
2014	53.5	61.5	75.8	28.3
2015	49.1	51.1	70.1	25.8

Public concerns were raised after the 2008 and 2009 NSC Mathematics and Physical sciences results that showed an increased number of students across the country that achieved more than 80 % in the final examination. It was found that the NSC Mathematics and Science examinations did not discriminate sufficiently between candidates, particularly among high achievers (Department of Education, 2009). In South Africa, a bachelor pass qualifies a grade 12 learner to enrol in any higher institution of learning. The results in Table 1.1 indicate a fluctuating outcome in both Mathematics and Physical sciences results across the years. The number of bachelor passes are alternating between a 2 % increase or decrease over this period. These results may suggest that the quality of learners to be accepted at higher institutions to pursue a science related career has dropped over time. The fluctuation may be as a results of changing curriculum policy and implementation, introduction of Mathematical literacy in the school curriculum, number of enrolled Grade 12 candidates sitting the NSC examination, learners' social backgrounds, lowered interest in both Mathematics and Physical Sciences amongst high school learners and quality teaching in schools.

Statistical data from the Department of Education (DoE) on the overall matric rates and results have also confirmed that in the past decade matric result have been declining from province to province (Department of Basic Education, 2010). From this analysis, the number of distinctions have also declined, which raises questions about the type of learners enrolling for school science in the FET phase (Grade 10) onwards. As a direct response to these discrepancies, in 2010 Government introduced extended programmes and directives to broaden access in the scarce skills area as means to increase students' throughput as support to the under preparedness of students during University studying. Breier and Erasmus (2009) anticipate that education has become an increasingly important predictor of employment status and to address the skills shortage in the country.

The political transition of 1994 was a clear opportunity for the African National Congress government to reduce racial inequalities in educational access to increase educational attainment among previously disadvantaged Africans (Wilson-Strydom, 2015). The skills shortage study by Breier and Erasmus (2009) was captivated by statistics that identified a trend in declining skills shortages in science related fields as a reason for concern in the growing demands of the South African labour force after 1994. For example, the study conducted in the engineering sector revealed a universal problem in the low acceptance rate of scholars in the engineering fields which is based on the quality of school Mathematics and Physical sciences (Breier & Erasmus, 2009), a crucial component to the skills development in an emerging economy such as South Africa. Wilson-Strydom (2015) reported that there was a follow up anecdotal talk where Universities were asked by Government to increase the number of engineering faculties in the country; however it was noted that the pool of potential higher education candidates had not significantly increased, especially in the higher grades of Mathematics and Physical Sciences due to the New Curriculum Statement (NCS) which stipulates that all Grade 10, 11 and 12 students are required to take seven subjects (Department of Basic Education, 2010). Out of the seven subjects; two of the subjects have to be languages, three subjects are their own elected subjects that determine their career paths and lastly two new subjects such as Life Orientation and Mathematical Literacy which are offered additionally to their subject choices.

Language policy

The language policy states that English alongside a home language should be introduced as early as Grade 1. Unfortunately, many schools are only introducing English as a subject in Grade 3, which is only a year before learners are required to use English to learn other subject matter (Department of Education, 2009). The impact of these challenges and difficulties is likely to be seen as learners' progress through their schooling and in the education system as a whole. Learners who were not given the opportunity to learn English appropriately over their schooling, do not have an adequate base and are likely to be disadvantaged later on.

According to Heugh (1995) many African parents believe that learning English from as early as possible will be academically beneficial for their children in the future. Therefore, middle class learners in modern day South Africa are educated in English from the first day of formal schooling. On the other hand, majority of non-English speaking learners are often educated in their mother tongue up until approximately Grade 4, and are thereafter educated in English (Foxcroft & Aston, 2006).

Heugh (1999) asserts that these learners by the end of four years of home language medium of instruction, accompanied by English as a subject, learners should have acquired a vocabulary of about 800 English words. This number is by far too little to the 5000 words considered to be necessary to cope with English as a medium of instruction (Rollnick, 2000). Therefore, a majority of students battle to use cognitively demanding language to learn and express themselves, resulting to a hindered performance and ability to study further.

1.4 Science language learning issues

Language in Science Education research over the past years has focused on the proficiency in the Language of Learning and Teaching (LoLT), to assume that first language speakers of that language will generally perform much better in their learning than second language speakers. de Kadt (2000) argues that Language proficiency can be defined in terms of three components which are (1) intelligibility (the ability to comprehend and be comprehensible), (2) use of appropriate language (3) and use of English as a cognitive tool for learning. Writing, particularly in academic writing is a cognitive task that in most tertiary education settings requires English as a cognitive tool.

The studies conducted in Europe by Cassels and Johnstone (1980), Pickersgill and Lock (1991), Prophet and Towse (1999); Oceania by Marshall and Gilmour (1990) and in Africa by Oyoo (2004, 2007,2008, 2012) agrees with Gardner's pioneering studies (1972, 1976) that the root problem would be in the nature, structure and context of use of the instructional language itself. The difficulty is embedded within the science contextual nature of the language used to teach science in classroom. Language in Science Education research has pointed out that non-technical terms that are highly frequent in science instruction and science textbooks are the source of difficulty. The main difficulty is in the everyday used terms that hold a different science context meaning as their everyday meaning.

In addition, learners' preparedness with the science language context and classroom instructional approaches are some of the overlooked general factors that affect learners' in schools. Expert authors in Language in Science Education studies, have also identified that there are far greater factors that affect the learning of science such as familiarity of science concepts, socio economics, interest in the subject etc. Oyoo (2016, in press) argues for a rethinking in language proficiency as the source of difficulty in learning science at instructional levels of the classroom to a focus on contextual proficiency as the source of difficulty in science. More of this is presented in Chapter 2.

1.5 Chapter Summary and Outline of Research Report

In Chapter 1, the purpose of this study is introduced with an overview of the factors that affected the overall matric statistics on South African Physical Sciences results over the past decade. The importance of quality Physical Sciences education for further University studying is highlighted as a predictor to the country's economy. Chapter 1 also highlights the efforts that the African National Congress government has made over the past two decades to increase access to quality education in South Africa. The aims, objectives and focus of the study are highlighted to answer the research questions outlined in this chapter. The rest of the report is structured in the following manner:

In Chapter 2, the conceptual framework and the literature review forms the basis of the arguments on students' difficulty and preparedness. The role that language plays in Physical Sciences classrooms in South African schools is highlighted as the main priority factor that affects meaningful understanding of non-technical terms' scientific context meaning in the science classroom. The review on difficulties related to non-technical terms highly frequent in school textbooks and classrooms around the world is highlighted. The general factors related to school preparedness are reviewed and discussed and linked to the theoretical framework as possible indicators on students University preparedness.

In Chapter 3, the research design and the methodology is provided to identify the difficulties that students are facing with meaning and familiarity of non-technical terms. The main data collection instruments are explained and described in detail. A step by step account of the strategy carried out in the codifying of questionnaires is provided under the data collection section. The University of the Witwatersrand Students' demographics where the study was conducted formed the broader context of the study. The study sample is drawn from participants of the study, and their home language background which informed the study further.

In Chapter 4, the data collected is codified and presented in tables, where the individual options scored are presented as percentages for further analysis. The selection criterion for difficulty is highlighted in the chapter and linked with the conceptual framework to identify the words which emerged as problematic to South African students. Since the focus is to identify students' familiarity and contextual understanding of non-technical terms in the options selected on the questionnaire, the words which emerged as difficult are analysed and discussed further to bring out the messages in the option selected to answer the underlined research questions in Chapter 1.

In Chapter 5, a summary of the finding is presented as well as the answers to research questions. The recommendations are linked to the implications on student preparedness from the findings highlighted and presented in Chapter 4. The Research Report is concluded with a reflection and a way forward for future research.

CHAPTER 2: THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.0 Introduction

In this chapter, the theoretical framework that guides this study will form part of the discussion. The literature reviewed is to establish a link to global trends with science difficulty and the South African schooling context along with this study's objectives. The review focuses on the difficulty in meaning that everyday used English words hold when presented in science contexts. The conceptual framework is linked to theoretical framework behind the study which is used to analyse the interview data later in Chapter 3. The science language components are discussed under the literature review, then followed by a brief summary of the South African diverse historical language background grounding the country's unique science language issues, schooling landscape and challenges. The structures mentioned are also linked and discussed as possible indicators and attributes to students' University preparedness.

2.1 Conceptual Framework

The science language articulates a 'science register' that employs everyday used terms to represent new concepts or a more direct phenomenon that builds into a science cultural world view. Leach and Scott (2003) argue that appreciable scientific knowledge should be consistent with empirical evidence of the natural world and be characterised by the ways we talk about the natural world. Marshall and Gilmour (1990) describe these words that form a science vocabulary as essential words to concept development, and go on to express the very importance of comprehension of these words as a basis of success in science. Therefore, the learning of the science language requires an understanding of the codes and symbols that it is identifiable with. The knowledge perceptible as 'science knowledge' is codified in the language used to teach and learn science. The vocabulary which informs everyday science talk comprises of technical and non-technical words commonly used in science. This suggests a need for shared thinking towards a common understanding of the meanings of words in all contexts of use (Oyoo, 2012).

The connection between language and the subject is best captured by the connection which draws from the fact that science knowledge is embedded in the language. The everyday meaning and use of these non-technical words is a keystone of the argument presented in this study, which is best captured in the following words by Postman and Weingartner (1971, p. 102) cited in (Oyoo, 2012, p. 854) who have argued that:

All of what we customary call "knowledge" is language. Which means that the key to understanding a "subject" is to understand its language ... What we call a subject is its language? A "discipline" is a way of knowing, and whatever is known is inseparable from the symbols (mostly words) in which the knowing is codified.

Isa and Maskill (1982) regard English as an indispensable language of science communication and for explaining clearly the concepts of science since many languages arguably do not possess a vocabulary for science concepts. From this view, there should be a complete shift in the focus that science has in the world currently, the focus should be on the written text and its meaning in its unique context.

Language formulates the groundwork of learners' conceptual ecology as well as the means for conceptual progression (Jones & Brader-Araje, 2002). Language and terminology is a factor throughout everyday speech, be it in the classroom or in the day to day form of communication. In the South African public schools context, the language policy informs the choice of LoLT in schools. In some instances, teachers adopt their vernacular languages in addition to the LoLT of the school since English is either a second or third language in the learners' everyday social communications.

Vygotsky's argument that language serves to mediate higher order thinking (Vygotsky, 1978) challenges teachers to reconsider the critical role of language in teaching and learning science. Teachers have adopted code-switching from English to the learners' home language as a classroom strategy (Probyn, 2005), to improvise on the learners' meaning and sense-making process by often seeking examples from their native cultural environments to achieve understanding of scientific concepts. The Theoretical framework related to the study is presented next.

This conceptual framework is used in section 3.4.3 as the analysis framework to the data collected in both the questionnaire and interview process to respond to the research questions.

2.2 Theoretical Framework

Language in Science Education studies around the world have looked at trends related to difficulties experienced in science as a subject in schools. One of the difficulties that is dominant across the globe is language. The language in this instance being the language used to teach and learn science as an entity. Tao (1994) describes words as the basic element of any language where language is viewed as a central tool to concept development in science, words forming a basic summary of the science register that is most dominant between the teacher and the learner in science classroom interaction.

The theoretical framework of this study is argued from a constructivist perspective where learning is mediated from learners' experiences of the natural world communicated through language. Brooks and Brooks (1993) defined constructivism as a non-objective theory about knowledge and learning where knowledge is viewed as a temporary, developmental, socially and culturally mediated construct. The argument of this study is linked to the conceptual framework in section 2.1, where Postman and Weingartner (1971, p. 102) cited in Oyoo (2012), asserts that what is called knowledge of science is actually the language of science which means that the key to eloquent understanding is to understand the meanings of the words used in science.

Vygotsky (1978) viewed basic development and learning from a higher mental functioning in the individual's mind that can be derived from social life. In the first instance, the language and other semiotic mechanism which provide the means for scientific ideas to be talked through between people on the social plane often also referred to as inter mental plane (Leach & Scott, 2003). Matthews (1998) argues that constructivist approaches to science entails that students try to make sense of the world by engaging students in a process of construction and reconstruction of knowledge through dialog, mediated by language and social interactions. According to Piaget (1964) cognitive development is influenced by social transmissions, learning provoked by situations or from others and teachers in social environments. Vygotsky (1978) believes social interaction is instrumental in development and that it heavily influences language and thoughts in development. Therefore, language and articulation of concepts through language plays a central role in concepts development from the more knowledgeable other.

According to Vygotsky (1986) as cited in (Tao, 1994) children build spontaneous concepts through their everyday interactions with people and the environment long before they can verbalise them. In essence, people learn words in the context of ordinary communication. This process is fast and successful by listening, reading and talking. In science learning by contrast to everyday discourse, learning words from abstract definitions and sentences stem from context of normal language use. This suggests that the teacher's language consciousness is vital in teaching science and creating the condition for meaningful learning. Therefore, the teacher will initiate the solution of the problem and with assistance from peers and the teacher, the learner should be able to internalise what is said during social interactions (Vygotsky, 1978).

Lemke (1990) argues that learning science is conceptualised as learning to talk in new ways through interactions shaped by meaningful social contexts for learning where students construct knowledge based on their own experiences of the world. The language used in science can be defined as the scientific social language, the scientific way of talking and thinking which has been developed within the scientific community. The fact is that knowledge of science is codified in the words used in learning of science which separates it from other disciplines. The key to understanding this science is by familiarising yourself with its language, the language organized by words. Therefore, whatever is called science content, cannot be separated from the words in which its coding is known (Hodson, 2009 as cited in Oyoo, 2012).

The Vygotskian view appreciates the fact that the social language we use to communicate with is an indication of the understandings and worldviews which learners bring to formal instruction. Leach and Scott (2003) further argue that the different social language and speech genres which are rehearsed on the social classroom setting offer learners the means to develop a range of distinctive modes of personal thoughts. Therefore learning science from social context requires a process where the individual learner internalise the social language and being able to associate and use the science words appropriately in various situations.

One of the major difficulties associated with learning science around the globe is the comprehension and use of non-technical words in everyday science discourse. The science language is characterised by terms which can either be technical or non-technical which in principle is inseparable from one another (Wellington & Osborne, 2001). Therefore, the instructional language that acts as a vehicle of the science language, in itself proves to be difficult to both first language speakers and second language speakers (Oyoo, 2007). This is due to the fact that the instructional language used in science is a collection of different languages. Oyoo (2007) highlighted that the prerequisite for successful learning is in the learners to develop proficiency in the instructional language. Lemke (1990) stated that learning to use the language of science is vital for learning science. My focus is on the non-technical component of the science language, since every day used words convey a different meaning when presented in the science context. So, the familiarity and use of these terms and words in science classrooms is of paramount importance for effective science learning and teaching in science classroom discourse. The literature review on meanings of non-technical words will be presented in the next section.

2.3 Literature review on meanings of words used in science context

Oyoo (2007) critically analysed findings from cross national studies on student difficulties to highlight the general difficulties of the instructional language to all learners in Science Education. As basis of the literature review for this study, the science classroom language components are reviewed.

Science classroom language components

The discussion starts with a review of the science classroom language components captured in Fig 2.1, as reference to the argument on student difficulties. The science language for learning and interaction comprises of a technical, non-technical component where the ***Technical component*** is made up of technical words or terminologies specific to a science subject which is distinguishable as a new language (Oyoo, 2007). In the Oyoo (2007) Language in Science Education review, words such as (mass, force…) that were originally argued by Gardner (1972) are given as examples of technical words. These words may also be referred to as technical terms, scientific terms or terminology, science terms or simply science words which explain science concepts (Oyoo, 2008). This component also forms a science sub culture which is employed differently in everyday classroom interactions.

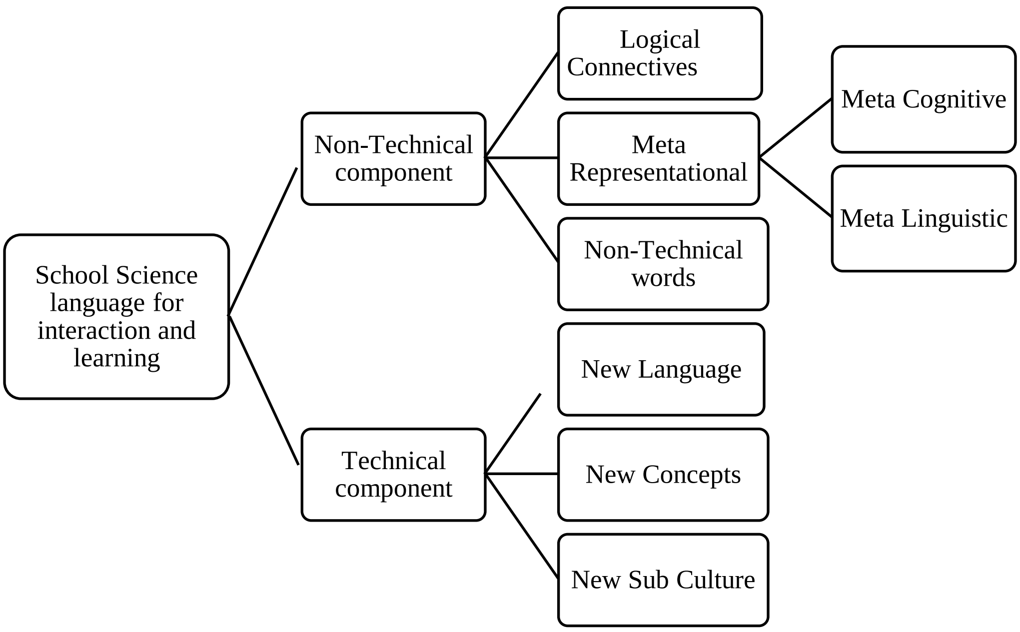

Fig. 2.1: Science classroom language components

The non-technical component makes up the science register which distinguishes science classroom talk from any other classroom talk. This register comprises of non-technical words, logical connectives and meta-representational words to make up an everyday science classroom teacher to learner discourse.

Logical Connectives are words or phrases which serve as links between propositions and a concept in a sentence. The examples from Gardner (1976) include ‘moreover’, ‘consequently’, ‘therefore’, etc. Oyoo (2007) further stresses that students’ understandings of these words would enhance learner’s classroom participation as well as the understanding of the processes of learning science.

Meta-representational terms refer to the non-technical words that signify thinking; which include metalinguistic and metacognitive words. Words such as ‘observe’, ’classify’, and ’analyse’ are words which are associated with learning and talking science (Lemke, 1990). The value of these ‘operative words’ may help learners’ answer science questions and improve their understanding of the instructional demands from a questioning point of view (Bulman, 1986 as cited in Oyoo, 2007).

Non-technical words are regarded as everyday used words whose meaning changes when presented in the science context. Words such as ‘diversity’, reaction, ‘spontaneous’, ‘disintegrate’ are important words that explain certain science concepts that exemplifies the school science language characteristic (Oyoo, 2007). These non-technical words are the words used in everyday common speech. The science language comprises of these words that are most frequently used in schools and school texts without their explicit science context meanings being emphasised. The studies conducted by Oyoo (2007, 2012) have pointed difficulty to stem from the meanings and interpretations of non-technical terms presented in the science context versus their everyday used meanings.

Student Difficulties

Most of the Language in Science Education research focused on the role of practical work, use of language in teaching and assessment (Oyoo, 2007). The factors that emanated from the research arguments were that learners’ lack general language proficiency, proficiency in the language of the exam due to little exposure or training in that language and learners’ writing ability as sources of difficulty (Oyoo, 2012). Vinjevold (1999) argues that difficulty arises from the little reading and writing that takes place in the classroom. Bunyi (1999) attributes these difficulties to a lack of relevance that the language presents to learner's everyday lives. (Strevens, 1980) refers to non-science specific words such as logico-grammatical items, as a source of difficulty in English, English being the language that is embedded in the science language for concept development. Clerk and Rutherford (2000) argue that the possible reasons for misconceptions and misinterpretations that contribute to the difficulty in science as a language can be attributed to the following factors:

> *the difficulty: the linguistic complexity of the text could simply be beyond the competence of the respondent; (2) error: typographical, grammatical or semantic errors could exist, making interpretation of the question difficult to understand; (3) ambiguity: the meaning of some key word or phrase in the question could be open to interpretation, even if no actual error is involved. This is especially possible where words and phrases are used, whose 'everyday' meanings differ from their scientific meanings.*

George (1999) as cited in Oyoo (2008) recorded that the general difficulty of school science, hence science content as is well known world over, vary in extent depending on the specific circumstances in different countries. On the other, hand Rollnick (2000) asserts that the difficulty is purely based on the meaning of words. Marshall, Gilmour, and Lewis (1991) asserts that every day words when used in a science context cease to be mere English words. The science language articulates a science register that employs everyday used terms to represent new concepts or a more direct phenomenon that builds into a science cultural world view. Thus, learning science can be argued as learning to talk in new ways. The argued science language difficulty rests within the comprehension of the non-technical component of the school science language for interaction and learning, stemming from lowered proficiency in the language in which science terminologies are embedded in (Oyoo, 2007).

Paul Gardner in 1972 conducted a pioneering study in Papua New Guinea which focused on student difficulties with non-technical words as used in science classrooms. He used a sample drawn from English second language secondary school learners and later that year from English first language speakers. In those studies Gardner (1972) tested the understanding of 599 words on a sample of about 7000 learners from 39 different schools across Australia (Farrell & Ventura, 1998). In the study with Form 1-4 learners' he found that learners experienced difficulty with everyday used words that teachers use in science classrooms (Oyoo, 2008).The results from this study indicated that less than half of the 12-year-olds understood 'average', 'composition', 'concept', 'contract', 'illuminate', 'factor', 'partial'; 'rate', 'valid', for example and these words still gave trouble to one third of 14-year-olds (Henderson & Wellington, 1998).The summary results indicated that 'disintegrate', 'random', and 'spontaneous' respectively were the most difficult terms with a scoring of 26%, 25% and 31% correctly scored out of the entire sample (Oyoo, 2008).

Later Gardner (1976) replicated a second study in the Philippines using English second language learners'. Both studies revealed similar trends in the understanding of the non-technical terms, with differences that reflected relative linguistic circumstances specific to each of the countries (Oyoo, 2008). Gardner's findings opened a new door to Language in Science Education research where in Britain Cassels and Johnstone (1985) tested 25 000 English first-language learners'. They discovered similar patterns in the difficulty with the meanings of everyday used words in science context including vocabulary.

Gilmour and Marshall (1990) in Papua New Guinea and Pickersgill and Lock (1991) in Britain expanded their study (Oyoo, 2008), with a sample consisting of grade 7 up to university students. Gilmour and Marshall (1990) tested the understanding of 45 non-technical terms selected from the words commonly used by teachers in science teaching. Similar to the other studies, they identified that learners were also experiencing difficulty with everyday words science context meanings. The study by Pickersgill and Lock (1991) detected no difference between the understanding of non-technical words in science by gender, no difference between the verbal reasoning ability of males and females, but found a positive correlation between a student's score on a verbal reasoning test and on a test of understanding of non-technical terms in science (Oyoo, 2008).

Numerous studies were conducted thereafter for example (Farrell & Ventura, 1998; Prophet & Towse, 1999; Oyoo, 2004), whose samples consisted of mainly English second language learners', different categories of learners at different levels of schooling. Farrell and Ventura (1998) concentrated on non-technical words as used in Physics. Prophet and Towse (1999) made comparisons in learners' performance on non-technical terms with samples drawn from developing countries and developed countries (Oyoo, 2008). In Africa, similar studies done by Oyoo (2004, 2007, 2012) reported on findings with Kenyan students and South African teachers opinions and attitudes, where he revealed that learners were experiencing instructional language difficulty in the science classrooms. Oyoo (2008) asserts that the origin of the general difficulty with technical terms lies in the general foreignness of science terminology or science content. Lemke (1990) adds that the foreignness of the science words may illuminate the gap that exists between the learners' perception of the world and the science culture they are meant to learn.

The general difficulty of science words is only a fragment of the difficulty that encompass the science teacher's instructional language (Oyoo, 2012). The studies conducted by (Oyoo, 2016, in press ; Oyoo & Semeon, 2015), in South Africa have pointed out there are other factors apart from the general difficulty with science words. They reported that teachers and learners are unwarily using these terms without comprehension of their science context meanings. These meanings are not explicitly outlined in classroom discourses in most schools. Consequently, South African learners also experience difficulties with meanings of everyday terms presented in a science context. The main source of difficulties encountered was learner inability to distinguish between the meanings of familiar everyday words as used in everyday parlance from the 'new' meanings of the same everyday words when used in the science context (Oyoo, 2016, in press), which directly influence learners' school preparedness for science learning at University. Similarly, the focus of this study is to investigate whether these trends reported from cross national studies especially in South Africa are still persistent even at University level.

In this study, students from the University of the Witwatersrand responded to a questionnaire consisting of 30 multiple choice questions on meanings of non-technical words used in everyday science talk. The students who were interested were invited to participate in an interview and discussion on their familiarity and contextual understanding of the 30 sampled non-technical terms highlighted in the questionnaire. The information collected in this case study was derived from University students' responses on the questionnaire to predetermined questions that were asked of a sample of participants in a semi-structured interview, an interview schedule was prepared upon interviewing students on their familiarity with non-technical terms as further analysis and indicator to their school preparedness.

2.4 Preparedness

In South African public schools the language policy is geographically bounded (Alexander, 2005), because the Department of Education in conjunction with the constitution recognises multilingualism in the country. In some townships and rural schools the home language is not the same as the schools official LoLT, due to number of factors that include, the lack of resources in those languages. School teachers are then forced to adopt their vernacular languages in addition to the LoLT of the school since English is a second or third language in the learners' everyday social communications. Sadly, in schools where English is rarely used, learners' English proficiency doesn't improve. One can imagine the difficulty that these learners have to deal with both intellectually and psychologically when they are faced with the final National examination that is in a language that is not their mother tongue.

> *In a multilingual country like South Africa it is important that learners reach high levels of proficiency in at least two languages, and that they are able to communicate in other languages. Learners' home languages should be used for learning and teaching whenever possible. This is particularly important in the Foundation Phase where children learn to read and write. When learners have to make a transition from their home language to an additional language for learning and teaching, careful planning is necessary.*
>
> Department of Education (2002, p.19-20)

The first influential problem is that teachers in South Africa do not have adequate proficiency in all eleven official languages (Nel & Müller, 2010). This factor affects primary school teaching mostly and results to reluctant behaviour in introducing English at an early stage in formal school learning. This reluctance to introduce English so early, deliberates the fact that learners may not yet be academically proficient in their respective home languages or mother tongue (van Zyl, 2011).

Van Zyl (2011) further argues that school readiness has a positive effect on the school performance of a learner in formal school situation, and quality early learning experiences are essential in order to reach the required stage of school readiness. In the early stages of schooling these traits are fundamentally important for their high school careers and for University preparedness (Bruwer, Hartell, & Steyn, 2014).

Many students and learners in South Africa come from home backgrounds that are not conducive to learning in any form, never mind the learning of, and success in, an additional language. Due to socio-political barriers, many learners receive a poor-quality education throughout primary and high school (Broom, 2004, p. 522). This means that learners may leave primary and even high school without developing a strong command of the English language. Nagel (2010) argues that due to the inequalities that still exist in the secondary schools, for example the importance that is placed on English or Afrikaans as the only languages of instruction has led to many students under performance in tertiary education. Chokwe (2013) adds that other contributing factors are ineffective writing skills, socio-economic issues and inadequate reading skills. This under-performance could be a result of inadequate teaching at high school level, especially in a subject such as English which is necessary for all academic encounters, assessments, presentations, teaching and learning in University (Maher, 2011).

Ramnarain and Molefe (2012) focus on students' lives and everyday educational experiences in school and at University, and therefore conclude that there should be a rethink on what University preparedness means and the implications thereof on student retention, throughput and ultimate success.

The most prominent cause of this academic under preparedness is the inequalities of the past, and repercussions of the apartheid regime (Maher, 2011). Bantu education in particular was prescriptive in the type of education it 'allowed' for African students, which has resulted in some of this deprivation and lack of school preparedness and inequality (Maher, 2011). Ramnarain and Molefe (2012) further adds that there may be other possible factors to students' preparedness which affect individual students' ability to engage with physics problems qualitatively rather than merely assuming an algorithm approach. Secondly, is having sound understanding of basic physics concepts and lastly, competence in reading and speaking the scientific language.

These mentioned factors are arguably and largely contributed by learners' high school instructional language preparedness, science classroom discourse, teachers indistinct teaching approaches and most importantly the understanding and use of non-technical terms' science context meanings (Ramnarain & Molefe, 2012).This study urges to inform or contributes to the learners' preparedness at high school level for university studies in the form of understanding everyday science classroom instructional discourse.

Conley (2007) cited by Ramnarain and Molefe (2012), argues that preparedness is a multi-faceted concept comprising numerous variables that include factors both internal and external to the school environment. Figure 2.2 highlights the four operational levels adopted and modified in this study as key facets of preparedness.

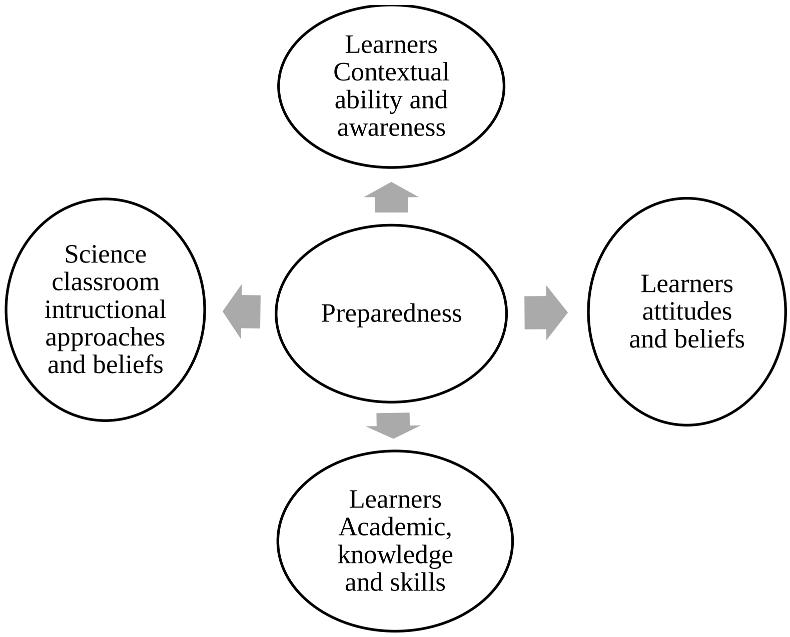

Fig. 2.2: Facets for preparedness

Academic behaviour, knowledge and skills refers to science content knowledge, understanding of non-technical terms that explain scientific concepts, self-monitoring skills and consistent work ethic related to science as a discipline. Self-monitoring is an awareness of one's current level of mastery and understanding of a subject, and the ability to reflect on what needs improvement in any particular academic task (Ramnarain & Molefe, 2012).

Contextual ability and awareness encompasses an understanding of how the school functions as a system and culture and how this culture differs at University level. Interaction with people from different backgrounds and cultures, communicate informally with mention of non-technical terms meanings while, identifying the different contexts that learners use in their sense making process (Ramnarain & Molefe, 2012).

Science classroom instructional approaches and beliefs focused on language consideration while preparing for and taking tests and examinations, identifying and using non-technical terms in resources such as textbooks, taking class notes, and language communication with teachers and classroom discipline. Science classroom talk and explicit mention of scientific terms understanding and comprehension and participatory science language are used during practical work (Ramnarain & Molefe, 2012).

Learners' attitudes and beliefs about science the attitudes that the learner have towards science, beliefs that may be influenced by the community, seeing the importance and need for scientific literacy in the community (Ramnarain & Molefe, 2012).

National Benchmark Test

In the South African circumstances, being eligible for University or better said meeting admission criteria does not necessarily mean that one is ready for University-even for students entering University with top school–leaving results (Wilson-Strydom, 2015). Admission in this occurrence refers to the process through which students enter tertiary education. McGhie (2007) explains that “under-preparedness of students due to the poor South African public schooling system” (p. 35) is one of the main factors impacting on the decision to introduce an academic literacy course at tertiary level. It was also explained that students cannot read comprehensively, write grammatically or fluently, and cannot “argue and engage with texts in a meaningful and critical manner” (McGhie, 2007, p. 35). These factors were largely attributed to the fact that students at tertiary level had often studied English as a second language at high school, as opposed to a first language (McGhie, 2007).

In 2009, National Benchmark Tests (NBT) were commissioned by Higher Education South Africa (HESA) as a tool to measure the quality of student enrolling at our higher institutions. These tests were intended to provide a service to HE institutions by providing additional information complimentary to school-leaving results that would assist higher institutions in the admission and placement of students in appropriate curricular routes as means to address the inequalities faced by black students in the past. More important these tests were to provide statistics on the level of academic literacy and proficiency in the country for those learners who have obtained a National Senior Certificate. These NBT processes differ from institution to institution. Initially the NBT was designed to inform the following points:

- *provide institutions with information that is additional and complementary to school-leaving results that will assist them in the admission and placement of students in appropriate Higher Education curricula and in programme provision;*
- *assess the entry-level academic and Quantitative literacy and Mathematics proficiency of students;*
- *assess the relationship between entry-level proficiency and school-level exit outcomes;*
- *Provide information to assist in the placement of students in appropriate curricular routes (e.g. regular, augmented, extended, bridging or foundation programmes); and to inform the development of curriculum for higher education programmes.*

Du Plessis and Gerber (2012, p. 84)

The NBT focused on the following core (domains) areas:

- *Academic Literacy (AL): Students' capacity to cope successfully with the demands of academic study in the medium of instruction.*
- *Quantitative Literacy (QL): Students' ability to manage situations or solve problems of a quantitative nature in real contexts relevant to higher education.*
- *Mathematics (Maths): Students' manifest ability to grasp Mathematical concepts, which form part of the NSC Mathematics curriculum.*

Du Plessis and Gerber (2012, p. 85)

Academic literacy encompasses reading, writing, listening or speaking, all which have been determined to be a main reason for success or lack of academic success in University students (van Dyk, Zybrands, Cillie, & Coetzee, 2009). Ideally, the capabilities for University success should be created in High School (Wilson-Strydom, 2015).

2.4.1 Historical language background in South Africa

Since the establishment of the Dutch East India company who were the first colonisers of the country, the language struggle '*taalstryd*' has been at the root of our current national language policy struggles (Alexander, 2013). During these times in the 1800's the first schooling systems have been in place to promote their colonial languages without consideration of the indigenous languages (South African Government, n.d; Alexander, 2013). South Africa's history is full of disputes over language of instruction policies that were taken to entrench various generations of political aspirations, from the British supremacy policies of the 1930's where Afrikaners were forced to speak English (Rollnick, 2000).

The apartheid government with their language policy for separation of the South African population was unsuccessful (Hurst, 2016, p. 221). The people in these areas were in situations that forced them to abide by the language-in-education policy of the country at the time. Following that, the Soweto student revolt in 1976 is identified as a pivotal point, resulting to educational responses which had aggravated academic failure amongst the majority of school students. The extent of failure worsened inexorably over the two decades since the 1976 rebellion of students in Soweto against the implementation of a language in education policy which required students then to learn through Afrikaans as well as English in secondary schools (Heugh, 1999).

The Republic of South Africa's constitution recognises 11 official languages, and the right of all South African citizens to receive education in their official language(s) of their choice in public schools (Alexander, 2003). South Africa has a language policy guided by principles enshrined in the Constitution of the Republic of South Africa (CRSA) and South African Schools Act (SASA) (Mkentane, 2003).

The first democratically voted government made quick decisions to change the language policy ahead of the 1999 elections, it failed to address the major factors which determine educational success, such as the relationship between languages of learning and learning. The evidence based on the failures amongst 80% of students, whose languages at home are other than English, in a school system which, since 1979 has been based on and taught through English as a second language (Heugh, 1999).

Recently School Governing Bodies have the authority to determine the language policy of an individual school (Mkentane, 2003). Bush and Heystek (2003, p.133) in Hurst (2016, p.224) argue that the power of schooling governing bodies to set school fees and the language of learning and teaching for schools, subject to parental approval, has led to situation historically advantaged city schools are still much better off financially than rural and township schools, particularly when the quality of inherited infrastructure is taken into account (Hurst, 2016).

Prior to 2009, most pupils learning in their home language in Grade 1-3 did not study English, although by Grade 4 they were expected to cope with it as the medium of Instruction (Department of Basic Education, 2010, p. 20). Since 2009, schools teach English from Grade 1. In wealthier suburbs and urban centres, the medium of instruction is predominantly English, with a smaller proportion of Afrikaans medium schools in Afrikaans-dominant areas, while schools in predominantly African language suburbs and rural areas may opt for an African LoLT in the foundation phase (Gr1-3) (Hurst, 2016). Subsequently, learners' exposure and geographical location has become one of the determining factors to learner's level of English proficiency and ease of access to University. For instance, you can find a teacher using isiZulu to explain scientific concepts to learners while the official medium of instruction English, is used for assessing learners and this is described as dual medium of instruction (Department of Basic Education, 2010). Recently the language issue in South Africa has made headlines where students are calling for inclusive education in respective mother tongues even at higher institutions.

2.4.2 Schooling landscape

The Schools in South Africa are categorised into Private schools (independent schools) and public government funded schools (Osman, 2015). Another schooling category is a high fee paying public school called an ‘ex-Model C’ school. This categorisation has led to a situation where learners are free to choose the schools they would like to attend. Pienaar and McKay (2014) assert that the current government adopted the funding policy from the historical apartheid legacy which resulted to historically black schools continuously being underfunded and under resourced. While white schools located in former white areas are able to levy much higher fees from the residential neighbourhood.

Schools have to give priority to learners from their feeder area or catchment area, therefore cannot refuse access to learners who live in the immediate area of the catchment area of the school (Hurst, 2016). The result to this present-day reality is that learners are taught in a language that they do not use at home (Hurst, 2016). English in this regard is as much a foreign language to the users other of the 10 official languages. However, in some cases the choice of school is limited to the area of residence which forms the school feeder area (Hurst, 2016; OECD, 2010).

2.5 Significance of the study

Most of the language in science research conducted in South Africa, have pointed difficulty to English language proficiency as a major contributor to student difficulties in science. However, Oyoo (2007) argues that the prominent issue that is overlooked is the nature and structure of the science register that forms classroom science talk. The studies conducted in Africa by (Oyoo, 2007, 2012, 2004) have suggested that familiarity and contextual proficiency of everyday used non-technical terms bearing a different science context meaning seems to be the major difficulty in science classroom discourses. Other contributors could be the teachers’ approaches, which are largely influenced by curriculum layout and beliefs about science as a discourse. Thus, this study sought to investigate the South African students’ preparedness in the language of science learning at University with specific focus on their familiarity with non-technical terms scientific context meaning. This study was drawing from the findings in studies conducted in South Africa on the difficulties that learners encountered. These difficulties can be related to the international studies first conducted by (Gardner, 1972, 1976).

2.6 Chapter Summary

This study advanced on studies with school learners to University students to detect whether students are experiencing any challenges, difficulty, and familiarity issues with non-technical terms' science context meaning. The historical language background and the schooling landscape has been examined and related to the current trends in South African Schooling system. Literature reveals that South Africa's apartheid legacy and current Language policy are the main factors to inequality in students' school preparedness. The conceptual framework was linked to the theoretical framework which highlighted that each discipline or subjects in schools should notice the barrier of communication between the learner and teacher, since the subject knowledge is communicated in symbols or words that make up the language where the meaning of the different concepts are defined and embedded in Postman and Weingartner (1971, p. 102) cited in (Oyoo, 2012, p. 854).

The literature reviewed as the foundation of the study revealed that learners' difficulty in science classroom interactions rests within the science contextual nature of the language used to teach science. Language in Science Education research (Oyoo, 2007, 2011, 2012, 2016, in press; Oyoo & Semeon, 2015), point out that non-technical terms that are highly frequent in science classroom instruction and that by far the prominent source to learners' difficulty in science .

In the next chapter the conceptual framework and the aim of the study was linked to inform the research design and the methodology during the analysis of questionnaires. The methods and approaches used to identify the words which emerged as problematic to students are also discussed further in Chapter 3 and later interpreted in Chapter 4.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.0 Introduction

This study investigated the language difficulties, familiarity, contextual understanding and meanings of everyday used words in science contexts by B.Ed. second year University students'. The focus is to identify the possible challenges that South African students are experiencing with language in learning science as a subject and as a possible indicator to their school preparedness for University Science studying. This chapter offers the methodological aspects, data collection approaches, the research design and actual data collection process that took place at the University of the Witwatersrand with second year students in the School of Education.

3.1 Research Approach and Design

According to Opie (2004, p. 16) methodology refers to the theory of getting knowledge while considering the best ways, methods or procedures by which data that will provide the evidence basis for the construction of knowledge about whatever it is being researched. Educational research involves the study of people, their social settings, and multiple perspectives and interpretations are almost inevitable (Opie, 2004). There are many types of research methods which are employed in research and these include: experimental, case studies, survey research, action research, evaluation research and document analysis research. The overall approach of this study is a case study. A case study is defined as an in-depth study of interactions of a single instance in a closed system (Opie, 2004, p. 74). Cohen, Manion, and Morrison (2011, p. 289) argue that a case study provides a unique example of real people in real situations, enabling readers to understand ideas more clearly than simply representing them with abstract theories or principles. It has the power to blend numerical and Qualitative data thus, this Qualitative in-depth study into the University of the Witwatersrand students' is a focus on their difficulty with non-technical terms' science context meanings, familiarity and usage. A case study was therefore the preferred choice for this study since case studies have the ability to recognize and accept that there are many variables operating in a single case and therefore capture the implications of these variables. This usually requires more than one tool for data collection and many resources (Cohen et al., 2011).

To blend the two features in this study a mixed method approach was used , since it can enrich a single study by involving both Quantitative and Qualitative paradigm characteristics (Cohen et al., 2011). The purpose of most Qualitative research is to: increase knowledge of people or situations that are not usually studied and to provide information that can be used for social change. On the other hand, Quantitative research is a process that is systematic and objective in its ways of using numerical data from only a sample of a population to generalise the findings to the population that is being studied.

3.2 Research Method and data source

There are many different ways of collecting data which can be employed in educational research which include: questionnaire, interview, observation, documents and audio-visual materials (Creswell, 2008). Most Qualitative in-depth research such as case studies depend on the use of multi-method strategies to collect data. In attempt to answer the research questions of this study on University students Language and preparedness; while focusing on students' science language contextual backgrounds and non-technical terms' science context meanings and familiarity, a questionnaire was used as the main method of data collection followed by an interview which uses an interview schedule to capture the questions to be used during the interview. Through a questionnaire, information is obtained from the participants' written responses to a list of questions. These data sources are now discussed in detail.

3.2.1 Questionnaire

A questionnaire is favourable because of its objectivity and potential to solicit a lot of information from respondents. A self-administered type questionnaire is the most reliable method for collecting such data, also the participants have control. For instance they can fill out the questionnaire at their convenience and can answer the items in any order (Borg & Gall, 2007) as cited in (Cohen et al., 2011). Once the questionnaire has been distributed, it's impossible to modify the items on them.

McMillan and Schumacher (2010) highlights the economic advantage of using questionnaires in research since questionnaires in large studies are efficient for all the participants and the same questions are used and that it may ensure anonymity. Questionnaires cannot probe deeply into the participants' inner experience, attitudes and beliefs. The respondents could interpret these words differently in their own contexts, thereby rendering the data ambiguous. The main problem of questionnaire is that different respondents interpret the same words differently (Cohen et al., 2011). So, the options selected will be an indicator to their science language preparedness and familiarity with non-technical terms used in a science context.

A questionnaire may consist of either open-ended questions or closed-ended questions. Open-ended questions are those which are questions to which the participants respond freely without being restricted to a choice from given alternatives. Closed-ended questions are those to which participants are provided with various alternative responses to choose from (Cohen et al., 2011).

This study used an adopted questionnaire from Oyoo (2004) which consists of 30 questions. Each question has a non-technical term and underlined in the sentence with four possible answers arranged from A, B, C and D to which participants were provided with various alternative responses to choose from (Multiple choice). All of the options in the questionnaire are possible answers, they are all correct for that term but only one is correct for that science context in which they are asked. Each question was intended to find students' ideas about some everyday used words in school science classrooms and textbooks. These non-technical terms such as *sensitive; trace; contract; spontaneous; retard* and *convention* were the focus words underlined in the questionnaire as reproduced below for the two words 'sensitive' and 'spontaneous'.

The beam balance is a very sensitive instrument. This means that it

A. can be used to weigh very small things
B. can be used only by sensible people
C. is hard to understand how it works
D. gets spoilt very easily

The two chemicals seemed to combine in a spontaneous reaction. This means the reaction

A. was very quick
B. happened by itself
C. once started increased vigorously
D. was explosive

Multiple choice items are prone to problems of word order and statement order (Cohen et al., 2011). Hence, the students were asked to read through all the options and to circle the correct meaning of the underlined non-technical term. The questionnaire also provided a section for each participant to fill in their gender, home language and language spoken at school, since this information was important to elaborate on the students' language and demographical background.

Another important section at the end of the questionnaire was included to reconfirm students consent to be interviewed by indicating with a tick in the appropriate box if they were willing to participate in small group discussions of the meanings of the underlined words in the questionnaire.

3.2.2 Interview

Since the questionnaire discussed in section 3.2.1 doesn't allow for any elaboration and exploring findings in detail, in short providing an answer to the 'why' behind it (Opie, 2004, p. 111), a need for a face-to face interviews became necessary to enable participants to discuss their interpretations of the meanings of the everyday words presented in the science context. Creswell (2008) defines an interview as the interaction between a researcher and one or more participants. These interactions can be in a form of open ended questions where the researcher records their answers and later transcribes and types the data into a computer file for analysis. The use of the interview in research marks a move away from seeing human subjects as simply manipulable and data as somehow external to individuals, and towards knowledge as generated between human, often through conversations (Kvale, 1996, p. 11) cited in (Cohen et al., 2011).

There are three basic types of interviews in Qualitative research and these incudes: structured interviews which impose on a situation and any results which are often used to try and make generalisations, they involve a series of closed-form questions and leads to ease of data analysis and the style of questioning is similar to those of a questionnaire which can lead to bias free research. The other type of interviews is the Unstructured interview which presupposes nothing about the direction of the interview or what will be learned, this approach involves the interviewer asking questions which gradually leads to the participants giving out the desired information (Opie, 2004). Lincoln and Guba (1985, p. 269) cited in (Cohen et al., 2011) suggest that the structured interview is useful when the researcher is aware of what he does not know and therefore is in a position to frame questions that will supply the knowledge required, whereas the unstructured interview is useful when the researcher is not aware of what he does not know, and therefore relies on the respondents to tell him.

In this study, a Semi-structured interview was preferred due to its flexibility as compared to a structured interview. Since a semi-structured interview allows for in-depth of feelings to be ascertained by providing opportunities to probe and expand the interviewee's responses (Cohen et al., 2011). An audio-video recorder was used to capture all the events during the interview; the use of a recorder was to help to clarify some points during the transcription.

This semi-structured interview method involved asking a series of structured questions and then probing more deeply with open-form questions to access further information.

Interview schedule

Interview schedules are commonly used for data collection in interviews. According to Opie (2004) an interview schedule is a critical element in ensuring that an interview goes well. The interview schedule is the driving tool for the interview since the research questions were on students' familiarity with non-technical terms.

The purpose of the interview schedule was to highlight questions which would require students to further elaborate on their understanding and choice of their selections made on the questionnaire. These questions would be to give the researcher a sense of the participants' familiarity, prior encounters with non-technical terms science context meanings.

The interview schedule was prepared on the bases of the responses which were challenging to the participants while completing the questionnaire. The main advantage to prior preparation of the schedule is that it offered the participant students latitude to choose the most problematic words they encountered upon completing the questionnaire. The interview schedule consisted of these example questions:

(1) Can you guide our meanings on the word spontaneous?

(2) Have you met this word anywhere before?

(3) Have you ever met this word in your class before?

(4) Give us your experience of the word spontaneous.

(5) *Do you hardly use the word?*

(6) Now, we have gone through all these. Suppose teachers were not teaching about the words, what can you say about that?

These questions were to ask students about their familiarity with non-technical terms and their prior (context) encounters with such words. A semi-structured interview with these questions was instrumental since it allowed participant students to explain why they chose certain meanings of non-technical words in the questionnaire. Such open-ended questions are advantageous since they offer the researcher flexibility to probe deeper or to clear up any misunderstandings while encouraging participants to cooperate and help establish a good rapport (Cohen et al., 2011). The particular open-ended questions in the above situations can also result in unexpected or unanticipated answers which may suggest hitherto unthought-of relationships or hypotheses.

The interview schedule consisting of a mixture of questions all related to the students' contextual familiarity, background, prior use of non-technical terms as a direct implication to their science language preparedness. The researcher further probed deeper into students' high school science and University science learning. In that process students could relate these terms to their everyday used meanings while justifying their information sources namely their other subjects, e.g. life sciences and evolutionary courses at University. With such questions, the interviewer could test the limits of the respondent's knowledge while allowing the interviewer to make a truer assessment of what the respondent really believes.

3.3 Population and Sample

3.3.1 Context of the study and sampling

Students' backgrounds

Higher Education institutions in South Africa are dominantly English; as a result of the colonial history of the country and its education system, a legacy which is exaggerated by the current dominance of English in Higher education worldwide (Hurst, 2016). In South African, English acts a gatekeeper for many South African English Universities where educational programmes and instruction is predominantly offered in English.

The schooling certificate (National Senior Certificate), can only be endorsed once a Grade 12 learner has passed English (Department of Education, 2009). This is ironic, since a majority of the country, doesn't speak English. Not all the South African learners sitting the end of year NSC examination have equal access to English in their various schools. This major factor, leads to situations where many potential students are unable to register at University due to their limited access to English.

Looking at the country's most spoken language demographics; only 24% of South Africans speak isiZulu as their primary language, 17.64% of South Africans speak isiXhosa as their primary language, while only 8% of South Africans speak English (Census 2001 by province and language, 2001). In other words, 92% of South Africans do not speak English as their mother tongue or first language. It is surprising, that the majority of one's education (throughout school, and in tertiary education) is spent learning in English, an additional or a non-mother tongue language.

This study was conducted at the University of the Witwatersrand which holds a reputation for enrolling top achieving learners in the country. According to the Wits statistics study done on first year students in 2016, it revealed that the demographics of students which make up the student population is mostly African. It also revealed that most of the students attending at the University are from schools which were ranked as highly resourced schools, the major first year group of students enrolled are mostly from Gauteng. 62.75 % indicated that their average class size ranged between an average of 20 -50 learners per class. From head counts 14.59 % students indicated that they came from schools where the average number of learners was above 80 in a class. This raises the question on one of the factors to poor student performance to whether the disconnect between pedagogies used to teach smaller high school classes versus large lecture class at a University like Wits (University of the Witwatersrand, 2016).

The University of the Witwatersrand which is based in Gauteng, Johannesburg metropolitan, forms the broader context of this case study. The University of the Witwatersrand is ranked as one of the best Universities in South Africa with a reputation for enrolling the best of the best students in the country. The recent University of the Witwatersrand (2016) analysis of student population indicated that 50.45 % of the students enrolled at Wits matriculated from highly resourced schools. 64.24 % of students enrolled for first undergraduate programmes at Wits come from schools that can be classified as having sufficient teaching and learning infrastructure and resources and only 33.37% of those enrolled students are students coming from under-resourced and disadvantaged backgrounds.

The university is surrounded by suburbs which host many schools ranging between independent (private) and public schools. From the self-description students gave of the place where their homes are situated and only 19.98 % of students indicated that they come from rural villages, informal settlements or farm environments.79.36 % of students reported that their homes were either located in major cities and towns, suburbs or township environments (University of the Witwatersrand, 2016). Therefore, the majority of students enrolled at Wits 81.25% come from either semi-urban or urban environments.

Table 3.1: Summary of Wits student background demographics

Province	Percentage	School Language	Home Language
Gauteng	63.99%	English	Mixed languages
Kwa-Zulu Natal	9.95%	English/IsiZulu	>IsiZulu > English
Limpopo	9.65%	English	Sepedi/Tshivenda
Mpumalanga	6.10%	English/Afrikaans	SiSwati
International	1.59%	Other	Other
Other 5 provinces	8.75 %	Other	Other

As indicated in Table 3.1, the majority of enrolled students are coming from South African schools where English is the medium of instruction, and had a negligible use of African languages in schools. African languages are often used, but clearly at a very limited rate with the exception of isiZulu (University of the Witwatersrand, 2016). In a large number of schools, Afrikaans was used as an alternative language to English, especially in Mpumalanga, Free State, North West and Northern Cape. Clarity is made here between High School language and post High School language (University). Since all of the participants' students are enrolled at an English medium University, their school language (lecture) changed to English.

In schools that used Afrikaans and other languages as official media of instruction, 55.96 % of students indicated that they were not taught in their home language, and only 43.79 % of respondents were taught in the official medium of instruction, English was often used as an alternative means of communication in class. In this case study which particularly focuses on students enrolled at the University of the Witwatersrand, the participants are drawn from this population of students and formed a sample of 47 second year Science Education students.

3.3.2 Sample Details

According to McMillan and Schumacher (2010), the number of participants or sample size plays a pivotal role in conducting and evaluating any research**.** Generally, it is safe to have as many participants as possible to enhance credibility of the results. From the population, only 47 participant students formed the sample and completed the questionnaire in the study. 80% of the sample was female and 20 % male. 90 % of the sample was black students and the other 10% is mixed consisting of white, coloured and Indian students.

Out of the 47 participants only 14 students indicated that they were not interested in a follow up interview discussion. The rest of the sample students indicated their interest in the study, but only 10 students responded to the email invitation sent to participate in the interview. The 10 students who participated in the interview were mostly females, and one black male participant. Out of the 9 females, only two participants were not black; they were Indian and coloured respectively.

The 10 participant students were mostly IsiZulu home language speakers. 6 females indicated that their home language is IsiZulu and out of the 6 only 4 indicated that their High school language was English, the other two had IsiZulu as their high school language. The two females (Coloured and Indian) were the only exception to report that their high school and home language was English. One black female participant indicated that her High school language was English but her home language was IsiXhosa. The male participant indicated that his home language and High school language was the same (English).

From the sample background discussed in section 3.3.1 the majority of students' were African, which suggests that the context as highlighted in section 3.3.1, support the context that forms the sample of the study. It is of note that the majority of students enrolled at the University of the Witwatersrand are predominantly English second language speakers.

3.4 Actual Data Collection

3.4.1 Gaining Access

It is worth mentioning that in educational research, the question of ethical considerations cannot be ignored because the data is sought from engaging human beings whose rights should be respected at all times. Research comes into the lives of people who are the focus in various ways, taking up their time, involving them in activities they wouldn't otherwise have been involved in, providing researcher with privileged knowledge about them and therefore, potentially, power over them (Opie, 2004, p. 25). This case study is part of a larger project run by the supervisor in this study as the chief investigator. The ethics approval of the project and by extension, permission to conduct the study had been applied for and granted by Wits School of Education's Human Research Ethics Committee and assigned the Protocol No: 2010ECE182C.

While invitation to participate was made on my behalf by the supervisor in this study at one of his lecture sessions with the second year students, an invitation email was sent to the 47 potential participant students' informing them about the study, dates, time and venue. It was explained on the email that a questionnaire would be completed first and thereafter, their selected choices would be discussed on an audio-video recorder to identify their familiarity, past experience and their reasons for the selected options. The students received a letter of consent to read through, with a detailed explanation of the study as assurance of the validity and reliability of the questionnaire. Students gave consent to voluntarily participation, to ensure that the researcher keeps their scores safe and to ensure participants anonymity.

Most importantly, a section on the questionnaire was provided where participants indicated their wish to continue with a follow up interview. While the participants were completing the questionnaire, two audio-video recorders were set up from two angles. The researcher felt the need to use two audio-video recorders to ensure that at least one of them would record in the event of unforeseen technical fault developed with any one recorder during the recording process.

The microphone and lecture venue technical specifications were tested to reduce reverbs and attain good sound quality. The interview schedules were prepared in front while patiently waiting for students to complete the questionnaire.

The questionnaire and interview were conducted on the same day only minutes after one another. Since we only had an hour for the session, the researcher decided not to mark the questionnaire first, but to complete the follow up semi-structured group interview on the same hour by inviting participants to identify the words that were a challenge to them.

3.4.2 Questionnaire implementation

A questionnaire will always be an intrusion into the life of the respondent, be it in terms of time taken to complete the instrument, the level of threat or sensitivity of the questions, or the possible invasion of privacy. The respondents cannot be pressured into completing a questionnaire. They might be strongly encouraged, but the decision whether to become involved and when to withdraw from the research is entirely theirs (Cohen et al., 2011). In doing so, participant students were welcomed and thanked verbally by the researcher for their willingness to take part in the study which was evident in their arrival.

Students were handed a questionnaire, each participant was reminded to fill in their information, language spoken at school and at home as well as gender. The researcher assured all participant learners of confidentiality and anonymity of their identities and that the data collected was solely for the study. They were encouraged to read each question carefully and to think about the meaning of the underlined word and lastly to answer all the questions. Each participant student was encouraged to take their time to read each item carefully and think about the meaning of the underlined word before choosing their answers.

The participant students were asked to put a circle round the letter (A, B, C or D) next to the sentence or phrase that they thought represented the nearest meaning of the underlined word. The researcher stressed that in the questionnaire all the options are correct, only indicate their choice by putting a circle on the letter of their choice (A, B, C or D) which they felt represented the nearest meaning of the underlined word on the questionnaire. The questionnaires were completed in 15-16 minutes. The questionnaires were not marked since it was all conducted on the same day.

3.4.3 The interview with the participant students

Actual Interview

Firstly, the interview had to be conducted in English for fairness to the other participants who were English first language, even though the majority of students were predominantly second language speakers. Secondly, the adopted questionnaire is structured in English with English non-technical terms as the focus of the context.

The participants were reminded that since the questionnaire used was not a test, there was no need for them to worry about their answers being wrong or right and that their answers would be kept confidential and anonymous. However, their selected choices were being discussed further to identify their familiarity, past experiences and their reasons for the selected options. Also, that they were to be and audio-video recorded. The researcher used group interview instead of individual interviews as a time saving strategy, and where students would feel more comfortable to participate.

A group interview is another form of interview that creates an atmosphere for discussions to develop. This yields a wide range of responses which enables participants to challenge each other and extend each other's ideas. However, group interviews do not allow personal matters to emerge and sometimes you have only a few individual participants dominating the discussions at the expense of others (Watts & Ebbutt cited in Cohen et al., 2011).

The information that comes from this interview can help in understanding issues relevant to the aims and objectives of the study while also answering the research questions. Semi-structured interviews with an interview schedule as its instrument, supplement data that have been collected by other methods such as questionnaires (Cohen et al., 2011).

The students were asked to sit closer to the two audio-video recorders which was placed on the in front of the interview venue. This was meant to capture all audio and video footage of whatever was being said during the interview.

The researcher allowed participants the opportunity to identify the non-technical words whose meanings they thought they had misunderstood or challenging in the questionnaire. These words were discussed during the interview with use of guiding questions as indicated in section 3.2.2 on the interview schedule to bring out students' contextual familiarity with the non-technical terms. The words which were identified as problematic to most participant students were: *sensitive; trace; contract; spontaneous; retard* and *convention*.

Coincidentally, these same words emerged in earlier studies as difficult, also when the questionnaires were later marked. During the interview, the researcher was able to ask a series of structured questions and probe the learners with open-ended questions to obtain additional information from the learners (Borg, Gall, & Gall, 2007). The group interviews with students were meant to help establish whether the choice of the answer was made due to familiarity with the scientific concepts, contextual proficiency or maybe misunderstanding of the meaning of the words used in science context as an indicator to their school science language preparedness.

As the interview progressed, the researcher would ask (probe) students' contribution on the option selected, e.g. by asking by a show of hands how many participants selected that particular option. After a show of hands, students would be asked randomly to contribute on their experiences and encounters with the words. The intended interest was to draw out their reasons for their selections and to try and access their past science background in terms of their contextual proficiency. It was anticipated that their lived experiences would inevitably influence their selections on the questionnaire. This process allowed students to reflect on their experiences and to assess or evaluate their own responses and understandings as they shared during the interview. In some instances, these group engagements would trigger some overlooked factors or some awareness of their surroundings.

The whole process went slightly above an hour, since participants were showing more interest into the whole interview. Due to time, we could only discuss those few words which participants identified as challenging words. Students were engaged and free in giving their honest views on the matters. The process went so well that singular participants had a chance to respond, critique and reflect on all the questions outlined in the interview schedule, including any other probing questions asked then.

At the end participant students were thanked verbally by the researcher and welcomed into the project for future studying and investigation on science language. Students were informed that they would be contacted in future to share the results of this study. And lastly the questionnaires were collected as students walked out of the venue. This marked the end of the data collection phase. Both Quantitative and Qualitative data had been accessed.

3.5 Data Analysis

3.5.1 Analysis Approach to Questionnaire Data

Data analysis approach is used in research to syndicate data for further interpretation. The questionnaires administered to students consisted of 30 non-technical terms with options ranging from A, B, C and D. The questionnaires were spread out on a 1-30 grid per word to code the different options e.g. A-D. Each number e.g. no.1 represented each questionnaire which consisted of 30 words. After the coding process, a new grid was simplified to identify the sample size but most importantly to give a frequency tally per item by counting the amount of times the letter A-D was selected per word.

To make the numerical data more manageable, an Excel spread sheet proved to be useful to organise the data in one table as percentages. Excel spreadsheets made the process much easier to manage and to descriptively analyse the data from different point of focus.

During the first scoring attempts, a separate list was populated to identify the options that were most frequently selected, the options that students scratched out to select another in its place, and the words which had two or more options selected were also identified as N/A in the new scoring grid. The selection criterion of 70 % was applied in the analysis of the questionnaire data presented in a table as a percentage. The most correctly answered word based on the answer expected was also considered and interpreted as words that represent less difficulty.

This descriptive analysis method allowed the researcher to describe the data in terms of percentages of students' who knew the meaning of the non-technical word, to make descriptive comparisons of the words whose meanings were found to be problematic to participants. It allowed data to be presented in a form of a table with the most difficult words. The findings from data sources were discussed and further analysed using the literature review and the conceptual framework.

3.6 Analysis Approach to Interview Data

A semi-structured interview approach was favoured for this study to allow for deeper interpretation to students' contextual familiarity and understanding of non-technical terms' science context meanings. The interview data were transcribed into a verbatim transcription to capture all the events of the interview. The verbatim transcription was analysed to establish whether participant students had met any of the words before from lectures, high school career, social background and any other experiences of the words. The answers provided gave an indication to the participants' contextual familiarity and understanding of non-technical terms' science context meanings to help answer the research questions. Interpretative analyses were done against the conceptual framework.

3.7 Chapter Summary

In this chapter, the research design and the methodology of the study was presented and justified including the advantages of the data collection methods used in the study. Further the chapter explained the instrument used to collect data. The Witwatersrand context where the sample is drawn from was fully described in terms of home language and school language demographics.

The actual data collection process was explained with a detailed step by step account of the implementation of the questionnaire and the strategy used to codify the questionnaires in the data collection process. The ethical procedures followed in gaining access to the research site and participants in this study have also been explained. The next chapter deals with analysis of data collected in this study where the problematic words are tabled per option selected and discussed further.

CHAPTER 4: DATA ANALYSIS AND FINDINGS

4.0 Introduction

In this chapter, findings from the data sources are analysed for meaning, discussed, interpreted and interrelated with literature reviewed as well as the conceptual framework of this study. The focus of this study was on the difficulty that B.Ed. second Year students at a South African University are experiencing with non-technical terms' science context meaning. The following were the research questions:

- Are there any indicators in the students' selection of items that indicates language difficulty with non-technical terms science context meanings?
- What are the explanations or reasons for the difficulties that students encountered with non-technical terms?

This chapter begin with an analysis of all the data obtained from the questionnaires which were codified into a grid with the percentage correct and incorrect answers identified and compounded into a table. This was to provide a holistic view of the words that appeared to be problematic to B.Ed. second year Science Education students. The words which students identified as problematic in the semi structured interviewed are discussed. The results from the group interview conducted with students on their choice of selection and meaning of certain words will also be presented and further analysed as an indicator to their school preparedness towards the end of the chapter.

4.1 Data Analysis Strategy

In this section, the questionnaire analysis strategy is first presented then followed by the Interview analysis strategy and lastly the selection criterion applied during the questionnaires analysis process to identify any difficult with non-technical terms.

Questionnaire Analysis Strategy

The analysis strategy followed to obtain data from the questionnaires focused on the options selected to identify any difficulty based on the following areas:

- The confusing combinations chosen by students
- The option least selected per item
- The option mostly selected per item

The questionnaires were analysed using a frequency tally method. The options e.g. A-D selected for individual items were coded on a tally grid. The options selected were then analysed against the correct answer for the context in which the term was tested in the questionnaire. A frequency tally per item was made after all the questionnaires were coded and presented as percentages by counting the number of times the letter A-D was selected per word (see appendix 3). The difficulty criterion was then applied on the percentage correct responses. The options which had a scoring of less than 70 % were considered difficult to students'. This approach was to identify any patterns or trends in students' selections which were interpreted as the difficult words. Scratched out options, unanswered question were coded as N/A, therefore considered difficult to participants. The items identified as difficult were then populated on a separate presented as Table 4.1 later, for further interpretation against the conceptual framework.

Interview Analysis strategy

The interview was transcribed into a verbatim transcription (see appendix 4) to capture all the events of the interview. The questions that were outlined in the interview schedule guided the interpretation during the analysis of the verbatim transcription. The aim was to establish whether participant students had met any of the words before from lectures, high school career, social background and any other experiences of the words. The options selected provided some indication as to where the difficulties encountered stemmed from. Interpretation was made against the conceptual framework which focussed on the answers that students provided an indication to their science language difficulties, contextual familiarity and understanding of non-technical terms' science context meanings. The difficulty could be traced back to the science classroom language usage, the indigenous local languages used in school and at home, the general use of English at home or in their respective social circles, familiarity with non-technical terms, understanding the meaning of everyday used English words science context meaning. Therefore, it was best to present and discuss the questionnaire findings and the interview findings together for each word in section 4.2.

4.1.1 Selection Criterion

This study focuses on B.Ed. second year University students. The researcher therefore felt that the selection criterion for identifying the difficult words should be based on the Admission Point Score (APS) scoring level for entry in South African Universities.

According to APS scoring system, 70 % is considered a distinction. The selection criterion for difficulty was 70 % and below. Due to the academic level of participants in the study, the selection criterion for the level of difficulty was applied on the lowest scored items on the questionnaire. This implied that all options below 70 % are considered difficult according to this criterion. Further, this criterion was applied to the individual options per item scored on the grid for each and every non-technical term. This data was distributed and populated in ascending order in a new table. The questionnaires were not marked due to participants' availability and time allocated in the data collection process.

4.2 Questionnaire findings

Questionnaires collected in this study amounted to 47. The individual options are summarised as percentages correctly scored and incorrectly scored options (see appendix 3). All the words and their individual options were carefully examined to identify the words which emerged as difficult to participants. Upon applying the selection criterion, the researcher identified seven words (in Table 4.1) selected from the summary of findings table (see appendix 3) that had the lowest overall percentage scored options. Coincidently the words that emerged as difficult in the questionnaire analysis were the same words that participant students identified as difficult in the interview.

Table 4.1: Table of the most difficult words

No	Word	PERCENTAGE CORRECT
9	Trace	49
7	Sensitive	62
19	Retard	66
4	Prepare	66
29	Disintegrate	66
14	Spontaneous	68
26	Evacuate	70

The focus during the questionnaire analysis was on the options scored per item alongside the expected context answer in the context of the question tested. Figure 4.1 was drawn with focus on only the words with high percentage incorrectly scored options. These words' every day and science context meanings are discussed, the frequent options that students selected were analysed in detail to identify the possible source of difficulty. The options that were scratched out to select another in its place, the words which had two or more selected option were also considered as difficult to students.

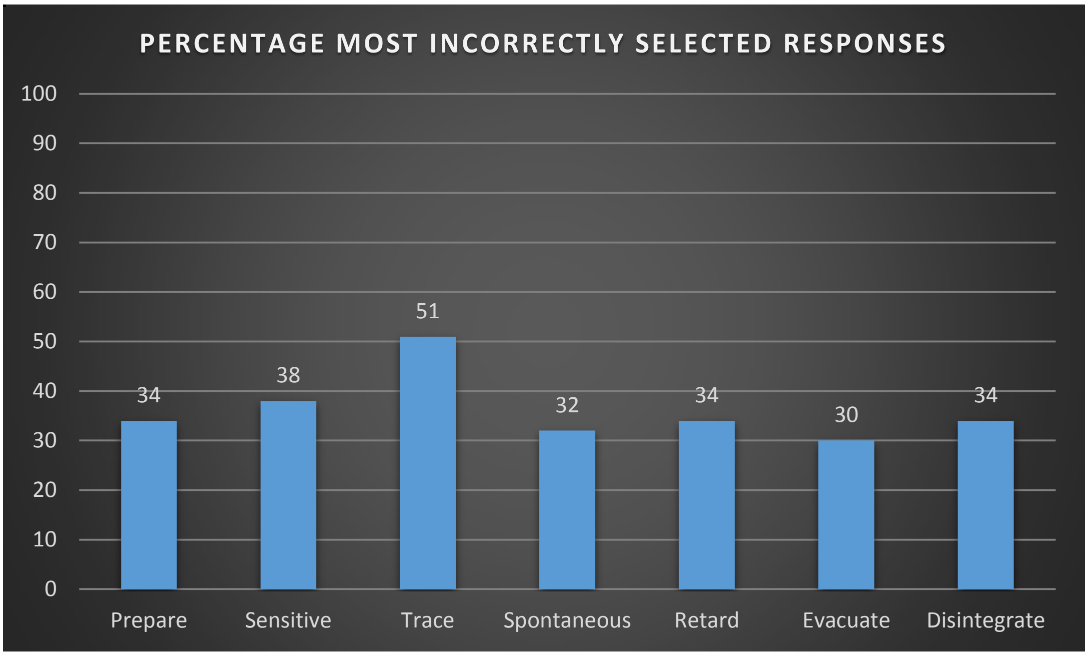

Fig. 4.1: Percentage incorrect responses

4.2.1 Most difficult words from the questionnaires

The most difficult words as per selection criterion outlined above in 4.2 were identified and presented in Table 4.1 with lowest percentage correct scores arranged in an ascending order. The seven words have been identified as the most difficult to the participants and the percentages are also graphically represented in Figure 4.1. Out of the list the term 'trace' had the lowest score of 49 % followed by the term 'sensitive' which had exactly 62 %. This suggests that the majority of the sample experienced some difficulty with these terms' science context meanings.

These seven words extracted from the questionnaire were discussed and interpreted further to find the sources of difficulty in the way the participants selected the different options. This process provided deeper insight into students' understanding of non-technical terms, and their use in their perceived scientific contexts. Out of the seven words which emerged as difficult in the questionnaire five of those words happened to be the same words that students identified and discussed in the interview. Presented next is the discussion of the difficult words from questionnaire findings together with interview comments.

4.2.2 Discussion and Interpretation of the difficult Questionnaire and Interview items

The background and meanings of non-technical terms which have been identified as the difficult words to students are now discussed and interpreted further. The discussion will start with the data from the questionnaire then followed by the students meaning of the words from the interview data. The first non-technical term which emerged as the most difficult in the questionnaire findings was ‘trace’.

TRACE

The Questionnaire context in which the term was tested in the questionnaire is given below:

The soil contained a trace of potassium. This means it

A. used to have some potassium
B. had plants which use potassium
C. had a very small amount of potassium
D. had a large amount of potassium

Table 4.2: A summary of how the options for trace were relatively selected

Word	Answer	A	B	C	D	N/A
Trace	C	22	2	23	0	0
Percentage	49 %	47%	4%	49%	0%	0%

Evidently 22 participants selected Option A (47%) which refers to the everyday meaning of the term; referring to:’ *to a visible mark, evidence or an indication of the former presence or simply the existence of something’* (South African Oxford Secondary School Dictionary, 2006, p. 666), two participants (4 %) selected option B to suggest that 26 participants (51%) struggled with this word.

The term ‘trace’ in this context is explaining a special case; referring to small reasons or these special properties in a science context. In everyday talk this term is used when referring to example tracing a stencil image onto a piece of paper for evidence or to make a traceable visible mark. According to (The Reader’s Digest Oxford Complete Wordfinder, 1990) the everyday meaning of trace refers to a visible mark, evidence or an indication of the former presence or simply the existence of something. From this everyday meaning and science context meaning it is almost inseparable, which increases difficulty if there is lowered exposure or familiarity with the English language.

49 % of the sample selected option C which was the expected answer for the context it was examined in the questionnaire, since it is suggesting a small amount present in the soil. 0 % of the sample selected option D which suggest the antonymous meaning ‘*abundance’* of the context it is presented in. In research investigations, this refers to a tiny, scarcely detectable amount or characteristics of the substance. In chemistry, it refers to the components of a chemical compound or an element present in quantities less than a standard limit e.g. in (Kelder, 2007, p. 80) *‘In this unit we will trace the reasons for these special properties’.* For

any person to know when to use *track* or *trace* would require more exposure not only in science but also in the English language; English being the language that is embedded in the science language and culture for concept development. Strevens (1980) defines such non-science specific words as logico-grammatical items, as one of the sources of difficulty in English which in turn results to lowered proficiency and comprehension in science.

Comments from the Interview results:

In the Interview comments, most of the interview participants' choices were between option A and C. Participant (P6) related the meaning of trace to the adjective use of 'trace substances' which means tiny amount of substances. She shared her reasoning between option A and C, where option A was inadequate to the term 'trace' context meaning that the substance is no longer there. She used a process of elimination while focusing on the scientific context meaning of trace. Participant (P6) started the discussion by explaining her choice of selection:

P6 – why I chose 'C' is the reason that I saw that 'A', it means it used to have some potassium, not quite. I was not satisfied by the answer and then I moved right along to 'B', yea had some residue, No, I just thought about trace meaning a description. It can describe as an adjective something like that so I just chose (small amount) 'C'.

Participant (P1) selected option A, her understanding of the word 'trace' was based on trace being used as a noun, which refers to the evidence of something. She further elaborated on the other options by arguing that exact quantities where not specified so she couldn't choose the other options.

P1 – I chose 'A' because I, the word trace in my understanding means the evidence of. So, they did not tell us how much evidence was there, so I cannot say large or small, but then I can say some amount was there. It used to be there, have I said 'A'.

This is a clear display of the complexity of the English language that the non-technical terms are embedded in. She understands trace as a noun and not its adjective and verb meaning. Participant (P4) has come across, used or heard the word before at school but not in the science context. She knows trace when used as a verb, her understanding could be from trace's everyday meaning to draw over a picture to copy it into a new smaller piece of paper is made or that contains potassium.

P4 – I do have something to say. For me trace, where we say something has potassium, we are assuming something small, so it's a trace.

R – Do you hardly used the word?

P4 – Hmmm, I have in school, trace of something, yea in school. I think I know what a trace is, a trace of something means, but then I never met the word trace in science.

Science context meaning of trace seems absent here even though she chose the correct option C.

Participant (P5) selected option A (used to be there) where he related trace to its everyday noun which means the evidence of or a visible mark.

P5 – I chose 'A ', I thought of if I can make an example, if I want to trace if someone broke into my yard. I can only trace that person using footsteps which is 'A'.

His interesting example is from the everyday used talk to relate to 'track' where trace is used as a verb for example to trace is to track down a criminal (South African Oxford Secondary School Dictionary, 2006). The term *'trace'* is often confused with the term *'track'* since they are phonetically similar Gardner (1972) and 'sound alike' (Cassels & Johnstone 1985, p. 14).

Participant (P2) selected option C which he related to the trace being used as a noun.

P2 – I chose 'C'. I think it was at school or on Television. I know that it means a small amount. Trace evidence of something, I have heard it before I can't pin point whether it was at school or a programme, but I know that trace refers to a small amount of something.

Participant (P1) gave an interesting account of how she related to the word. Her reasoning was informed by the use of the word in life sciences. She clearly showed how her familiarity with apparently the word in life sciences and not in physical sciences helped her to correct option C.

P1 – When we were doing evolution, we talked about trace of evolutionary changes and whatever so, I can't say that there is a big change or a small change from us to apes. We look for the trace of or the traces, so the apes had this skull and we have this, so we look at the features, the trace of evolutionary development of how we move from apes to us.

In her reasoning, she focused on change and how she could trace development (evidence of) in evolution. The degree of change was her motivating factor to associating amount to trace.

SENSITIVE

The Questionnaire context in which the term was tested in the questionnaire is given below:

The beam balance is a very sensitive instrument. This means that it

A. can be used to weigh very small things
B. can be used only by sensible people
C. is hard to understand how it works
D. gets spoilt very easily

Table 4.3: A summary of how the options for sensitive were relatively selected

Word	Answer	A	B	C	D	N/A
Sensitive	A	29	1	2	15	0
Percentage	62 %	62%	2%	4%	32%	0%

The most frequently selected options from the sample were A and D. In this questionnaire option D describes the everyday meaning of '*sensitive'* which refers to a quick detection or emotional response to any slight change that may influence or spoil the substance. This option also refers to the external influences that may trigger a permanent change which is irreversible. The participants that selected option D (32%) associated 'sensitive' with spoilt: a verb (used without object), spoiled or spoilt, spoiling, to become bad, or unfit for use, as food or other perishable substances; become tainted or putrid e.g. Milk spoils if not refrigerated (The Reader's Digest Oxford Complete Wordfinder, 1990).

Whereas Option A (62%), the expected answer in this context refers to the use and specifications of an instrument (The Reader's Digest Oxford Complete Wordfinder, 1990). In science, the word explains the vulnerability, instability of the variable brought about by slight external changes. This word may be a characteristic of some substance or equipment that would distinguish it from others e.g. '*the retina consists of light-Sensitive cells called rods and cones'* (Kelder, 2007, p. 70). It may also suggest something weakening factor of the process used to collect some product from a series of notable reactions.

The everyday meaning of '*sensitive'* refers to quick detection or response to any slight changes or influences. An example of its scientific context use is adapted from Kelder (2007, p. 88-89) where it says: *As we grow older, we become less sensitive to high frequencies. The basic frequency or fundamental has a number of overtones, or harmonics.* 48 % of the sample, demonstrated their understanding of 'sensitive' from an emotion point of view, since the term is popularly used in everyday language to describe emotion e.g. *a person being emotional* (South African Oxford Secondary School Dictionary, 2006).

2% of the sample selected option C. On the other hand, its science context meaning is adjectively used to explain specific or peculiar characteristics of a device which associates the term sensitive to the sophisticated nature of the instrument. The students that selected this option may have the impression that a beam balance is a new or sophisticated device to measure substances. It is also possible that students are not familiar with a beam balance since in modern school labs, curriculum, textbook experiments and illustrations an electronic scale is used.

Comments from the Interview results:

In the Interview comments for the term 'sensitive'**,** two participants each selected option A and B and the rest of the participants selected option D. The two participants (P1) and (P6) acknowledged that they were familiar with the word sensitive when associated to emotions. The first participant (P1) meaning of sensitive refers to an emotional person, short temperament. While making her selections, she could easily relate the everyday meaning to fragile objects. Both participants confused option D and option C which could mean that they had difficulty interpreting how things can easily get spoilt therefore it requires specific understand of how it works. Their responses when merged came to this:

> *P1 – Ok, a sensitive person is a person with a short temper or a person with emotional baggage. So, it makes sense that something like glass, we would say glass is sensitive, if it falls it breaks even this one can easily be spoilt as well as 'C'. I thought it can also be correct when you say it is a sensitive something it means it needs a specific understanding or knowledge, it is sensitive to what you think or handle it.*

Participant (P2) chose option A by using a process of elimination. Her motivation for selecting option A had apparently been informed by her understanding or familiarity with a beam balance (weighting objects on a scale).

> *P2 – The reason why I chose 'A" was Uhm…I wasn't sure what to choose here but ended up choosing 'A' coz it is a sensitive instrument, so if you want to measure or weigh out small things, you can use that instrument, that is why. I chose that one, in terms of the second one, it just didn't make sense because you are using a beam balance, it doesn't matter the faculties the person has, should have the person should be able to use it. It has no relation in conflict what sensitive is and uhm…in terms of understanding it inclinates so, I just eliminated the ones and 'A' seemed to make sense to me, so it was a process of elimination to me 'A' made a lot of sense.*

From this reflection, I think she related the term to '*short tempered person'*.

Further she mentions that she was familiar with the word but in the questionnaire context she related the term sensitive to the instrument that can measure small objects instead of the context meaning of sensitive. It seems that she used her familiarity with beam balance to answer the question.

P2 – No, I have seen it in context, they all relate to the word sensitive, based on the sentence and the context that is why I chose 'A'.

SPONTANEOUS

The Questionnaire context in which the term was tested in the questionnaire is given below:

The two chemicals seemed to combine in a <u>*spontaneous*</u> *reaction. This means the reaction*
- *A. was very quick*
- *B. happened by itself*
- *C. once started increased vigorously*
- *D. was explosive*

Table 4.4: A summary of how the options for spontaneous were relatively selected

Word	**Answer**	**A**	**B**	**C**	**D**	**N/A**
Spontaneous	B	11	32	4	0	0
Percentage	68%	23%	68%	9%	0%	0%

'Spontaneous' had confused combinations between item A and C whereby the correct answer B had 68 % answering correctly and in total the incorrect responses tallied to 32 %.

From the analysis, it seems that participants who selected option A (23%) confused 'spontaneous' with the term *rate* of reactivity; possibly because students had been previously exposed to courses in reactivity topics dealing with common reactions that yielded some energy to the surroundings e.g. potassium and water, a very reactive metal that reacts very quickly and explosive reactions. It is possible that participants may have done or observed chemical reactivity in the classroom or in their first year chemistry courses, therefore confusing option A and C.

Participants who selected option C (9%) related the term 'spontaneous' science context meaning to the everyday preferred meaning which refers to something occurring as a result of a sudden inner impulse or inclination without premeditation or external stimulus (The Reader's Digest Oxford Complete Wordfinder, 1990). In science, it actually refers to something occurring without apparent external cause while in chemistry it means that a chemical reaction occurs naturally without any apparent external influences e.g. heat being applied. In life sciences it refers to instinctive, involuntary behaviour or action.

Option D (0%) wasn't selected at all. It's possible that participants are familiar with the difference between explosions. Participants with increased content knowledge could easily distinguish between the meaning of vigorous and explosion.

Comments from the Interview results:

From the Interview analysis, majority of participants opted to discuss spontaneous first. With a quick show of hands, majority of participants selected option A, B and C and none for option D. In the interview students justified their choice of their selections and share their meaning of the word spontaneous.

R - Ok she says we should discuss the word spontaneous. Can you guide us on your meanings on the word spontaneous?

Participant (P1) opened the discussion with her experiences on the word spontaneous. She selected option A (was very quick), based on her experiences where she attested that she had met the word before but never paid close attention to the possibility that it may have a different science context meaning.

R – So we have people selecting 'A' and 'B' only. Have you met the word before, the word spontaneous?

P1 – Yes, but I never paid attention

When she reflected on the motivation for her choice of selection, she showed to have used trial and error or logical reasoning based on her classroom exposure with spontaneous and non-spontaneous reactions.

P1 – I don't know, it just made sense that it means it is fast coz when I looked, it said it happened by itself.

Her reasoning was between substances that react on their own without any perceived external influence such as lighting a match or burning the substance before being exposed to the tube. Her motivation rests between option A (was very quick) and B (Happen by itself). Participant (P1) confused 'spontaneous' with 'instantaneous' since they are phonetically similar Gardner (1972) and 'sound alike' (Cassels & Johnstone 1985, p. 14). When asked about the context in which she had met this word before, she clearly showed that it was in a section dealing with chemical reactions in high school not at University level.

P1 – We were talking about rapid reactions

At school level chemistry, in the topic dealing with rapid reactions which comes earlier in a section dealing with periodic trends. Her understanding of rapidness (fast reactions) was her ground basis for a synonym that could explain her selected option.

P1 – Uhm…Instantaneous is at a particular point in time, so I related……ok time, so it was everywhere (inaudible)

In her reasoning, she was looking for a word she could relate to instantaneous. However she ended up confusing spontaneous with instantaneous.

R – Ok, but have you met this word anywhere before?

P1 – Yes Sir; No, I related it to instantaneous

Clearly her choice for option A corresponds with the meaning of instantaneous. Which confirms that there was a confusion between instantaneous and spontaneous, possibly due to prior instruction where the two's meaning where not explicitly explained.

In her reasoning process, she could rule out option D and grapple with option C and in the end, choose option A as the correct answer over B. Her reasoning for selecting option A was strongly motivated by the knowledge with gaseous reactions. '*When gasses react they combine instantly'* which she interpreted as spontaneous.

P1- So obviously it will happen by itself coz you mixed two chemicals. We are mixing them, we expect a reaction to happen. Looking at option 'C', where it says one started to increase vigorously, then it makes sense but then it means it did not happen fast for some time. I checked, it said once they combine the reaction was spontaneous, so it made sense that 'A' is the correct answer.

Participant (P2) drew from her science classroom experiences, practical observations and further reading in her chemistry textbook, but struggles to give a reason for her selection even though she had experienced the word before in her schooling. Participant (P2) strongly argued for option B as the correct answer.

P2 – Uhm…I have come across the word before, so Uhm…I just know that when a spontaneous reaction takes place, it happens on its own, there is no Uhm… Uhm…, there is no catalyst to start with. That's why I have come across it before, so I know that a spontaneous reaction it happens Uhm… it happens without, Uhm…, it happens by itself basically.

Her motivation for the selection was based on her familiarity with the terms in her school chemistry, in the topic dealing with rates of reactions. She displayed slightly deeper understanding of the topic that is perceived as difficult to learn and teach in schools.

P2 – Uhm...I have read it in books, but at mostly in chemistry they talk about spontaneous reactions.

R – at University level?

P2 – Oh No, no at school

R – Which topic at school?

P2 – I can't remember in chemistry, it was when we did Gr 10, 11, 12...it was studied in chemistry and they used to talk about spontaneous reactions, reactions that happen by themselves. Yea!

Participant (P3) also chose option B and in her motivation, she reasoned from the everyday meaning of spontaneous.

P3 – Uhm….Well I have come across it in chemistry but Uhm… it describes in words when a person says spontaneous, it means yea, you can like do whatever, so I related it to: when a person says you are spontaneous, you are not very quick, so you won't explode, so it won't happen by itself, won't increase vigorously.

Here she articulated human responses to real life situations, by saying you are spontaneous if you are a vibrant, a bubbly person that does things without thinking twice. In her justification, she clearly made the distinction between quick human reactions that may lead to violent behaviour (explode).

P4 – Yes, on physical sciences, especially chemistry where a reaction is either spontaneous or non-spontaneous. I do not remember the way it was (inaudible….)

Participant (P4) also confirmed her familiarity with the word spontaneous from school level chemistry; when she was busy with spontaneous and non-spontaneous reaction. Although she chose the correct answer, she couldn't explicitly explain her choice of selection and her understanding of the word spontaneous.

RETARD

The Questionnaire context in which the term was tested in the questionnaire is given below:

The pupil was trying to find a chemical that would <u>retard</u> the reaction. This means the chemical would

A. speed up the reaction
B. make the reaction go the other way
C. slow down the reaction
D. gives maximum yield from the reaction

Table 4.5: A summary of how the options for retard were relatively selected

Word	Answer	A	B	C	D	N/A
Retard	C	4	11	31	0	1
Percentage	66 %	9%	23%	66%	0%	2%

The participants confused options A, B and C. The expected answer was option C which had a 66 % scoring. The distribution of incorrect responses is amongst the highest between option A with (9%) and B (23 %).

Option A refers to a catalyst or an inhibitor, so participants confused 'retard' with a catalyst; '*a substance that speeds up the reaction'*; similarly (Oyoo, 2007) identified that students often selected options with the opposite of the terms' meanings. Option B refers to the reversibility nature of the reaction probably the participants thought that retard means reverse which relates to the science classroom encountered meaning that suggest reversible movement in physics.

This term in the science context refers to the slowing down of a reaction. Option C (66 %) in the questionnaire context was the correct answer; of which three quarter of the sample selected correctly. This may suggest that participants are familiar with the use of this term section dealing with the factors that affect reactions. This may also have direct implication to the amount of time this term is relatively explained in everyday classroom context. Another possibility could be the revision modern materials such as textbooks where particular words have been changed to students' vocabulary and reading levels.

The everyday meaning of the term *retard* refers to a delay or a hold back in terms of progress in development. This word is also used to refer to a mentally slow developing being whereas in science it refers to the opposition to acceleration a hold back in motion or an opposing force to motion in physics.

Comments from the Interview results:

With a show of hands, seven participants indicated having selected option C (slows down the reaction). Out of all the interview participants, only three participants were not familiar with the word: one left out the question completely while the other two participants guessed to the correct answer. The two participants both guessed that option C is suitable for this context. When they were asked why they selected option C couldn't articulate a reason to their choice of selection or their strategy used to get to that particular option.

P6 – I actually guessed.

P6 – Yea, I have never met the word before. I have never, actually it's my first time.

P7 – I missed my answer

R – You missed?

P7 – I just guessed

This suggests that these students lacked familiarity with this word both in the science context and in their everyday vocabulary. From the students' background in section 3.3.1, participants indicated that English was rarely spoken at home, it is the reason their vocabulary is lowered. The participant that did not select any option confessed that he had never seen or heard this word before in his life and schooling career. He felt that this word was so difficult that he had no way of answering it.

P5 – I did not even chose the answer, because I have never come across the word before.

R – You have never heard of the word before?

P5 – No!

Five participants were somehow familiar with the word because somewhere in their lives they had come across this word they could select option C. Evident in respective excerpts below their separate meanings of the word seemed to stem from the everyday meaning of the word retard. The first participant (P4) gave an example of where she had used this word. Retard according to her is a word associated with human abnormality that is often regarded as being dumb or catching on slowly. Among the options provided, her choice of selection was motivated by the word 'slow'. The three participants (P4, P1 and P3) used their familiarity with retard's everyday meaning to select option C. It is evident that their choices were informed by the word slow in the questionnaire as the most suitable word to relate to the science context meaning of the word retard.

P4 – Uhm…I have come across the word retard for example, a person would tell another person you are a retard meaning that you slow. So when a reaction is retarded, it means you slowing down the reaction.

P3 – Uhm…the same as (P4). I know that retard is a mental illness or psychological whatever, so yea a person who is retarded is slower than everyone else so that's how I related it to 'C'.

P1 – Someone who is dumb, someone, someone who is slow. So 'A' does not make sense and 'D' would not make sense but then 'B'. Ok, it could yield an incorrect result as an exchange, but then how can you make a reaction go the other way? What other way is that, so no I said 'C'?

Participant (P1) could demonstrate her logical reasoning while answering the multiple-choice questions. Through trial and error informed by her experience with the everyday meaning of the word 'retard' she could relate that meaning to correct answer in the questionnaire context. Further she displayed her understanding of chemical reaction mechanisms and reversible reactions to possible meanings of the word 'retard' and related that with the everyday meaning of retard.

Participant (P8) guessed to the correct answer. Her reasoning is from a scientific point of view of the word 'retard' science context meaning. She used a process of elimination while focusing on reactions involving catalysts.

P8 – I literally guessed, but then I chose 'C' because number 1 speeds up the reaction means there is a catalyst and then to make a reaction go down uhm… No and they give one…that is also like speeding up the reaction. So I chose 'C'.

Participant (P2) says she has never seen or heard the word before in her schooling (science class) but she is familiar with the term used outside the classroom in everyday talk when referring to a people with learning difficulties.

P2 – Yes, I also chose 'C' because of the fact that Uhmm retard is basically someone who is Uhmm…slow and has difficulty learning so that's why I chose 'C'.

R – Ok, Yea so there is nowhere in your class schooling where you met this word?

P2 – In science, No!

Again here, in the questionnaire item the word 'slow' was the motivating factor when related to the everyday meaning of the word retard.

DISINTEGRATE

The Questionnaire context in which the term was tested in the questionnaire is given below:

The tube may disintegrate when the reacting gasses are released into it. This means the tube may

A. break up into small pieces
B. change colour.
C. be seen to glow
D. collapse in on itself.

Table 4.6: A summary of how the options for disintegrate were relatively selected

Word	Answer	A	B	C	D	N/A
Disintegrate	A	31	1	3	10	2
Percentage	66%	66%	2%	6%	21%	4%

The 10 participants selected option D (21%) missed or did not know that disintegration is a transformation of the gas released in the gas and not the characteristic of the tube. Option D suggests that students' understandings of 'disintegrate' in this context refer to the collapse of the tube in on itself upon the release of the reacting gasses in the tube. This selection may be indicating the approach students used to answer the question, the apparent understanding of this term was in the focus of the tube and not the gas.

One participant selected option B (2%) which means that the participant had difficulty with the meaning of this term as presented in this context. A further 4% of the sample didn't answer this question and another 6% misinterpreted disintegrate with the expectation of a product of the observed phenomenon in the gas tube. This options associates change in colour to disintegration.

As a verb in Physics it refers to a radioactive nucleus that changes spontaneously into one or more different nuclei in a process in which atomic particles, as alpha particles, are emitted from the nucleus, electrons are captured or lost, or fission takes place (Collins English Dictionary, 2012; Dictionary.com, 2014). The expected answer is option A, surprisingly 66% of the participants selected option A. This was in spite of the fact that the section on nuclear reaction in modern physics has been withdrawn in the South African school curriculum.

Comments from the Interview results:

One participant admitted that this words meaning was difficult to discern. In his reflection, he is not sure whether he has come across it in everyday talk but he is convinced that in science he has never seen this word before. The possible reason why participants couldn't explain their choices is due to a lack of English language exposure or ambiguous use of the word in South African School classrooms (Oyoo & Semeon, 2015).

P5 – has 'chowed' me

R – Again…

P5 – Maybe I have come across it, but in science No…Not in science

Another participant (P1) knew the antonym of dis integrate and therefore uses the opposite or the prefix in front of the word to interpret the meaning of disintegrate.

P1 – Yes, integrate means to put together. Take things and put them together, so the prefix 'dis' it means to take away.

Participant (P3) on the other hand related the words meaning to her personal experience. She had heard the word being used before where the everyday meaning was associated with collapse in itself. It is also possible that students may have associated the term with a specific reaction in chemistry.

P3 – Collapsing on itself, it is a personal experience. There was this flower in our garden it would open up at a certain time and collapse in itself, so my Dad would say it disintegrates so that's why I said 'D'.

The majority of the participants admit to the difficulty stemming from the lack of familiarity and irregular use of the word.

This confusion may also be due to a lack of familiarity of the term used in context, it is possible that the students may have never encountered this term in their schooling career and that possibly teachers may have used this term unwarily of the difficulty (Oyoo, 2012; Oyoo & Semeon, 2015).

PREPARE

The Questionnaire context in which the term was tested in the questionnaire is given below:

If you are asked to describe how to prepare oxygen, it means that you are to say

A. the substance it is made of.
B. What it is used for.
C. how it behaves.
D. how it is made.

Table 4.7: A summary of how the options for prepare were relatively selected

Word	Answer	A	B	C	D	N/A
Prepare	D	7	3	2	31	4
Percentage	66 %	15 %	6 %	4 %	66 %	9 %

6% of the participants associated the term with option B; meaning which refers to the use of oxygen rather than the preparation. It is possible that due to the curriculum structures and level of laboratory work in South Africa, students are not required to prepare gasses from a series of experiments, instead in this case oxygen can be bought and simply be used in laboratory work.

Almost 10% of the sample left out this question deliberately or scratched it out due to its difficulty. 9% didn't answer this question; this may be due to numerous factors including familiarity of the context or to the complexity of the question. The fact that there is production of something may have been difficult to comprehend. The everyday meaning of 'prepare' is to make something ready for further use or consideration, in psychology it means to make someone ready or to equip someone with the necessity to deal with something (South African Oxford Secondary School Dictionary, 2006).

In chemistry, the term commonly refers to the setup of equipment for experiments; it also means the process to make a chemical product by allowing a reaction or a series of reactions between elements or compounds to proceed. The terms '*prepare*' and '*generate*' are often used interchangeably in explanations that refer to chemical reactions. Both of these terms are employed in the production business in science, from this analysis it would be fair to say that these two terms are synonyms in the "science register", science register which in my opinion basically refers to the terms used to express a concept in scientific context.

Participants who voluntarily took part in the interview discussion, couldn't identify this word as a problem. This could be due to numerous other factors such as familiarity with the word or its ambiguity as used in the science context.

4.3 Interview Discussion

4.3.1 Discussion of Difficult words

In the interview findings students identified only five out the seven the non-technical terms questionnaire findings in section 4.2. The terms' '*spontaneous', 'retard', 'trace', 'disintegrate' and 'sensitive'* emerged as the most difficult words in the group interview. Earlier studies with Grade 12 learners in Oyoo and Semeon (2015) also identified that similar words like '*spontaneous', 'retard', 'trace', 'disintegrate' and 'sensitive'* including *'convection'* and *'contract'* were challenging to learners'. Similarly, with this study participants from a University a level higher were also experiencing difficulty with non-technical terms' science context meaning.

Summary of Findings

The interpretation was done against the theoretical and conceptual framework on the premise that what we call knowledge is embedded in the language which is key to understanding a subject (science subject) Postman and Weingartner (1971, p.102) in Oyoo (2012). The focus in this study was on students' meanings of non-technical words as presented in the science context. From students' own reflection towards the end of the interview participants acknowledge that the major reason for their difficulty with the words is in the familiarity with its use and meaning in the science context.

P6 – I met one word of which I knew. When I anticipated an answer I wasn't sure so sometimes it brings me to that when I meet words I need to look deeply into what they mean and contextually.

One participant in her reflection did admit to the important relationship between language, context and the discipline.

P1 – So we use words in English or in our everyday conversations and then depending on the context that is language in the context. We use words in different subjects which is discipline so some words are similar and some are not similar depending on the discipline for number 7 in this context it makes sense.

They acknowledged that explicit meaning should be made when teaching to make learners aware of the different meanings that non-technical terms have in different contexts. Further they acknowledged that familiarity is the major factor or their difficulty since they have different lived experiences.

P8 – I will say that it helped me to pay special attention to details like looking at the instructions. You have to pay attention to details on what is the context of the word in use.

Due NSC examination strategy which largely influences algorithmic, procedural teaching approaches in classrooms, teaching would be less conceptual meaning it is possible that explicit mention of these terms' meanings may be overlooked resulting to conflicts or confusion in this section.

The lack of comprehension of the word meaning as associated to the science context may be expressed by the number of students selecting options that infer to non-technical terms general everyday meaning. This suggests that these terms' particular science context meanings presented some difficulty to students, and by our admission, that was due to the lack of students' familiarity or knowledge of the terms used in a science context.

It is possible that participants that selected incorrect options, have a mistaken or non-existent, unfamiliar idea and use of this term in the science context and in the English language. Common to earlier studies as Oyoo (2007), participant students selected the option with the opposite meanings to the intended meaning of the term in the question. On the other hand, Strevens (1976) points out that another possible indicator to difficulty is in the mutual comprehension of grammar and vocabulary, especially in South African spoken English that can be a sources of language difficulty.

The difficulty in identifying the appropriate use of the term ‘trace’ can be associated to the antonymous meaning of ‘trace’ in scientific contexts, mainly because of the way the term is used in everyday classroom discourse either as a verb, noun or adjective. From students own lived experiences, they related these terms meanings to the words’ common used meanings from the way these are commonly used by South Africans in their communities or their social backgrounds.

The strategies that students used to answer the questionnaire are a clear display of the complexity of the English language that the non-technical terms are embedded in. The confusion between nouns, adjective and verb meaning of terms can be attributed to lowered proficiency in English. This may also have direct implication to the amount of times terms are relatively explained in everyday classroom context due to teachers’ lack of awareness and familiarity with non-technical terms (Oyoo & Semeon, 2015).

The difficulty based on the knowledge gained in school chemistry, especially in the topic dealing with rates of reaction, explicit mention of these terms’ meanings may have been overlooked resulting to conflicts or confusion. The results from other studies and this study suggest that South African learners and students are also likely to encounter difficulties with meanings of everyday words when used in science context.

4.3.2 Implications for preparedness

The high percentage of confused options can be attributed to lack of familiarity, science context meanings and use of the non-technical terms in classroom explanations. It is possible that teachers are not explaining the meaning of these words the interviewer used in science context; this may be that teachers themselves are unaware or unfamiliar with the differences in meaning that these non-technical terms bear in the science contexts (Oyoo, 2012). This may be again due to the structure of the National work schedule that teachers follow, which doesn’t emphasise the explicit focus on the explanation of these non-technical terms in the science context (Oyoo & Semeon, 2015). This raises questions to possible contribution of the National work schedules to level of preparedness of learners in their schooling career for further University studying.

4.4 Chapter Summary

From the seven words identified as problematic from the questionnaire responses as well as from the floor by interviewee’s, it is evident from these findings that South African University students are experiencing difficulties with non-technical terms’ science context meaning similar to Grade 12 learners. From students own account and reflection, it is clear that these difficulties are ranging mainly from a lack of familiarity of the terms’ science context meaning but also depending on their personal lived experiences, whether they have come across the words irrespective of their learning at school. Teachers’ use of language in science classroom talk, inexplicit explanation of meaning of non-technical terms may have contributed to students’ difficulty. Students have looked at these words in many different ways, but lack of familiarity with the terms contributed to the lowered ability to the meanings or the comprehension of these terms’ meanings when presented in the science context.

In the next chapter, the overall study findings based on the aims and objectives to answer the research questions are presented. Relevant recommendations, personal reflections, implications based on the findings in Chapter 4 are also presented.

CHAPTER 5: CONCLUSION ON FINDINGS

5.0 Introduction

The focus of this study was to investigate the challenges, concerns, familiarity and understandings of the difficulties that non-technical terms may present to B.Ed. second year University students. This case study explored whether issues with non-technical terms' science contextual meanings and familiarity in science related fields of study are still persistent at University. The science language contextual factors of difficulty identified were to be interpreted as possible indicators to students' level of preparedness in science and for science related University studying. Details of how the data collected and analysis have been presented in section 3.4 and section 3.5. What now follows is a summary of findings.

These findings have been corroborated in semi-structured group interviews that students participated in, and which allowed for deeper interpretation to their contextual familiarity and understanding of non-technical terms' science context meanings. In this chapter, a summary of the findings from data collected in questionnaires and interviews are presented together with recommendations, limitations, and my reflections on this study. All this will be as a means to respond to the following research questions that this study sought to answer.

1. Are there any indicators in the students' selection of items that indicates language difficulty with non-technical terms science context meanings?
2. What are the explanations or reasons for the difficulties that students encountered with non-technical terms?

The data collected in this case study was derived from University students' responses on the questionnaire to predetermined questions that focused on non-technical terms meanings. The results in studies with Grade 12 learners show that South African school learners encountered difficulties with the non-technical terms presented in the science context. The main sources of difficulty identified in the study were attributed to the South African language and historical background which contributes to poor vocabulary, lowered exposure of English language usage, lack of familiarity and lack of comprehension of meanings of non-technical terms used in a science context of which in other studies it is interpreted as LoLT science (Oyoo, 2016, in press).

5.1 Summary of the Findings in this study

The focus of this study was on the challenges, concerns and difficulties that B.Ed. second Year students at a South African University are experiencing with non-technical terms' science context meaning. Similarly, to other studies that this study drew from, South African learners encountered difficulties with meanings of everyday words when used in science context. The questionnaire findings and the interview results indicated that students in this study were also struggling with non-technical terms' science context meaning.

The findings from the actual interview in section 3.4.3 with participants gave an indication to their contextual familiarity and understanding of non-technical terms' science context meanings. The findings were interpreted as indicators of their school preparedness in science for University studying. A summary of the explanations or reasons for the difficulties with terms' science context meaning are discussed next. The summary is done as per context of the study as mentioned in section 3.2.2.

5.1.1 Difficulties of the Words

Upon applying the difficulty criterion on the 47 questionnaires completed by students, seven terms were identified as the most difficult in the whole process. Out of the seven words identified in the questionnaire findings in section 4.2, interview participant students identified five words out of the list in the following order '*spontaneous', 'retard', 'trace', 'disintegrate' and 'sensitive'.* Similar to the study conducted by (Oyoo & Semeon, 2015), with high school learners. Students in this study were also struggling with non-technical terms' science context meaning. The terms which emerged as difficult in this study were similar to the words identified by Gardner (1972, 1976) in Australia; Farrell and Ventura (1998) in the United Kingdom; Prophet and Towse (1999) in Botswana and Oyoo (2004) in Kenya as reported in Chapter 2. In the study by (Oyoo & Semeon, 2015), their results included the terms '*convection' and 'contract'* as difficult words from the questionnaire. In all the above mentioned studies, participants experienced difficulty with meanings of the term 'spontaneous'. In the same way this study focusing on University Students, the term 'spontaneous' emerged as one of the difficult words both in the questionnaire and in the interview findings.

From the discussion in section 4.3.1 on students' perceived difficulty, the following and most important contributors to their difficulties were the contexts in which the words were used against their familiarity with non-technical terms in everyday parlance. In cases where they were familiar with the terms, the challenge to participants was understanding the science context meaning as examined in the questionnaire.

Out of the 10 interview participants, three participants were not familiar with most of the words, where one left out the questions completely and the other participant guessed to the correct answer. The two participants both guessed to find the suitable answer for this context. Some of the participants confessed that out of their schooling careers, it was their first time that they had encountered such words for example (retard):

P6 – I actually guessed. Yea, I have never met the word before. I have never, actually it's my first time.

Surprisingly, this participant student lacked exposure and familiarity with this word both in the science context and in their everyday vocabulary. The students enrolled at the University of the Witwatersrand thus are no exception to the findings as in previous studies by (Oyoo & Semeon, 2015) conducted at school level, even though the University holds a reputation for enrolling the best of the best in the country.

From the student demographics discussed in section 3.3, the students' backgrounds revealed that students are from mixed home language backgrounds where English was highly spoken in school. The University of the Witwatersrand (2016) analysis indicated that 50.45 % of the students enrolled at Wits matriculated from highly resourced schools. 64.24 % of students enrolled for first undergraduate programmes at Wits come from schools that can be classified as having sufficient teaching and learning infrastructure and resources and only 33.37% of those enrolled students are students coming from under-resourced and disadvantaged backgrounds. Therefore, the majority of students are from schools which were ranked as highly resourced schools, the major first year group of students enrolled were mostly from Gauteng schools where their average class size ranged between an average of 20 -50 learners per class. Only 14.59 % students came from schools where the average number of learners was above 80 in a class.

From this examination, students' proficiency in LoLT should be higher. Oyoo and Semeon (2015) on the other hand recognized that learners with high level proficiency in LoLT may still encounter difficulties with the same language when used in science classrooms. This finding seems to support Marshall et al.'s (1991, p. 334) assertion that "everyday words cease to be mere English words when used in a science context". Due to English being mixed in their home backgrounds, it could have contributed to the lowered vocabulary, contextual familiarity attributed by their social backgrounds.

Ironically the term 'prepare' was the option which most participants didn't answer on the questionnaire. Almost 10% of the sample left this question or scratched it out. Likewise, during the interview, students couldn't recognise this word for any further discussion. This may be due to numerous other factors including familiarity of the context or to the complexity of the question, but for the purpose of this study, the possible factor could be that maybe participants were not aware of the terms' science context meaning nor its use within the school science context. Oyoo (2016, in press) asserts that contextual familiarity is the main source of difficulty with non-technical terms in LoLT science.

5.1.2 Context

According to Farrell and Ventura (1998), the context in which non-technical terms are used affects comprehension or understanding of the word. When using English words in our everyday conversations it is apparent that meanings of these everyday used words can change depending on their use and therefore depending on the context that is what we phrase as language in the context. We use words in different subjects which characterises the subject or discipline where some words are similar and some are not similar in meaning depending on the context.

Previous studies done by Gardner (1976), Farrell and Ventura (1998) and Oyoo (2007) have indicated similar struggles that science learners are facing e.g. words that 'sound-alike' and 'look-alike'. For example, some participants used the antonym of 'disintegrate' by changing the prefix (dis) in front of the word to interpret the meaning of disintegrate. Another participant related the words meaning to her personal experience where she had heard the word being used before where the everyday meaning was associated with something collapsing in on itself. Participants in this study also confused options e.g. A (*was very quick*) and B (*Happen by itself*). This confusion is between 'spontaneous' with 'instantaneous' since they are phonetically similar Gardner (1972) and 'sound alike' (Cassels & Johnstone, 1985, p. 14). When asked about the context in which participants had met this word before, they revealed that it was in chemistry section dealing with chemical reactions in high school not at University level.

Participants’ understandings of rapid (fast reactions), was the basis for a synonym that could explain the process. This confirms that there was confusion between instantaneous and spontaneous possibly due to prior instruction where the two meanings were not explicitly explained. The motivation for the choice of selection, leaned towards trial and error; logical reasoning grounded on prior exposure with the spontaneous and non-spontaneous reactions. Subject content familiarity informed participants reasoning between substances that react on their own without any perceived external influence such as lighting a match or burning the substance before being exposed to the tube.

In another case, participants related the meaning of *‘sensitive’* to an emotional person, short temperament, while making selections; they could easily relate the everyday meaning to fragility of objects. Other participant confused option for example D (*gets spoilt very easily*) and option C *(is hard to understand how it works)* which could mean that they had difficulty finding appropriate English words that describe how things easily spoil.

5.1.3 Familiarity

Most of the participants showed some familiarity with chemistry concepts. They may have done or observed chemical reactivity in the classroom or in their first year chemistry courses. The options which referred to the reversible nature of chemical reaction were easily interpreted for example ‘retard’ means reverse which relates to the science classroom encountered meaning that suggests reversible movement in physics.

Some participants selected options associated with colour changes in a reaction vessel with the meaning of the term ‘disintegration’, possibly due to lack of English language exposure or a lowered use of the word in South African School classrooms or their social backgrounds. It is also possible that students may have associated the term ‘disintegration’ with the technical reference to reaction in chemistry. This confusion may also be due to a lack of familiarity of the term used in the South African school chemistry context. It is also highly possible that the students may have never encountered this term in their schooling career; possibly teachers and textbooks not be explaining or highlighting non-technical terms explicit science context meaning since the non-technical component of science teachers’ classroom language is recognizable as the same as the language in which textbooks are written (Oyoo,2007).

5.2 Implications for Preparedness

Chinua Achebe (1990, p.162) cited in Oyoo and Semeon (2015, p. 43) seems certain that learning science in a language needs more than mere proficiency in a language (i.e. basic language concepts) when he asks:

> *"What kind of science can a child learn in the absence, for example of basic language competence and attendant inability to handle concepts?"*

From the findings, the physical sciences national curriculum should be language consciously reviewed based on findings from such studies to ensure excellent performance in South African schools. Participants acknowledge that explicit meaning of non-technical terms' science context meanings should be made when teaching science. Science instruction needs to pay special attention to details on the context of the word in use as a preparatory measure at University level. Students have the right to be made aware of the different meanings that non-technical terms have in different contexts. This claim is more on the fact that, participants acknowledged that familiarity is the major factor to their difficulty based on their different lived experiences.

This raises questions to possible preparedness of learners in their schooling career for further University studying. The motivation behind students' selections points to a close relationship between familiarity and context. In turn, this relationship can be fostered in schools to prepare learners for further University studying irrespective of their social language backgrounds and gender. Like these participants, even though they have high levels of proficiency, there is evidence that the difficulties associated with non-technical terms still persist amongst University students.

5.3 Implications

From findings in this study and previous studies at school level, South African students lack the exposure, and contextual familiarity to the language that these meanings are embedded in. This may have led to students' inability to differentiate between non-technical terms' specific scientific context meaning from terms everyday meaning. The exposure to these terms' actual contextual meanings against their everyday context meaning, use inside and outside classroom conversations is a factor that needs to be countered.

From the difficulty in the questionnaires it is clear that the approaches used by teachers in the classroom are not explicitly clarifying the specific science context meaning of these terms during important practical and theoretical sessions. This results to students' resorting to associating meanings with the technical nature of the subject and not its actual intended science meaning. The students may be interpreting from their own lived experiences and relating terms' meanings to terms common used meaning from the way it is commonly used in their communities or their social backgrounds. The lowered use of the English language in their social and community backgrounds in addition, contributes largely to these difficulties which is interpreted at University level as High School under preparedness for University studying.

5.4 Recommendations/Suggestions

Language proficiency has been the main focus area in previous studies in South African schools, where it was indicated that learners studying science in schools are experiencing difficulties. Oyoo (2016, in press) and Oyoo and Semeon (2015, p. 47) argue that:

> *Proficiency is necessary (as a prerequisite for any learning in a language) but not a sufficient factor of successful learning (ability to tell context); contextual proficiency is a necessary additional for successful learning in science, given the way in which meanings of everyday words change when used in a science context.*

Oyoo (2012, p. 854) points to the necessity for guidance on shared thinking towards a common understanding of the meanings of everyday words used in science contexts since new words meanings are a result of the changed context. The teachers' role can be a powerful source of knowledge in classroom interactions and possibly the nearest to confirm learners' verbal and written ideas or view, especially when learners participate in classroom discussions related to language difficulties. The difficulties clearly reveal that the current Curriculum is not language conscious in the teaching of concepts, a fact that clearly has not been identified by the current NBT upon University enrolment. This implies that thousands of students in South Africa cannot associate their science difficulty to appropriate terms that explain concepts in the science context. Equally, to school learners, large numbers of University students are unfamiliar with non-technical terms' science context meanings which imply an underprepared workforce.

5.5 Further Research

This study has pointed that there are far greater reasons to the difficulties associated with non-technical terms. For the scope of this study, it is evident that the most dominant factor yet rests within the relationship between context and familiarity of mere everyday used English words that have a different meaning when presented in the science context.

From the sampled questionnaires, only 10 students participated in the interview. I would have liked to have a larger sample. Further, due to time constrain we couldn't discuss all the non-technical terms that are on the questionnaire, we were only limited to an hour with participants.

The study couldn't explore other factors due to the scope and nature of the sample, however for further research trajectories, a larger study should be conducted on non-technical terms vocabulary in science from an NBT approach to explore the whole Wits student demographics.

South African Science Education has to take a turn through active engagement with teachers in schools. A separate assessment or feedback portal should be administered, phased in schools to find feedback from learners on how they perceive science and most importantly to share on their experiences with science language.

5.6 Reflections

Recently the language issue in South African higher institutions made headlines, from the arguments that students and protesting students provided. There needs to be a review to the current language policy in the country. To be more direct, the language difficulty argued in this study is related to the language used to learn science in science instruction. From the studies reviewed, science teaching should be made more language conscious to ensure excellent performance in South African school science.

In South Africa, the shortage of skills still remains a huge challenge to our economy. The country's economy depends on the skilled middle class with expertise in Science, Mathematics and Technology. Unfortunately, the number of student enrolments in these fields of study is not conducive to meet the challenges of the economy.

From the research that I reviewed, I have seen science teaching from a different perspective. I believe with awareness to LoLT science and non-technical terms science context meaning versus their everyday meaning could result to improve Grade 12 results. As I engaged with the theory and the findings and investigation, I identified the crucial importance of the language component in science. It has made me change my teaching approach to an approach that is more language conscious by linking the science instructional language demands and learners lived experiences.

My classroom practice has changed, where vocabulary has taken centre stage as a prerequisite to science learning. My teaching is slightly language orientated rather than the repetition of words in long confiding sentences'. I have seen the need to make mention of explicit meanings in the words which embed the science concepts. I hope to make physical science teachers aware of the instructional approach to lower the difficulties that learners are facing in science instruction.

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APPENDICES

Appendix 1: Questionnaire

University of the Witwatersrand, Johannesburg, SOUTH AFRICA

Investigation of Meanings of Everyday Words used in the Science Context Questionnaire

This questionnaire has questions which are to find your ideas about some words used in School Science. **It is not a test,** so you need not worry about your answers being right or wrong. Your responses will be kept confidential and anonymous. Please supply all information requested and attempt all the questions. After finishing, please drop your questionnaire in the communal return envelope for immediate sealing.

(a) Name..(b) Adm. No. ....

(c) Gender: Female □ **Male** □ (Please tick)

(d) Language used most while at:

(i) School............................... (ii) Home (after school).........................

****

Read each question carefully and think about the word that is underlined. Put a CIRCLE round the letter (A, B, C or D) next to the sentence or phrase that you think represents the nearest meaning of the underlined word.

1. The rabbit was weighed at midday on ten consecutive days. This means it was weighed
   A. on the first and tenth days.
   B. every tenth day.
   C. every day for ten days.
   D. ten times every midday.

2. When the stone is lowered into a beaker of water, it displaces some of the water. This means it
   A. reacts with some of the water.
   B. pushes away some of the water.
   C. gets bigger.
   D. simply falls through the water to the bottom of the beaker.

3. The speed limit for the vehicles was 40km/h. This means that vehicles could travel
   A. at exactly 40km/h.
   B. between 45 and 35km/h.
   C. at an average speed of 40km/h.
   D. at not more than 40km/h.

4. If you are asked to describe how to prepare oxygen, it means that you are to say
   A. the substances it is made of.
   B. what it is used for.
   C. how it behaves.
   D. how it is made.

5. The child is dehydrated. This means it has
   A. not enough water in its body.
   B. too much water in its body.
   C. the right amount of water in its body.
   D. just drunk a lot of water.

6. Animals generate heat through respiration. This means they
   A. lose heat.
   B. gain heat.
   C. produce heat.
   D. do not need heat.

7. The beam balance is a very sensitive instrument. This means that it
   A. can be used to weigh very small things.
   B. can be used only by sensible people.
   C. is hard to understand how it works.
   D. gets spoilt very easily.

8. The gas had a <u>characteristic</u> smell. This means the gas had a
   A. nice smell.
   B. smell unlike any other.
   C. strong smell.
   D. bad smell.

9. The soil contained a <u>trace</u> of potassium. This means it
   A. used to have some potassium.
   B. had plants which use potassium.
   C. had a very small amount of potassium.
   D. had a large amount of potassium.

10. Some students were studying the <u>fundamental</u> laws of science. This means they were studying the
   A. old laws of science.
   B. most important laws of science.
   C. modern and newly discovered laws of science.
   D. most easily explained laws of science.

11. The temperature of the liquid was <u>constant</u>. This means it was
   A. staying the same.
   B. getting colder.
   C. getting hotter.
   D. getting hotter then colder.

12. The experiment was to prove that the brass rod would <u>contract</u> when cooled. This means the rod would
   A. change colour.
   B. become harder.
   C. become shorter.
   D. become longer.

13. The explanation the student gave of the experimental results was <u>valid</u>. This means the explanation was
   A. well argued.
   B. not correct.
   C. brief.
   D. very new.

14. The two chemicals seemed to combine in a <u>spontaneous</u> reaction. This means the reaction
   A. was very quick.
   B. happened by itself.
   C. once started increased vigorously.
   D. was explosive.

15. The outcome of the chemical reaction depended on many <u>factors</u>. This means it depended on
   A. the method.
   B. accomplishments.
   C. the experimenters.
   D. influences.

16. Working through many exercises improved the student's <u>concept</u> of chemical bonding. This means the student's
   A. issue improved.
   B. design improved.
   C. idea improved.
   D. method improved.

17. The class is studying the <u>diversity</u> of plant life in the school compound. This means they are looking
   A. for new kinds of plants.
   B. at the variety of plants.
   C. at the rate of growth of plants.
   D. for plants they can eat.

18. The car's movement was <u>linear</u>. This means the car
    A. moved in a straight line.
    B. kept stopping and starting.
    C. was dangerous.
    D. swerved from side to side.

19. The pupil was trying to find a chemical that would <u>retard</u> the reaction. This means the chemical would
    A. speed up the reaction.
    B. make the reaction go the other way.
    C. slow down the reaction.
    D. give maximum yield from the reaction.

20. If you were asked to find the <u>effect</u> of adding acid to a metal, this means you would try to find
    A. the reason for adding the acid.
    B. the quantity of acid used.
    C. how long the reaction took.
    D. what happened.

21. The results of three experiments were <u>consistent</u>. This means the results were
    A. variable.
    B. the same.
    C. adequate.
    D. adjusted.

22. The pupil knows the <u>function</u> of her heart. This means she knows
    A. how the heart is made up.
    B. what is wrong with the heart.
    C. what influences the heart.
    D. what the heart does.

23. The students were asked to describe the human digestive <u>system</u>. It means they were asked to describe
    A. what humans eat.
    B. what forms a balanced diet.
    C. the difference between the foods humans eat.
    D. the link between the organs involved in breaking down the food.

24. By <u>convention</u>, when writing a chemical formula, the symbol of the metal is usually written first. This means that this way of writing
    A. has been accepted as an agreed practice.
    B. is a result of chemical formula.
    C. was developed as metals were discovered first.
    D. has been arrived at but is still not accepted by everybody.

25. After studying the various conditions that may be affecting the quantity of solid produced from the reaction, the pupil concluded that the effect of pressure was <u>negligible</u>. This means that the pupil felt that pressure
    A. was the only factor operating.
    B. was the most important factor.
    C. need not be taken into account.
    D. was the first factor to operate.

26. Your science teacher said that she was going to <u>evacuate</u> the flask. This means the teacher will
    A. cool it in a vacuum.
    B. close the flask.
    C. clean the flask.
    D. empty the flask.

27. The students were able to <u>estimate</u> the volume of water in the container. This means they
    A. measured the volume carefully.
    B. made a careful guess of the volume.
    C. poured out some water from the container.
    D. filled the container from the tap.

28. People are asked to switch off light whenever they leave a room in order to conserve energy. This means people are asked to
    A. avoid risk of a fire.
    B. make light brighter on switching on again.
    C. use energy carefully to make it last.
    D. not make use of the light at all.

29. The tube may disintegrate when the reacting gases are released into it. This means the tube may
    A. break up into small pieces.
    B. change colour.
    C. be seen to glow.
    D. collapse in on itself.

30. The motion of the solid particles suspended in the water was described as random. This means that the motion
    A. was very fast.
    B. had no order at all.
    C. was starting and stopping.
    D. occurred every ten seconds.

Participation in Small Group Discussions

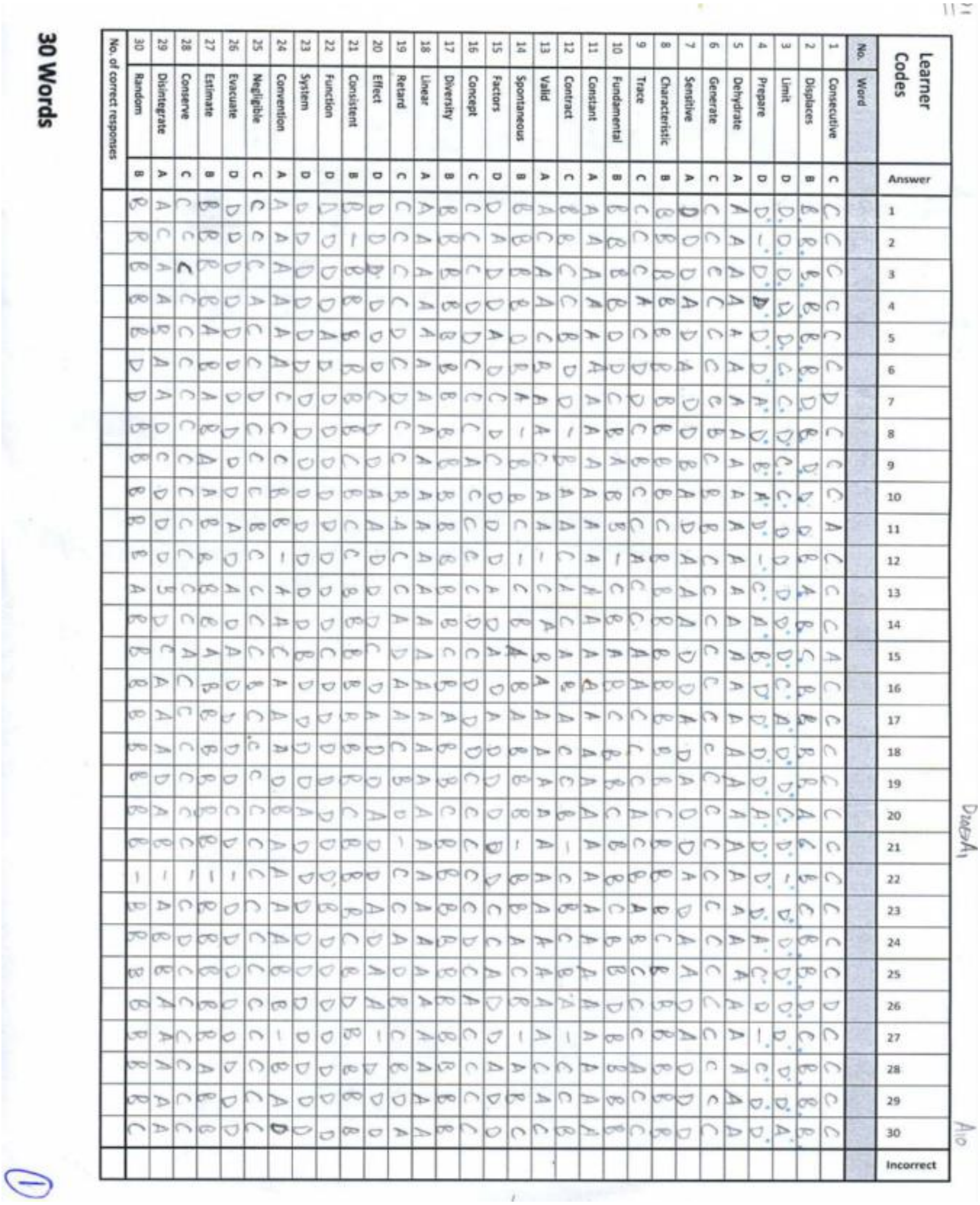
Would you be willing to take part in small group discussions of the meanings of the underlined words in this questionnaire?

Please tick one box ***YES*** □ ***NO*** □

This is the end of the questionnaire. Please check that you have answered every question.

Thank you for your time.

Appendix 2: Tally Grids



30 Words

No.	Word	Answer
1	Consecutive	C
2	Displaces	B
3	Limit	D
4	Prepare	D
5	Dehydrate	A
6	Generate	C
7	Sensitive	A
8	Characteristic	B
9	Trace	C
10	Fundamental	B
11	Constant	A
12	Contract	C
13	Valid	A
14	Spontaneous	B
15	Factors	D
16	Concept	C
17	Diversity	B
18	Linear	A
19	Retard	C
20	Effect	D
21	Consistent	B
22	Function	D
23	System	D
24	Convention	A
25	Negligible	C
26	Evacuate	D
27	Estimate	B
28	Conserve	C
29	Disintegrate	A
30	Random	B
No. of correct responses		

Learner Codes: 1–30; Incorrect

Dzaeh A1

A10

Appendix 3: Summary of Questionnaire Findings

Students Codes		Correct Answer	TOTAL NUMBER OF OPTIONS (N= 47)					TOTAL	NUMBER CORRECT RESPONSES	OVERALL % PER OPTION SELECTED					NUMBER INCORRECT RESPONSES	PERCENTAGE INCORRECT	PERCENTAGE CORRECT	CONFUSING COMBINATIONS
No	Word		A	B	C	D	N/A			A	B	C	D	N/A				
1	Consecutive	C	0	3	43	1	0	47	43	0	6	91	2	0	4	10	91	
2	Displaces	B	0	38	0	9	0	47	38	0	81	0	19	0	9	23	81	
3	Limit	D	0	0	4	43	0	47	43	0	0	9	91	0	4	10	91	
4	Prepare	D	7	3	2	31	4	47	31	15	6	4	66	9	16	41	66	A/D
5	Dehydrate	A	47	0	0	0	0	47	47	100	0	0	0	0	0	0	100	
6	Generate	C	1	5	41	0	0	47	41	2	11	87	0	0	6	15	87	
7	Sensitive	A	29	1	2	15	0	47	29	62	2	4	32	0	18	46	62	
8	Characteristic	B	0	43	3	1	0	47	43	0	91	6	2	0	4	10	91	
9	Trace	C	22	2	23	0	0	47	23	47	4	49	0	0	24	62	49	
10	Fundamental	B	1	44	1	1	0	47	44	2	94	2	2	0	3	8	94	
11	Constant	A	47	0	0	0	0	47	47	100	0	0	0	0	0	0	100	
12	Contract	C	0	6	38	3	0	47	38	0	13	81	6	0	9	23	81	B/C
13	Valid	A	45	0	2	0	0	47	45	96	0	4	0	0	2	5	96	
14	Spontaneous	B	11	32	4	0	0	47	32	23	68	9	0	0	15	38	68	A/C
15	Factors	D	1	0	3	43	0	47	43	2	0	6	91	0	4	10	91	
16	Concept	C	0	0	43	4	0	47	43	0	0	91	9	0	4	10	91	
17	Diversity	B	0	47	0	0	0	47	47	0	100	0	0	0	0	0	100	
18	Linear	A	47	0	0	0	0	47	47	100	0	0	0	0	0	0	100	
19	Retard	C	4	11	31	0	1	47	31	9	23	66	0	2	16	41	66	D/C
20	Effect	D	8	0	0	39	0	47	39	17	0	0	83	0	8	21	83	
21	Consistent	B	2	36	8	1	0	47	36	4	77	17	2	0	11	28	77	
22	Function	D	0	0	0	46	1	47	46	0	0	0	98	2	1	3	98	
23	System	D	0	0	0	46	1	47	46	0	0	0	98	2	1	3	98	
24	Convention	A	37	4	3	2	1	47	37	79	9	6	4	2	10	26	79	
25	Negligible	C	0	3	43	0	1	47	43	0	6	91	0	2	4	10	91	
26	Evacuate	D	6	3	4	33	1	47	33	13	6	9	70	2	14	36	70	
27	Estimate	B	0	46	0	0	1	47	46	0	98	0	0	2	1	3	98	
28	Conserve	C	1	0	44	0	2	47	44	2	0	94	0	4	3	8	94	
29	Disintegrate	A	31	1	3	10	2	47	31	66	2	6	21	4	16	41	66	A/D
30	Random	B	0	44	1	0	2	47	44	0	94	2	0	4	3	8	94	

Appendix 4: Verbatim Transcript

Verbatim Transcription

Introduction

*in all cases, **R** means Researcher, and **P** participant student*

First 16 min participants were asked to complete the questionnaire.

[00:16:41]

R – Ok now, if you are done, let us discuss your answers. There are no wrong answers, they are all right as per your perception. You can pick or we can ask you to discuss or maybe you have any specific words we can discuss.

C- Whispering

P1 - Spontaneous

R - Ok she says we should discuss the word spontaneous. Can you guide our meanings on the word spontaneous?

P2 - Which question is that?

R – The meanings, number 14.Yes the word spontaneous. Do not change your answers, they are all right. So what is the answer for spontaneous?

P1 – I said ‘A’ Sir

R - ‘A’, (that is very quick).

P2 – ‘B’ (Happen by itself)

R – So we have people selecting ‘A’ and ‘B’ only. Have you met the word before, the word spontaneous?

P1 – Yes Sir, but I never paid attention

R – Just tell us why you picked that answer

P1 – I don’t know Sir, it just made sense that it means it is fast coz when I looked, it said it happened by itself.

R – Yes, yes (*probing*)….

[00:18:42]

P1- So obviously it will happen by itself coz you mixed two chemicals. We are mixing them, we expect a reaction to happen. Looking at option ‘C’, where it says one started to increase vigorously, then it makes sense but then it mean it did not happen fast for some time. I checked, it said once they combine the reaction was spontaneous, so it made sense that ’A’ is the correct answer.

R – Ok, but have you met this word anywhere before?

P1 – Yes Sir, No, I related it to instantaneous

R – But you did not meet it anywhere else in your class

P1 – No!

R – Ok, you have never met this word in your class?

P1 – Not in the class I have taught but in my schooling experience yes.

R – Tell us about that experience

P1 – Slight laughter…. (Shying away)

R – What did you meet in your schooling experience? What was happening?

[00:19:51]

P1 – We were talking about rapid reactions

R – Ok, It is fine. Why did you pick ‘B’ for an example (P2)?

[00:20:02]

P2 – Uhmm….I have come across the word before, so Uhm…I just know that when a spontaneous reaction takes place, it happens on its own, there is no Uhm… Uhm…, there is no catalyst to start with. That’s why I have come across it before, so I know that without a spontaneous reaction it happens Uhm…that’s why it happens without, Uhm…, it happens by itself basically.

R – Where did you meet it before?

P2 – Uhm...I have read it in books, but at mostly in chemistry they talk about spontaneous reactions.

R – At this level (University level)

P2 – Oh No, no at school

R – Which topic at school?

[00:20:37]

P2 – I can’t remember in chemistry, it was when we did Gr 10, 11, 12...it was studied in chemistry and they used to talk about spontaneous reactions, reactions that happen by themselves. Yea!

R – Ok, what do the other say about ‘B’? Why did you pick ‘B’ (P3)

[00:20:57]

P3 – Uhhmm….Well I have come across it in chemistry but Uhm… it describe in words when a person says spontaneous, it means yea, you can like do whatever, so I related it to: when a person says you are spontaneous, you are not very quick, so you won’t explode, so it won’t happen by itself, won’t increase vigorously.

R – So, you just do things…..

P3 – Yea, you spontaneous, so you just do things.

R – Would you say the same thing…..Give us your experience of the word spontaneous.

[00:21:36]

P4 – As the same as theirs it is similar so I can't add

R – I want your words.

P4 – I have also come across the word spontaneous at school.

R – Ok, yes….

[00:21:54]

P4 – Yes, on physical sciences, especially chemistry yes, where a reaction is either spontaneous or non-spontaneous. I do not remember the way it was (inaudible….)

R – Ok anything else you would like to say about the word .Do you want to say something? Let's quickly talk about instantaneous. How does it play with this?

[00:22:18]

P1 – Uhm…Instantaneous is at a particular point in time, so I related……ok time, so it was everywhere (inaudible)

R – Any other reactions before, we move to the next word?

R – Ok, Thank you for that. Now any other word you would like to discuss?

P1 – What is the answer Sir?

R – Any answer is right

C – Ha ha ha Sir…..

R – But Uhm… its 'B'.

R – (P5) so which item? Which question?

[00:23:10]

P5 – Uhm… retard.

R – Retard

P5 – Yes, I did not even

R – Which number?

P5 – 19

R – Yes…

P5 – I did not even chose the answer, because I have never come across the word before.

R – You have never heard of the word before?

P5 – No!

R – So you have never picked this word before?

P5 – No

R – Ok, so others?

[00:23:38]

P4 – I chose ‘C’ for Retard.

R – Ok, you chose ‘C’ for retard (Slows down the reaction).

P4 – Yes.

R – How many chose ‘C’?

(Hands raised 7)

R – Ok so everybody chose ‘C’. Tell us why you chose ‘C’. Slows down the reaction

P4 – Uhm….I have come across the word retard for example, a person would tell another person you are a retard meaning that you slow...

R – Yes, when you are retarded!

[00:24:04]

P4 – So when a reaction is retarded, it means you slowing down the reaction.

R- You linked it with that

P4 – Yes!

R – Ok, that’s how she linked it. What would you say about that meaning ‘C’?

P6 – I actually guessed.

R – You guessed?

P6 – Yea, I have never met the word before. I have never, actually it’s my first time.

R – She guessed! You chose ‘C’

P1 – Yes Sir, Ok retard for me I related that person who is dumb

R – Who is dumb…..

[00:24:49]

P1 – Someone who is dumb, someone, someone who is slow. So ‘A’ does not make sense and ‘D’ would not make sense but then ‘B’. Ok, it could yield an incorrect result as an exchange, but then how can you make a reaction go the other way? What other way is that, so no I said ‘C’?

R – So, you could relate it with that. Everybody picked ‘C’. Let us hear what she says.

[00:25:36]

P7 – I missed my answer

R – You missed?

P7 – I just guessed

R – Why are you guessing? You never heard the word before? You do not know the word?

P7 – Mm mm mmmmm…….

R – Ok, why did you pick 'C'?

[00:26:01]

P3 – Uhm…the same as (P4).I know that retard is a mental illness or psychological whatever, so yea a person who is retarded is slower than everyone else so that's how I related it to 'C'.

R – Ok, Our friend there…

P8 – I literally guessed, but then I chose 'C' because number 1 speeds up the reaction means there is a catalyst and then to make a reaction go down uhhmm… No and they give one…that is also like speeding up the reaction. So I chose 'C"

R – Ok, and then you also chose 'C'

[00:27:07]

P2 – Yes, I also chose 'C' because of the fact that Uhm retard is basically someone who is Uhmm…slow and has difficulty learning so that's why I chose 'C'.

R – So it is really based on you linking it to slow people.

P2 – Yea

R – Ok, Yea so there is nowhere in your class schooling where you met this word?

P2 – In science, No!

[00:27:47]

R – Ok, that why you never learnt the word (P5) because you never met it. Any other word which struck you?

P1 – Trace!

R – Ok, number 9!

R – What option did you pick for trace?

[00:27:55]

P6 – 'C'

R – (*Reading option C*) any other answer?

P5 – Chose 'A'

R – Any other answer?

P2 – 'C'

R – We will start from 'C'. Tell us more about your answer (P6).

[00:28:23]

P6 – why I chose ‘C’ is the reason that I saw that ‘A’, it means it used to have some potassium, not quiet. I was not satisfied by the answer and then I moved right along to ‘B’, yea had some residue, No, I just thought about trace meaning a description. It can describe as an adjective something like that so I just chose (small amount) ‘C’.

[00:29:07]

P1 – I chose ‘A’ because I, the word trace in my understanding means the evidence of

R – The evidence of

P1 – Yes

R – Ok

[00:29:16]

P1 – So, they did not tell us how much evidence was there, so I cannot say large or small, but then I can say some amount was there.

R – It used to be there

P1 – It used to be there, have I said ‘A’.

R – Yea, she has something to say

[00:29:38]

P4 – I do not have something to say. For me trace, where we say something has potassium, we assuming something small, so it’s a trace.

R – Something small

[00:29:49]

P4 – It’s a trace of potassium

R – You hardly used the word before

P4 – Hmmm, I have

R – In School

P4 – In school, trace of something

R – Trace of

P4 – Yea in school

R – Ok, so was it estrange to you or you were trying to figure out something .Traces of……

[00:30:00]

P4 – I think I know what a trace is, a trace of something means, but then I never met the word trace in science.

R – Ok fine let’s all talk

[00:30:28]

P3 – I said ‘C’ as well as she said the same thing I know trace to be like a small amount.

R – Our friend there (P7), Do you know the word? You do not know it? Ok …….

[00:30:53]

P5 – I chose ‘A ‘, I thought of if I can make an example, if I want to trace if someone broke into my yard. I can only trace that person using footsteps which is ‘A’.

R – Used to be here

P5 – Even potassium was like the footsteps.

[00:31:31]

P8 – They have explained it all (P1) and (P).

R – Evidence of, which is ‘A’.

P8 – Yes

[00:31:37]

R – Ok…

[00:31:39]

P2 – I chose ‘C’.I think it was at school or on Television. I know that it means a small amount. Trace evidence of something, I have heard it before I can’t pin point whether it was at school or a programme, but I know that trace refers to a small amount of something.

R – That’s fine

[00:32:06]

P1 – Sir, I am thinking about in life sciences….

R – In Life sciences (Probes)

P1 – When we were doing evolution, we talked about trace of evolutionary changes and whatever so, I can’t say that there is a big change or a small change from us to apes. We look for the trace of or the traces, so the apes had this skull and we have this, so we look at the features, the trace of evolutionary development of how we move from apes to us.

R – Ok... Trace development!

P1 – So it is evidence of

R – From Life sciences

P1 – yes

R – Any other answer?

[00:33:11]

P5 – Number 29

R – Disintegrate?

P5 – Yes

R – That one

P5 – has chowed me

R – Again…..

P5 – Maybe I have come across it, but in science No……Not in science

[00:33:46]

P1 – Yes Sir, integrate means to put together. Take things and put them together, so the prefix 'dis' it means to take away.

R – So you arrived at the meaning by looking at the prefix of. How else did you arrive at the answer? How did you (P3)?

P3 – Me?

R – Yes

[00:34:28]

P3 – Uhm…What I said is 'D'.

R - 'D'

P3 – Collapsing on itself, it is a personal experience. There was this flower in our garden it would open up at a certain time and collapse in itself, so my Dad would say it disintegrates so that's why I said 'D'.

R – Yea, Anybody else who has never met the word before in science?

P6 – In Science?

R – Yes, tell us

P6 – I haven't met it

[00:34:52]

R – In this case, what is your answer?

P6 – I think I made the same association as (P1),because I know that integrate means coming together so opposite if it is 'dis'-integrate.

R – Ok, ok that's fine

P3 – What is the correct answer?

R – Correct answer is fall into pieces.

P3 – So it is wrong if I say it collapses into itself?

R – All these are answers, it's all based on your experiences and your meanings. We do not have a lot of time but can we look at the word number 7.Sensitive, what was your answer? How many picked 'A'?

A – P2 and P8

B -

C -

D –P3, P1, P4 and P6

R – So I think the majority thinks spoils very easily. Tell us why you picked 'D' and One 'A'.

[00:36:33]

P1 – Ok Sir, a sensitive person is a person with a short temper or a person with emotional baggage.

R – Yea

P1 – So, it makes sense that something like glass, we would say glass is sensitive, if it falls it breaks even this one can easily be spoilt and also 'C'.I thought it can also be correct when you say it is a sensitive something it means it needs a specific understanding or knowledge, it is sensitive to what you think or handle it.

R – Yes (P6) anything different?

P6 – It is more of what she said, because I thought of it, sensitive person is easily touched, so it means that easily touched.

R – Why chose 'A' can be used to measure very small things

[00:38:05]

P2 – The reason why I chose 'A" was Uhm…I wasn't sure what to choose here but ended up choosing 'A' coz it is a sensitive instrument, so if you want to measure or weigh out small things, you can use that instrument, that is why. I chose that one, in terms of the second one, it just didn't make sense because you are using a beam balance, it doesn't matter the faculties the person has, should have the person should be able to use it.it has no relation in conflict what sensitive is and uhm…in terms of understanding it inclines so, I just eliminated the ones and 'A' seemed to make sense to me, so it was a process of elimination to me 'A' made a lot of sense.

R – So you chose 'A' not because you have met this word before.

[00:39:07]

P2 – No, I have seen it in context, they all relate to the word sensitive, based on the sentence and the context that is why I chose 'A'.

[00:39:29]

R – Thank You. Now, we have gone through all these. What is interesting about this? Anything?

[00:39:44]

P6 – I met one word of which I knew. When I anticipated an answer I wasn't sure so sometimes it brings me to that when I meet words I need to look deeply into what they mean and contextually.

[00:40:10]

P5 – Yea, this part was interesting, I have learnt a few words of which I never came across and since I am a teacher I was never going to know when a child asks me: "Sir, what does it mean?" I will never know how to explain what it means. I will be chowed, but yea this was helpful, I have learnt something new.

[00:40:43]

P1 – I have learnt the relationship language context and discipline, so the language.

R - Language, context and discipline….

P1 – Yes

R – Ok

P1 – So we use words in English or in our everyday conversations and then depending on the context that is language in the context. We use words in different subjects which is discipline so some words are similar and some are not similar depending on the discipline for number 7 in this context it makes sense.

R – Please say something

[00:41:43]

P7 – What I can say is that some of the words I have seen here are the words I come across every day, but then what is surprising is that when I actually have to give the meaning of them I do not understand them but then like…

R – Like then….

P7 – I come across them every day, but I can't give the definition

R – In that context

P7 – (Nods)

R- Ok….Would you like to say something (P3)?

[00:42:20]

P3 – Uhm...I think this just shows how different people can understand things differently, like the various understandings of each word. So as a teacher that really is important coz there are learners who understand things differently, you need to look at it in every possible way as you can.

R – Ok, Do you want to say something (P8)?

P8 – I will say that it helped me to pay special attention to details like looking at the instructions you have to pay attention to details on what is the context of the word in use.

R – Say something…..

[00:43:11]

P4 – Ok, I have also learnt that Uhm…any word can mean many things depending on how we use it for example what we doing here as you said there is no wrong answers, depends on your explanations.

[00:43:46]

P2 – Uhm...I learnt that people see things in different ways and that it also depends on their experience as well, whether they have come across the words, irrespective of whether they are learning at school, so they look at words in many different ways. It all boils down to our experience and on whether we have seen it and the way we identify and how it is explained to us as well.

R – On that note, of course teachers cannot be explaining the words they use. Suppose teachers were not teaching about the words, what can you say about that?

[00:44:34]

P1 – It creates miscommunication, like when you wrote to us that we are going to take a test, you didn't explain. We didn't sleep studying for the test since we thought we were going to write the test so that creates miscommunication if you do not explain what you mean.

R – I think I must that you very much for coming and participating, we will keep you updated. I am sure you will be coming to our assistance next time. I will introduce Siphesihle Sibiya, my masters' student. Because you agreed to take part, you are now a part of us.