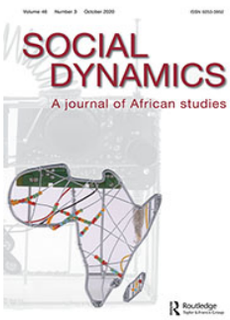

Routledge
Taylor & Francis Group

Social Dynamics
A journal of African studies

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rsdy20

Towards a policy on teacher use of language during science teaching and learning in South Africa

Samuel Ouma Oyoo & Nkopodi Nkopodi

To cite this article: Samuel Ouma Oyoo & Nkopodi Nkopodi (2020) Towards a policy on teacher use of language during science teaching and learning in South Africa, Social Dynamics, 46:3, 471-492, DOI: 10.1080/02533952.2020.1853955

To link to this article: https://doi.org/10.1080/02533952.2020.1853955

SOCIAL DYNAMICS
2020, VOL. 46, NO. 3, 471–492
https://doi.org/10.1080/02533952.2020.1853955

Routledge
Taylor & Francis Group

Towards a policy on teacher use of language during science teaching and learning in South Africa

Samuel Ouma Oyoo[a,b] and Nkopodi Nkopodi[a]

[a]Department of Science and Technology Education, University of South Africa (UNISA), Pretoria, South Africa; [b]School of Education, Maseno University, Maseno, Kenya

ABSTRACT

The preferred and dominant language for learning and teaching (LOLT) in secondary schools across South Africa is English. Questionnaire studies on students' understandings of everyday English words commonly used by teachers in school science classrooms have revealed near to identical kinds of difficulties students encounter with these words. One important highlight of the findings has been the fact that when used in the science context, everyday English words cease to be mere English words. This paper presents findings in investigations conducted in South Africa of the sources of difficulties students encounter with everyday words when used in the science context. The study participants consisted of 715 Year 11 science students and their respective teachers (N = 20). Data were sourced by use of a questionnaire to student participants followed by focus group and in-depth interviews with both categories of participants. One major revelation is that science teachers' preferred approaches to use of instructional language during teaching is key to the students' ability to tell the meanings of everyday words when used in the science context. The findings in this study are drawn on to suggest a practice policy on science teachers' use of instructional language for effective teaching of school science.

KEYWORDS

Science; English language; proficiency; polysemy; context; precision

> . . . any learning difficulties observed in South African science learners who learn in a language other than their home language are still generally assumed to stem almost exclusively from such learners' perceived lower levels of proficiency in the LOLT. (Oyoo 2017, 791)

Introduction

Recent rankings by reputable bodies of South African Science Education on the global platform have presented a very undesirable picture of the quality of outcomes in science by school learners. The groups of South African learners, who participated in the Trends in Mathematics and Science Study (TIMSS) in 2001 and 2003 (Reddy, Kanjee, and Diedericks 2007), were ranked last out of 50 countries (Kriek and Grayson 2009). In 2013, ten years after the last TIMSS that South Africa participated in, the South African Institute of Race Relations (2013) also placed South Africa last in the ranking of 62 countries in the quality of Science Education. In the 2014 survey conducted by the World Economic Forum (WEF)

CONTACT Samuel Ouma Oyoo soyoo@maseno.ac.ke

the quality of South African Science Education was also ranked last, but this time, out of 148 countries. The government has many policies and programmes in place, directed at schools, to turn around the current state of Science Education (Cameroon 2009; Capazorio 2013); the major objective of the particular policies and programmes targeted at schools is to improve enrolment and performance as a twin strategy to have adequate science-oriented personnel to run and sustain the nation's economy (Reddy, Kanjee, and Diedericks 2007; Department of Education [DoE] 2009; Makgato 2007). In these project drives, one important component of student learning or attractiveness of science has generally not been given due attention: the place of the language of learning and teaching [LOLT] in South African schools (Prinsloo and Harvey 2018; Prinsloo and Rogers 2013).

Language and education in South Africa

South Africa is a country that has 11 official languages and, as provided for in the Constitution, everyone has the right to education in the official language of their choice. Despite this constitutional provision, the instructional language or language of learning and teaching (LOLT) in all schools above Grade 3 including all secondary schools in South Africa is either Afrikaans or English (Greenfield 2010). Since the end of the apartheid era, the number of schools using Afrikaans has declined (Department of Basic Education [DBE] 2010) but with a corresponding increase in the number of schools that use English as a medium of instruction (DBE 2010). The majority of learners in South Africa learn in a second or third language and gaining a level of proficiency in the LOLT is therefore a very necessary first step; learning can be possible only in a language that a learner has some proficiency. The observation that those who have attained good levels of proficiency in the LOLT (English or Afrikaans) have always appeared to do better than those with lower levels of proficiency is a message that achieving a high level of proficiency in a LOLT is very important for good outcomes in the learning process (Howie 2003). This observation could be the origin of the widely held assumption in South Africa that once proficiency in a LOLT is attained, all learning can thereafter proceed undeterred. This is in spite of an absence of consensus on what may be considered a benchmark for adequate proficiency in a LOLT upon attainment of which all learning will then take place smoothly thereafter (Oyoo 2007).

The generally lower scores in Science by South African learners in both internal and external assessments as discussed here seem to strongly suggest that even a high level of proficiency in the LOLT could be only one among, possibly, many other factors that positively influence high outcomes in school science. The fact that the assumption about the link between proficiency and learning (as depicted on this article's banner quote) is widespread lends credence to the claim in Vorster, Mayet, and Taylor (2013) that how the language of instruction impacts learning is still generally misunderstood in South Africa.

Locating our concern and focus

The authors of this article share the concern that a misunderstanding of how language impacts learning of science in South Africa exists. Both have conducted several studies already available in the public domain in the area of language and science education and which have informed the need to conduct a study to help sort the misunderstanding.

This paper draws from data collected in a research project where South African physical science Grade 10–12 learners' difficulties with the science classroom language were investigated. It in particular draws from data on Grade 11 learner understandings of meanings of selected everyday [non-technical] English *words presented in a science context*. This particular focus is to highlight the potential "impact of context of use" on the difficulty of the LOLT as used in science teaching, as a means to better inform on how the language of instruction impacts learning of science. In other words, this is as a means to resolve the misunderstanding that indeed exists in South Africa, on how language impacts learning of science.

The focus on the South African situation and on students' difficulties with non-technical words of the LOLT presented in the science context, in particular, has benefitted from the earlier works by the first author in two ways. First, the study was motivated by findings in a review of all published transnational studies in this area by the first author (Oyoo 2014) including Paul Gardner's pioneer study (Gardner 1971, 1974) that the general difficulty of the science classroom language is for reasons other than student levels of general proficiency in the LOLT. Secondly, the particular design of this study has also been directly influenced by the earlier works by the first author (Oyoo 2012). In the earlier study in reference, findings of the sources of difficulties learners encounter with the non-technical words commonly used in the science classroom including the possible contribution of science teachers to learner difficulties with the words have been reported. In the earlier study in reference, the influence of outside of school context and teachers' non-explanation of the meanings of the words in the context of use have been identified as important sources of learner difficulties with meanings of all words that comprise the instructional language as used by teachers during teaching of science. The science teachers' non-explanation of the meanings of everyday words in the context of use were also revealed to be because of the teachers' 1) lack of awareness of the potential difficulties of the non-technical words of the instructional language, or 2) failure to distinguish between the non-technical words used in the science context and science words [technical words].

The discussions in the next section are arguments to reveal the nature of the instructional language as used in science classrooms, and why basic proficiency alone (possessing general proficiency) in a language of learning and teaching may not be adequate for successful learning of science.

Polysemy, contextual proficiency, general proficiency, and difficulty of the LOLT science

While language has long been recognised as a tool that facilitates communication between the teacher and the learners including during teaching of science (Scott 1998; Scott, Mortimer, and Ametller 2011), the language of the science classroom or science texts can be divided into two broad parts namely: the *technical* and the *non-technical* components.

Polysemy and Context: In earlier works (Oyoo 2007, 2009) has argued that the technical component comprises technical words which are specific to a science subject or discipline. For example, the words/terms: *photosynthesis, respiration* and *genes*, are generally associated with Biology; *force, capacitance* and *voltage* are words generally associated with Physics; while

atoms, elements, and *cations* are words most commonly used in Chemistry (Oyoo 2007). The examples of technical words used here, by association, seem to give identity to particular science subjects and/or the science discipline. Learning of science is often of the meanings of the technical terms – science terms/terminology, that in many instances are common everyday words deliberately used as science concepts, and which used thus, become polysemous in nature.

Non-technical component of the science classroom language on the other hand is made up of non-technical words and define or give identity to the particular LOLT in use in a classroom or the language of a science text; this is to the extent that we are able to tell which language is in use, whether the language is Afrikaans, English or any other. Although all words in the non-technical component of the instructional language are non-technical words, three categories within have been derived in research literature on instructional language for/in science education (Oyoo 2010). The three categories, *logical connectives, metarepresentational terms* and *non-technical words used in the science context*, can be distinguished from one another.

Fensham (2004) has referred to *logical connectives* as "words or phrases which serve as links between sentences or between a concept and a proposition, e.g., 'since', 'because', 'conversely' and 'therefore'" (102). *Metarepresentational terms* on the other hand are words or terms which signify *thinking* and include: metalinguistic verbs – words which take the place of the verb to *say* such as, "define," "suggest," "explain," "describe," etc. (Oyoo 2017, 786) and metacognitive verbs – words which take the place of the verb to *think* such as "calculate," "observe," "analyse," "deduce," "predict," "hypothesize," etc. (Oyoo 2017, 786). The functional value of this category of words is in the fact that knowledge of their meanings may enhance students' understanding of the demands of the questions and to, accordingly, design the correct responses (Bulman 1988); students' understanding of the meanings of these words may also be expected to enhance their classroom participation.

The category referred to as *non-technical words used in the science context* are those words which have become part of the language typical of a science subject but do have meanings in the science context that are different to their meanings in everyday use of a language; examples include, "reaction," "diversity," and "disintegrate." Each of these non-technical words (reaction, diversity, and disintegrate) when used in the science context "embodies certain concepts important to the process of learning specific science subjects" (Oyoo 2012, 852).

Context and "new" meanings of everyday words of the LOLT science: The way the words in this category, for example, "reaction," "diversity," and "disintegrate" – mean differently when used in the science context to their everyday use is now discussed to locate the place of context in meaning recognition as well as to demonstrate the need for contextual proficiency as a necessary and additional factor to general proficiency for successful learning to occur in any language. As in the Oxford South African Secondary School Dictionary for Grades 8–12 (OSASSD 2018), everyday English meanings of the words "reaction," "diversity" and "disintegrate" are as follows:

> The word *reaction* refers to "the way one feels, does etc. as a result of something that happens, e.g. *My immediate reaction was one of shock*." (OSASSD 8/12 2018, 508); *diversity* taken to be synonymous to the word "variety" refers to "a quantity or range of different things" (OSASSD 8/12 2018, 695), i.e. to very different people or things existing within

> a group or place, while the everyday English meaning of the word *disintegrate* is "to break up into small parts" (OSASSD 8/12 2018, 175).

In the science context however, the word "reaction" assumes two different meanings: as used in Physics it becomes a technical term – force ("a force exerted by a body in response to another force applied to it, which is equal in strength and acts in the opposite direction" [OSASSD 8/12 2018, 508]), while in Chemistry, its use is as a non-technical word, to describe what happens when two or more substances are mixed ("a chemical change produced by two or more substances acting upon each other" [OSASSD 8/12 2018, 508]). The word "diversity," as commonly used in Life Sciences refers to the various types of species such as plants and animals ("a thing that differs from others in the same general class" [OSASSD 8/12 2018, 695]). The word "disintegrate" is used in Physics when reference is being made to the *decay* of an *unstable nucleus* (Oyoo 2017). How the word "disintegrate" is used in physics gives meanings to the words "decay" and "unstable nucleus" as relevant to the science context, where "disintegrate" will not mean the "breaking of the nucleus into lots of small pieces" but rather a reorganisation of the sub-atomic particles in the nucleus of an atom. The word "decay" does not refer to "rotting" ("to rot or cause something to rot" [OSASSD 8/12 2018, 155]) or "decomposition" of the nucleus but to transformation into a new nucleus which has properties "very different" from those of the original one ("said about radioactive substance or particle – to undergo change to a different form by emitting radiation" [OSASSD 8/12 2018, 155]); in physics, the outcome of the nuclear decay process is in fact referred to as a "daughter" nucleus. The "**daughter** nucleus is different from the **parent** nucleus" and "this changing of one element into another is called **transmutation**" (Giancoli 2005, 842).

The way the meanings of words as known in everyday parlance can change with the context of use as has been illustrated here with the words "reaction," "diversity," and "disintegrate" and "decay." Thus, changeability of everyday words' meanings due to context of use reveals why *context of use is a source of difficulties that may be encountered with the meanings of this category of words of the LOLT science. That words may acquire new meanings when the context of use changes therefore* becomes recognisable as one reason why even learners with high-level proficiency in a LOLT may still encounter difficulties when it comes to telling the meanings of everyday words of the same language when used in the science classroom. This has been strongly suggested by the types of difficulties as have been reported to have been encountered with the *non-technical words when used in the science context* category in all transnational studies that have been conducted since Gardner's 1971 pioneer study. The pioneer study (Gardner 1971) as well as all studies that have so far been reported are provided in Oyoo (2017). As a summary, the types of difficulties from the studies have included:

- Students selecting words whose meanings are opposite to the intended meanings. For example, *negligible* for *a lot; random* for *well ordered; initial* for *final.*
- Students confusing words in the same semantic fields. For example, *isolate* with *insulate; detect* with *project; theory* with *fact* or *belief.*
- Students confusing words which look alike, or words which sound alike. For example, *complex* with *compound; component* with *opponent; detect* with *protect; accumulate* with *accommodate; proportion* with *portion* (Oyoo 2008).

General proficiency and contextual proficiency: Since these types of difficulties can be encountered only by those with some proficiency in a LOLT, one important factor of these types of difficulties arguably can be the transformed meanings of everyday English words when used in the science context. Context of use is thus a source of difficulties that may be encountered with this category of words of the LOLT science. This is further supported by the observed patterns of the difficulties with these words especially that the difficulties have not been specific to any particular level of proficiency in the LOLT science – the difficulties have been encountered by student participants from the whole linguistic spectrum including those whose first language is the LOLT (Oyoo 2007). Difficulties with the meanings of this category of non-technical words observed across the whole spectrum of linguistic proficiency can therefore be explained on the failure to recognise the context of use of the respective words, in effect, a failure to recognise that "every day words cease to be mere English words when used in a science context" (Marshall and Gilmour 1991, 334). The need for contextual proficiency as additional to general proficiency in a LOLT for recognition of word meanings and successful learning in a language has therefore become more apparent.

Difficulty of the LOLT Science and in Science Texts: The foregoing has served to define the place of context and therefore a recognition of the need for contextual proficiency in the ease with which the meanings of words presented in the science context may be told. All categories of words in the non-technical component of the LOLT characteristic of the science classroom (as discussed here) present difficulties to all categories of learners. In a review of studies of difficulties students encounter with all categories of words that comprise the non-technical component of the LOLT science, it has been revealed that,

> … students encounter difficulties with all categories of everyday [non-technical] words common in science teachers' classroom language irrespective of whether they learn using their first [home] language or not (linguistic circumstances), or whether they are females or males (their gender). The types of students' difficulties have also been irrespective of individual cultural backgrounds. (Oyoo 2004, 70–71)

While the difficulties encountered with the "*non-technical words when used in the science context*" category can be explained best on the changed meanings of everyday words when used in the science context, it can be argued that any challenges students have been reported to encounter with *logical connectives* (Gardner 1977a, 1977b) and *metarepresentational terms* (Oyoo 2004; Wilson 1999) – the first two categories of words in the non-technical component of the instructional language – can be traced to the relative levels of general proficiency in the instructional language. This would confirm that attaining general proficiency is a necessary first step in any learning in any language (Oyoo 2007). An important question by Chinua Achebe, the foremost African language scholar, relevant to this situation is posed in the words: "*What kind of science can a child learn in the absence, for example, of basic language competence and an attendant inability to handle concepts*?" (Achebe 1990, 162; italics added for emphasis), alerts us to the fact that learning science in a language calls for more learner attributes than mere possession of basic language competence in a LOLT. Taking a situation where the capability in and aptitude for science of all learners are taken to be the same, it will be possible to emphasise as a conclusion that yes,*general proficiency is necessary (as a prerequisite for*

any learning in a language) but is not a sufficient factor of successful learning (ability to tell word meanings in a changed context). Contextual proficiency is a necessary additional for easy recognition of word meanings, hence successful learning in science, given the way meanings of everyday words change when used in a science context. Based on this conclusion, a perspective on language that also formed the conceptual as well as the analysis framework in this study is now discussed.

Words, language, knowledge, context and science learning

How word meanings depend on the context of use as has been derived here clearly informs on how the context of use is a possible source of difficulty of (words in) a language in which adequate proficiency may already have been acquired. The particular picture of transformation of meanings of words when used in a science context as presented here is one explanation of the possible difficulty of the language of instruction (LOLT) as used in the science classroom. In line with these discussions, therefore, the conceptual framework on how words make sense including in the science context/zone conforms to the following assertion by Vygotsky, the fact that,

> … the sense [meaning] is … the sum of all the psychological events aroused in our consciousness by the word. It is a dynamic, fluid, complex whole, which has several zones of unequal stability. Meaning is only one of the zones of sense, the most stable and precise zone. A word acquires its sense from the context in which it appears; in different contexts, it changes its sense [meaning]. (Vygotsky 1986, 244)

This assertion is also applicable to helping learners resolve polsemy when everyday words have been used as technical words or science terminology, i.e., science terms, e.g. *force, power, pressure, resistance, work*, etc. Recognition of meanings of everyday words in the context of use, i.e. contextual proficiency, in addition to general proficiency in the instructional language as key to understanding of a discipline or words used in the language may also be argued further on the fact that the meaning of each word is its use and function in the context in which it is used (Hodson 2009; Gyllenpalm, Wickman, and Holmgren 2010; Postman and Weingartner 1971). This in turn calls for necessary guidance if the new word meanings that are the result of the changed context of use are to be recognised; in a classroom situation, this guidance need be about "… shared thinking towards common understandings of the meanings of everyday words [language] used in science context between the teacher and the learners" (Oyoo 2012, 854). This makes it more apparent that any focus on general proficiency in the classroom instructional language or only on knowledge of the words [vocabulary, being able to name or give dictionary meanings of non-technical words] as used in everyday parlance but devoid of the particular context of use would therefore not fully serve to help recognition of word meanings in the context of use. The foregoing discussion based on the link between words, context, and meaning was adopted in this study as the conceptual framework or working perspective on language. Recognisably this was a pragmatic perspective (Gyllenpalm, Wickman, and Holmgren 2010) on how words of a language mean differently depending on the context of use.

Sourcing and analysis of data: the rationale and approaches

The general difficulty of the LOLT, as has already been discussed here, to also apply to those who learn in their home language, is evidence that the difficulty of LOLT is not solely about whether one has adequate proficiency in it or not; the role of the context of use has also been made apparent in the discussions. As already mentioned (including as this article's banner quote), any learning difficulties observed in South African science learners who use a language other than their home language are still generally assumed to stem almost exclusively from such learners' perceived lower levels of proficiency in the LOLT (see Oyoo 2017). Necessarily therefore, this study was to moderate the widespread assumption about the place of general proficiency in a LOLT for all learning.

Given the now well-established role of language in all learning, the need to moderate on the assumption about the impact of a LOLT in all learning (as just mentioned) was as a means to equip science teachers/educators for a more effective participation in the rectification of the prevailing poor status of Science Education in South Africa. *The poor status of science education in South Africa as discussed earlier in this article therefore presented the contextual background as well as the significance of this study to the South African situation. This study especially investigates the place and role of the language of instruction in the possible enhancement of school science outcomes.*

As is already apparent, this study aimed to investigate South African learner difficulties with the language of learning and teaching via a study of Grade 11 physical science learners' difficulties with *everyday words when presented in a science context* (i.e. the third category of non-technical terms) as already discussed in this article. Since no study of student difficulties with everyday words presented in the science context focusing on South Africa had been detected in all literature search, this study was an exploration of the case of South Africa. However, apart from the exploration of whether South African Grade 11 physical science learners also encountered difficulties with the meanings of everyday words when used in science context, the study was designed to also directly investigate reasons for and whether participant teachers could also be contributors to the difficulties learners may encounter with everyday words presented in the science context. This particular design was to cover a gap common to all previous transnational studies in this area (Oyoo 2007),where the detected student difficulties with these words were explained solely on perceived relative levels of proficiency in English language of the participants in the studies (Oyoo 2007). The difficulties encountered by student participants were also not explained on the possible role of their respective teachers although the words investigated in the studies are unavoidable in the language typical of the science teachers, science classrooms, and the science texts.

The following three research questions guided this study: 1) Do South African grade 11 physical science learners also encounter difficulties with everyday words when used in science context? 2) What are the sources of the difficulty of the words? 3) What roles do the teachers possibly play in the difficulties learners encounter with the language of teaching and learning science?

A total of 715 physical science learners all Grade 11 drawn from 20 public secondary schools in Johannesburg participated in the study. All were English second language learners but were considered highly proficient in English, the LOLT. A physical science educator/teacher from each school making a total of 20, all males, participated. All the participant teachers were well qualified to teach physical science at secondary school level

and had taught physical science for years ranging from at least 5 years to 25 years by the time of this study. Although serving at secondary schools in South Africa at the time of this study, the participant teachers had however received their respective initial education as science teachers at different institutions across Africa; with the majority having been educated as teachers in Zimbabwe, others had initially been prepared as science teachers at institutions in South Africa, Nigeria, and Ghana.

The study used a survey/questionnaire (De Vaus 2002) as the main data collection instrument. Data were also collected using semi-structured interviews. The study adopted with permission the questionnaire which was used in Oyoo (2004) study. It was possible to use the adopted the questionnaire without being piloted; this was because it had been tested for validity and reliability prior to its use in the Oyoo (2004) study. Further, Kenya, the context of the study in Oyoo (2004), is also a sub-Saharan African country of comparable economic status. The participants in this study were also students/learners at a similar level of schooling as in Oyoo (2004) study. The questionnaire (included here as Appendix A) comprised of 30 multiple-choice questions each with (the target word underlined) and with four options to choose from (A, B, C, or D) as the meanings of non-technical words presented in science context. An example of the items with everyday words used in science context as in the questionnaire (see also Appendix A) is given here of the word consecutive:

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.

The participant learners responded to the 30 words' multiple-choice questionnaire by selecting the nearest meanings of the underlined non-technical words when used in science context, then semi-structured interviews were conducted with them in small groups. The physical science teacher from each school participated in the face-to-face interviews only; both the interviews with the learners and the teachers were audiotaped and later transcribed verbatim. Content analyses of both the learner and teacher verbatim interview transcripts were conducted to access more data from both learner participants and their respective physical science teachers (Oyoo 2012).

The assertion by Vygotsky (1986), as already discussed, provided the link between words, meaning, and context of use and was adopted as the conceptual framework in this study and also served as the data analysis framework for this study. The survey/questionnaire responses were statistically analysed for mean score patterns and trends to arrive at conclusions as answers to the first two main research questions.

In South Africa, 30% is the pass mark in any subject in all grades including in the National Senior Certificate Examination. Similarly in this study, if the mean score on an item by 30% of the participants (Grade 11 learners) showed that they didn't know the contextual meaning of the everyday word used in science context, the word was considered to be difficult. Relative difficulty between the words was judged on the respective mean scores attained per item.

The analysis of *the interview* responses on the other hand was done using an interpretive approach to source answers to the second and the third main research questions based on the framework or perspective on language used in the study. Content analysis, but this time as an approach to data analysis was also used to reveal patterns in the learner and teacher interview responses which in themselves served as answers to specific research questions used in the study (Oyoo 2012).

The nature of the difficulty of science classroom language

Difficulty of the non-technical words to South African Grade 11 physical science learners: The following seven words in a descending order of difficulty emerged as *very* difficult to the participants in this study: *sensitive; spontaneous; retard; trace; contract; convention* and *disintegrate*. Figure 1 however shows how all the words that emerged as difficult based on the approach used in this study to analyse the questionnaire items, as just discussed, were relatively scored by the participant students. Figure 1 shows how the student participants selected between the options A, B, C, and D for each item (see also Appendix A for details of A, B, C, and D for each of these items).

As also illustrated in Figure 1, it was the meaning of the word "sensitive" (seen by the number of incorrect selections between options) that the participant learners in this study found most challenging. In other studies, however, the word "spontaneous" that has emerged as the second most difficult word in this study has been enduring as the most difficult word (Oyoo 2013).

Since this study was to detect whether South African Grade 11 physical science learners also encounter difficulties but not to compare learners' performance in the questionnaire, the overall pattern in the performance was what was to deliver the message. Thus this study has demonstrated that South African Grade 11 physical science learners also encountered difficulties with everyday words when presented in the science context. This is a finding that has been common in all studies in this area as attributed to a recent review (Oyoo 2014) earlier in this article.

Why the non-technical words are difficult: Talking to learners and talking to teachers: So as not to exceed the length restrictions for this article, interview responses regarding only three words: "sensitive," "contract," and "retard" have been singled out and now discussed as representations of the typical learner and teacher interview

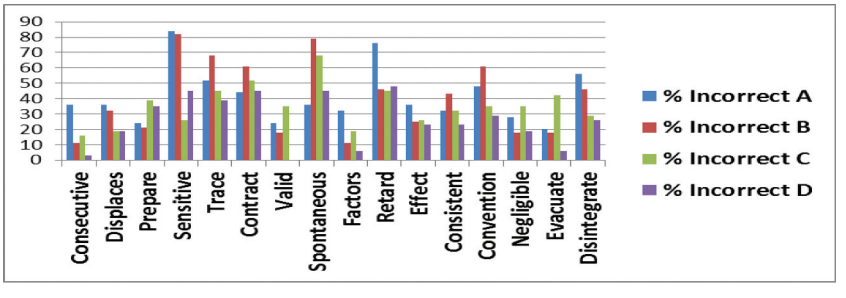

Figure 1. Difficult words for Grade 11 learners.

responses obtained in the study as the reasons for the difficulty of everyday words when presented in a science context.

Difficulties with everyday words presented in the science context: according to the learners

Sensitive: The word *sensitive* appeared in the questionnaire as reproduced 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

While the learners mentioned that the word "sensitive" was familiar to them, only 24% of all the participant learners knew the meaning of the word in the context as expected in the questionnaire: can be used to weigh very small things (**A**). This is same as in OSASSD 8/12 (2018, 565): "(said about an instrument) readily responding to or recording slight changes of condition." Most of the learners took the word *sensitive* to refer to fragile or to something that gets spoilt easily (**D**).

The learners further argued that "if you are a *sensitive* person it means you can easily get angry; you are very fragile so other people should handle you with care because your emotions can easily be spoilt", same as in OSASSD 8/12 (2018, 565): "(said about a person) easily hurt or offended." Since they were familiar with the word "sensitive" the participant learners who missed the meaning as suggested by the context of use appeared to have been misled by their common everyday use of the word *sensitive*.

Contract: The word *contract* appeared in the questionnaire as follows:

The experiment was designed to prove that the brass rod would contract as the temperature fell. This means the rod would

A. change colour
B. become harder
C. become shorter
D. become longer

53% of all the participant learners did not know the meaning of "contract" when used in science context; they chose option **B** (becomes harder) instead of the correct option **C** (becomes shorter) i.e. "to make something smaller, or become smaller" (OSASSD 8/12 (2018, 130). During interview, although the learners indicated that they had met this word before, very interesting participant learner responses were obtained as their justifications for having selected option **B**. The excerpt below was typical:

Learner: Yes ., I said so . . . I watched a movie . . . so what happened is that they heated the metal to a very high temperature and they quickly cooled it and it became very hard so you don't expect the metal piece to become smaller but to become harder.

Researcher: Ok-a-y . . . so that was the reasoning behind that.

Learners (*chorused*): … we expected it to become harder.

This excerpt confirms that the learners had once again drawn from their other experiences outside the school/science classroom environment to select "their correct" meaning of this word. They based their answer on what was observed in a particular movie where they had watched a hot metal becoming very hard on being cooled. By using this observation in answering the question as presented in the questionnaire, these participant learners clearly had failed to recognise the context in which the same word was presented in the questionnaire. In the questionnaire, the focus was on the meaning of the word "contract" not on an observation.

Retard: The word *retard* appeared in the questionnaire as reproduced below:

The pupil was trying to find a chemical that would retard 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.

Retard was not an unfamiliar word to the participant learners according to the learners' interview responses. However, 54% of the learners didn't know its meaning when used in science context, that to *retard* a reaction is "to slow down the reaction" (**C**). This huge number of participant learners instead opted for **B** (make the reaction go the other way). According to these learners, they use the word *retard* almost daily, but to refer to people who do not think or act in a normal way – people who seem to act opposite of the expected. This is the everyday meaning/use of the word to refer to retarded persons: "mentally less developed than is usual for their age" (i.e. "to make something smaller, or become smaller" (OSASSD 8/12 2018, 528). Even though this item "retard," as was structured applied more to chemistry, even in physics, when references are made to a moving object going through or *undergoing a retardation*, the context meaning is always that the object is moving with a decreasing speed or *slowing down*. Thus the correct answer here, "to slow down the reaction," was in line with the meaning as also provided in OSASSD 8/12 (2018, 528), as "to slow down or delay the progress or development of something." Similar to "sensitive" and "contract" above, the participant learners appeared to have been influenced by how the word "retard" is used or had been encountered in their daily environment to arrive at their preferred meanings which were, however, wrong as per the context in the questionnaire.

The role of context in the difficulty: In sum, considering the common approach used in the learners' explanations of how they arrived at their (wrong) meanings of these three words against the expectations, it seems clear that outside-of-school contexts in which they had encountered the words had been particularly strong influences. This is a source of difficulty not directly based on any lack of adequate proficiency in English, the language used in the questionnaire; all the words used in the questionnaire including the three discussed here, were by admission, familiar to the participant learners. The difficulty with these words had its origin in the failure of the participant learners to detect the correct context.

The scope of the current study, however, dictated that further studies will need to be conducted so as to be able to give a more comprehensive explanation of the origin of this kind of difficulty. However, since the environment in which the words have been encountered seemed to have been a strong influence on the meanings the learners held dear, the role of their respective science teachers in the learners' ability to tell the contextual meanings of the words which are common (in fact unavoidable) in the language of the science classroom and of the science texts was followed up in teacher interviews.

The Science teachers as potential sources of learners' problems with LOLT in science

The interview results with participant teachers revealed (the unanimous finding) that they never expected their learners – the student participants in this study – to encounter any difficulties with "simple" English words like those that were used in the questionnaire. Near identical interview responses also showed that the participant teachers couldn't differentiate non-technical words from technical words/science words. To the teacher participants, there was no difference between the functions of the non-technical words used in the science context such as "prepare," "sensitive," and "negligible" as used in the questionnaire and the technical words like "work" and "power," themselves individual concepts in physical science/physics curriculum. The difference between the categories of these words has also been provided as the Theoretical Framework section of this article. The following excerpt was a typical response by the 20 participant teachers during interview:

Researcher: … Do you explain the meaning of everyday words when used in science context to your learners?

Teacher: We start from everyday meanings when you are looking at '*power', what 'power' would mean eeh … in the streets and then we get into the scientific or technical meaning of the word* … There are certain words which we just take for granted … *we assume* umm … *that learners understand* and we are communicating … . [Italics added]

Both these findings that indicate the participant teachers' general lack of awareness of the functional value of the non-technical words as well as the potential difficulty of the words concur with those in Oyoo (2012). As observed in Oyoo (2012), this deficiency in teacher knowledge about functional value and nature of the words in the LOLT science makes them unable to help learners onto the meanings of the everyday words in the physical science context of use; in effect therefore, the teachers bar learners from the concepts embodied in this category of words of the LOLT.

From research to policy on language use in science classrooms

This article drew on a study that explored whether South African Grade 11 physical science learners also encounter difficulties with the meanings of everyday words when used in science context, reasons for any difficulties encountered and whether teachers could be contributors to the difficulties encountered by learners. The results from this study have revealed that participant Grade 11 learners faced difficulties with meanings of everyday words when used in science context in a similar manner as has been reported in

all known studies so far in this area. As learners in Grade 11, and in the absence of a benchmark upon which adequate proficiency in English as a LOLT is ever based (Oyoo 2007), they were perceived to have high levels of proficiency in English given that they had used the language in classrooms for at least eight years (since Grade 3). The difficulties encountered by participants in this study were therefore not due to the participant learners' level of proficiency in English language. Since it became clear during the interviews that all the words used in the questionnaire were familiar to the participant learners, it is hereby asserted that the dominant source of word meanings and difficulty with the words was the outcome of how the participant learners had encountered or used these words in the mainly outside of school/science classroom experiences.

The role of the participant teachers in the participant learners' difficulties with meanings of the words stemmed from the participant teachers' not being aware that everyday words could be misunderstood by the learners. This is one reason why participant teachers may not have explained the meanings of these words in the context of use during teaching (Oyoo 2004). They, however, did explain meanings of technical words or science words such as "work" and "power." This apparent inability to distinguish between non-technical words and technical words is recorded here as an indicator of teacher unawareness of the functional value of the non-technical words common in the language typical of the science classroom. The admission by the participant teachers that "this study was actually an eye opener" can therefore be accepted as confirmation that prior to this study, the participant teachers had no awareness of the potential difficulty of non-technical words commonly used during teaching other than the technical words – the science concepts. This finding on teacher unawareness of the difficulty learners encountered with meanings of everyday words when used in the science context has also been reported in the Oyoo (2012) study of Kenyan physics teachers. The participant teachers' (originally prepared as science teacher at four different countries including South Africa) unawareness of the potential difficulty of the non-technical words when used in the science context suggests that the science teachers who participated in this South Africa study could have contributed to the difficulty that participant learners faced with everyday words as used in the questionnaire. The participant teachers therefore contributed to the difficulty of language of the science classroom and, by extension, also to the low outcomes in science as discussed in the opening paragraph to this article. The participant teachers' language-use practices during teaching were therefore wanting.

Drawing from these findings, it has now become possible to re-emphasise that difficulties with the meanings of non-technical words used in the science context (and therefore with the science classroom language) will be encountered where there has been a failure to recognise that "every day words cease to be mere English words when used in a science context" (Marshall and Gilmour 1991, 334) Difficulty of the science classroom language in addition to general/simple proficiency, is also because of how the words mean differently when the context of use changes like when the words are used in science.

Based on literature accessed for this article and the findings in this study, it has now become possible to affirm that: Proficiency in the language of instruction, though a prerequisite for any understanding in a LOLT, may be just one factor of the difficulty of the science classroom language, or, for this study, of non-technical words when presented in the science context. In South Africa, and as may need be the case in all science learning contexts, this article serves as a recommendation that physical science

teachers should be encouraged to ensure that as a policy during teaching, the meanings of non-technical words are shared with the learners during all use, as a means to more successful learning of science for improved outcomes. The impact of this suggested practice policy on use of language during teaching by science teachers can be felt more with adjustment of curricula used at initial teacher education stage to also include issues on language use and talk in teaching and learning science, as well as (perhaps more aggressively) through in-service or continuing professional development ventures and by continuing professional educators (Korthagen 2017). This study has been an "eye opener" according to all the participant teachers including those who received their initial preparation as science teachers at South African institutions. Revision of the science teacher education curricula to include language issues (as focused on in this article) in learning and teaching science will be necessarily placing teachers to recognise in their daily work, that the context in which a word is used affects its comprehension or understanding. Teachers and all other stakeholders therefore need, as a new practice or management policy, to shift from considering the learners' ability to learn science to be based only on attaining general proficiency in a LOLT but also on attaining/development of contextual proficiency. It will be moving away from the current practice as presented on this article's banner quote that,

> … any learning difficulties observed in South African science learners who learn in a language other than their home language are still generally assumed to stem almost exclusively from such learners' perceived lower levels of proficiency in the LOLT. (Oyoo 2017, 791)

In this study and in the similar study (Oyoo 2012) that informed it, the appropriately qualified and appreciably experienced teacher participants demonstrated lack of awareness as well as difficulties with these same words in similar ways as their respective students. A change in the practice policy by science teachers at school level on approaches to use of language during teaching as well as by science teacher educators at initial preparation of science teacher institutions seems urgent, as a means to turn around the low science outcomes as are the current concern in South Africa. In the Oyoo (2012) study where similarly educated teachers were the participants for example, participant teachers were unanimous that during their initial preparation as science teachers there had been no particular focus on language in learning science like has been in the study reported in this article; the following responses were typical of the submissions:

> Well, in my training I don't remember having looked at specific words and may be giving concern to meanings of certain words. It was not stressed during my training and I just learn of the problem of the use of words during my teaching. (T1)

> It was not stressed in college; it is something that you just discover on your own in the field. (T2)

> It was not stressed but what was stressed was always to write spellings on the board when you are dictating notes and you come up with a new word when you are writing; that one was stressed and a bit of explanations but not so much. (T6) (Oyoo 2012, 868)

It is these kinds of admissions that can be taken to further justify the argument for adoption of new practice policies as so far suggested in this article, by classroom teachers as well as science teacher educators at teacher preparation levels.

Compliance with ethical standards: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and comparable international standards. Informed consent was obtained from all individual participants (and ascent from the parents of participant minors) in the study after being informed of their research participation rights.

Acknowledgments

Sincere thanks to the Editor and the two anonymous reviewers for the insightful comments on an earlier version of this work.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work is based on the research supported by National Research Foundation (NRF) of South Africa Grant Number [113631] to the first author.

Notes on contributors

Samuel Ouma Oyoo is an Associate professor NRF-rated researcher currently affiliated to both the Department of Science and Technology Education, University of South Africa, Pretoria, South Africa, and School of Education, Maseno University, Maseno, Kenya. He researches and publishes in science education and science teacher education in Kenya and South Africa.

Nkopodi Nkopodi is the Associate professor Chair of the Department of Science and Technology Education, University of South Africa. His sustained research and publication interests are in Language in Science as well as Indigenous Knowledge Systems; he has also conducted numerous workshops for science and mathematics teachers in South Africa.

References

Achebe, C. 1990. "What Has Literature Got to Do with It?" In *Hopes and Impediments: Selected Essays*, edited by C. Achebe, 154–170. New York and Toronto: First Anchor Books Edition.

Bulman, L. 1988. *Teaching Language and Study Skills in Secondary Science*. London: Heinemann Educational Books.

Cameroon, L. 2009. "Higher Grade Dinaledi Schools Initiative Helps Boost Mathematics and Science Pass Rates." *Engineering News* 29 (32): 1–104.

Capazorio, B. 2013. "Millions Spent on Science and Maths Education, but Little Change- Report." *The Saturday Star*, June 22.

De Vaus, D. A. 2002. *Surveys in Social Research*. 5th ed. Australia: Allen & Unwin.

Department of Basic Education (DBE). 2010. "The Status of the Language and Teaching (LOLT) in Schools: A Quantitative Overview." Accessed 14 November 2020. https://evaluations.dpme.gov.za/evaluations/135

Department of Education (DOE). 2009. *The Dinaledi Schools Project Report: Report from a Strategic Arrangement between the National Department of Education and Business on Increasing Support for Mathematics and Science in Schools*. Pretoria: Department of Basic Education Publications.

Fensham, P. J. 2004. *Defining an Identity: The Evolution of Science Education as a Field of Research*. Dordrecht/London/Boston: Kluwer Academic Publishers.
Gardner, P. L. 1971. *Project SWNG – Scientific Words: New Guinea*. Melbourne: Faculty of Education, Monash University.
Gardner, P. L. 1974. "Language Difficulties of Science Students." *Australian Science Teachers Journal* 20 (1): 63–76.
Gardner, P. L. 1977a. *Logical Connectives in Science: An Investigation of Difficulties in Comprehending Logical Connectives in Both Scientific and Everyday Contexts Amongst Junior Secondary School Students in Victoria*. Melbourne: Faculty of Education, Monash University.
Gardner, P. L. 1977b. "Logical Connectives in Science: A Summary of the Findings." *Research in Science Education* 7 (1): 9–24. doi:10.1007/BF02643108.
Giancoli, D. C. 2005. *Physics: Principles with Applications (International Edition)*. Upper Saddle River, NJ: Pearson Education.
Greenfield, D. 2010. "'When I Hear Afrikaans in the Classroom and Never My Language, I Get Rebellious': Linguistic Apartheid in South African Higher Education." *Language and Education* 24 (6): 517–534. doi:10.1080/09500782.2010.502969.
Gyllenpalm, J., P. Wickman, and S. Holmgren. 2010. "Teachers' Language on Scientific Inquiry: Methods of Teaching or Methods of Inquiry?" *International Journal of Science Education* 32 (9): 1151–1172. doi:10.1080/09500690902977457.
Hodson, D. 2009. *Teaching and Learning about Science. Language, Theories, Methods, History, Traditions and Values. The Language of Science and Science Education*. Netherlands: Sense Publishers.
Howie, S. J. 2003. "Language and Other Background Factors Affecting Secondary Pupils' Performance in Mathematics in South Africa." *African Journal of Research in SMT Education* 7: 1–20.
Korthagen, F. 2017. "Inconvenient Truths about Teacher Learning: Towards Professional Development 3.0." *Teachers and Teaching: Theory and Practice* 23 (4): 387–405.
Kriek, J., and D. Grayson. 2009. "A Holistic Professional Development Model for South African Physical Science Teachers." *South African Journal of Education* 29 (2): 185–203. doi:10.15700/saje.v29n2a123.
Makgato, M. 2007. "Factors Associated with Poor Performance of Learners in Mathematics and Physical Science in Secondary Schools in Soshanguve, South Africa." *Educational Research* 4 (1): 89–103.
Marshall, S., and M. Gilmour. 1991. "Problematical Words and Concepts in Physics Education: A Study of Papua New Guinean Students' Comprehension of Non-technical Words Used in Science." *Physics Education* 25 (6): 330–337. doi:10.1088/0031-9120/25/6/309.
Oxford South African Secondary School Dictionary for Grades 8–12 (OSASSD). 2018. Cape Town: Oxford University Press Southern Africa.
Oyoo, S. O. 2004. "Effective Teaching of Science: The Impact of Physics Teachers' Classroom Language." PhD diss., Monash University.
Oyoo, S. O. 2007. "Rethinking Proficiency in the Language of Instruction (English) as a Factor in the Difficulty of School Science." *The International Journal of Learning* 14 (4): 231–238.
Oyoo, S. O. 2008. "Going Round the Foreign Language Problem in African Science." In *Teaching and Education for Teaching in Developing Countries*, edited by A. Garuba and I. Irwin, 103–124. Winneba, Ghana: SACOST, University of Education.
Oyoo, S. O. 2009. "Beyond General Proficiency in Language of Instruction: Towards the Appropriate Perspective on Language for Effective Learning in African Science Classrooms." In *Proceedings of the 17thAnnual Conference of the Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE 2009)*, edited by M. Shafer and C. MacNamara, 197–212. Republic of South Africa: Rhodes University, 19–22 January.
Oyoo, S. O. 2010. "The 'Anatomy' of the Instructional Language of Science Classroom: How Physics Teachers Use It, What They Think about It and Why." *Proceedings of the Institute for Science & Technology Education (ISTE) University of South Africa International Conference*, 200–218. Republic of South Africa: Kruger National Park, October 18–21.

Oyoo, S. O. 2012. "Language in Science Classrooms: An Analysis of Physics Teachers' Use of and Beliefs about Language." *Research in Science Education* 42 (5): 849–873. doi:10.1007/s11165-011-9228-3.

Oyoo, S. O. 2013. "Foreign Languages in African Science Classrooms: Perspectives on and Approaches to Language Use during Teaching." *Conference Book*: Refereed *Proceedings of the Distance Education and Training in Africa* Conference *(DETA), Volume 2*, 121–147. Maputo, Mozambique: University of Eduardo Mondlane, 3–5 August 2011

Oyoo, S. O. 2014. "Language of Instruction and Science Learning in African Science Classrooms." In *Multilingualism and Education in Africa: The State of the State of the Art*, edited by D. O. Orwenjo, M. C. Njoroge, R. W. Ndung'u, and P. W. Mwangi, 24–49. Cambridge: Cambridge Scholars Publishing.

Oyoo, S. O. 2017. "Learner Outcomes in Science in South Africa: Role of the Nature of Learner Difficulties with the Language for Learning and Teaching Science." *Research in Science Education* 47 (4): 783–804. doi:10.1007/s11165-016-9528-8.

Postman, N., and C. Weingartner. 1971. *Teaching as a Subversive Activity*. Harmondsworth: Penguin Books in association with Pitman Publishing.

Prinsloo, C., and S. Rogers. 2013. "The Missing Link: Language Skills Crucial to Mathematics and Science." *Human Sciences Research Council Review* 11 (2): 26–27.

Prinsloo, C. H., and J. C. Harvey. 2018. "The Differing Effect of Language Factors on Science and Mathematics Achievement Using TIMSS 2015 Data: South Africa." *Research in Science Education*. doi:10.1007/s11165-018-9769-9.

Reddy, V., A. Kanjee, and G. Diedericks. 2007. *Mathematics and Science Achievements at South African Schools in TIMSS 2003*. Cape Town: Human Sciences Research Council.

Scott, P., E. Mortimer, and J. Ametller. 2011. "Pedagogical Link-making: A Fundamental Aspect of Teaching and Learning Scientific Conceptual Knowledge." *Studies in Science Education* 47 (1): 3–36. doi:10.1080/03057267.2011.549619.

Scott, P. H. 1998. "Teacher Talk and Meaning Making in Science Classrooms: A Vygotskian Analysis and Review." *Studies in Science Education* 32 (1): 45–80. doi:10.1080/03057269808560127.

South African Institute of Race Relations. 2013. "Press Release: Only 1 in 5 Matrics Get More than 50% in Maths and Science." January 29. Accessed 14 November 2020. https://irr.org.za/media/media-releases/1_in_5_matrics_get_50-for_maths_and_science.pdf/view

Vorster, C., A. Mayet, and S. Taylor. 2013. "The Language of Teaching and Learning in South African Schools." In *Creating Effective Schools*, edited by N. Taylor, S. van der Berg, and T. Mabogoane, 135–156. Cape Town: Pearson.

Vygotsky, L. 1986. *Thought and Language*. Cambridge, MA: MIT Press.

Wilson, J. 1999. "Using Words about Thinking: Content Analyses of Chemistry Teachers' Classroom Talk." *International Journal of Science Education* 21 (10): 1067–1084. doi:10.1080/095006999290192.

Appendix A. The Questionnaire

Learners' Meanings of Selected Non-Technical Words when used in the Science Context

(a) Admission Number..... (b)Are you Male/Female (Please Circle)

(c) Language used most while at (i) School..... (ii) Home.....

This questionnaire has questions, which are to find your ideas about some words used in science education. **It is not a test**, so you need not to worry about your answers as being right or wrong. Your responses will be kept very confidential. Attempt all questions. After finishing, drop this questionnaire immediately into the collection envelope. To record your answers to the questions do 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 for 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 that
A. reacts with some of the water
B. simply falls through the water to the bottom of the beaker
C. gets bigger
D. pushes away some of the water
3. The speed limit for the vehicles was 40 km/h. This means that vehicles could travel
A. at exactly 40 km/h
B. between 45 and 35 km/h
C. at an average speed of 40 km/h
D. at not more than 40 km/h
4. If you are asked to describe how to prepare oxygen, it means that you are to say
A. how it is made
B. what it is used for
C. how it behaves
D. what substances are needed to make
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. During some chemical reactions, heat is generated. This means that heat is
A. lost
B. gained
C. produced
D. is not needed
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 characteristic smell. This means the gas had
A. nice smell
B. smell unlike any other
C. strong smell
D. bad smell
9. 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
10. Some students were studying the fundamental 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 constant. This means it was
A. staying the same

B. getting colder
C. getting hotter
D. getting hotter then colder

12. The experiment was designed to prove that the brass rod would contract as the temperature fell. This means the rod would
A. change colour
B. become harder
C. become shorter
D. become longer

13. The teacher felt the learners' interpretation of experimental results was valid. This means the teacher felt it was
A. well argued
B. not correct
C. brief
D. very new

14. 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

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

16. The learner's concept of chemical bonding improved when he worked through many exercises. This means the learner's
A. issue improved
B. design improved
C. idea improved
D. method improved

17. The class is studying the diversity of plant life in the school compound. This means that 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 the plants.

18. The car's movement was linear. 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 learner was trying to find a chemical that would retard 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 effect 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 consistent. This means the results were
A. variable
B. the same
C. adequate
D. adjusted
22. The pupil knows the function 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 system. 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 convention, 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
D. has been arrived at but is still subject of controversy
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 negligible. This means the learner felt that pressure
A. was the only factor operating
B. was the most important factor
C. need not to be taken into account
D. was the first factor to operate
26. Your science teacher said she was going to evacuate the flask. This means the teacher will
A. cool it in vacuum
B. close the flask
C. clean the flask
D. empty the flask
27. 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.
28. The students were able to estimate 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
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 teacher referred to the motion of the solid particles suspended in the water 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

Thank you for taking time to complete this questionnaire