SCIENCE TEACHERS’ AWARENESS OF THE IMPACT OF THEIR CLASSROOM LANGUAGE

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ABSTRACT

One reason the quality of approaches in science teaching are often equated with kinds of practical activity that teachers and students engage in is because school science has tended to be viewed mainly as a ‘practical subject’. While in practice, the teaching of science involves practical work as well as use of language, often written or in the form of teacher and student talk, the manner of talk or use of the language of instruction in the classrooms by the science teachers as a factor in the quality of learning or the persistently and comparatively lower outcomes in school science subjects is still a rare focus in science education research. This article draws from findings from an exploratory study (Oyoo 2004) that sought to answer the question: How is the manner of use of language of instruction in the classroom by the science teachers a source of the difficulties students encounter in learning and retaining scientific concepts? Evidence is provided of teachers’ general unawareness of the nature, functional value and difficulty of the non-technical component of their classroom language. Implications of this general science teachers’ unawareness on the initial preparation and continuing professional development of science teachers are considered.

INTRODUCTION AND OVERVIEW

School science has tended to be viewed mainly as a “practical subject” (Wellington & Osborne 2001: 3) although its teaching involves practical work as well as use of language. The use of both these approaches is evident in characteristic practice during effective teaching of science as described by Matthews (1998)

…teachers convey the ideas of science by trying their best to explain the concepts and operations clearly, to make use of metaphors, to use demonstrations and practical work to flesh out abstractions, to utilise projects and discussions for involving students in the subject matter. (Matthews 1998: 9)

With regard to practical work, this has been highlighted in the assertion that

…meaningful practical work, whether by scientists or by children, is always embedded in conversation, – a discussion of ideas that makes it necessary to check those ideas against experience. (Sutton 1998: 174)

This means that in establishing scientific knowledge in the classroom, the teachers’ and students’ talk around the activities is at least as important as the activities themselves (Leach & Scott 2003; Mortimer & Scott 2000; Ogborn, Kress, Martins & McGillicudy 1996; Sutton 1998; Wilson 1999). While the suggestion that teaching and learning generally occurs extensively in the medium of language is in the fact that language used in teaching science is often written or in the form of teacher and student talk, the importance of teacher talk in all learning may be based on the common observation across a wide range of teachers and countries that the greater percentage of talk in many classrooms including those of science comprises that of the teacher (Barnes, Britton & Rosen 1969; Barnes 1976; Barnes, Britton & Torbe 1986; Barnes & Todd 1995; Edwards & Mercer 1987; Wilson 1999; Bleicher, Tobin & McRobbie 2003). Edwards and Mercer
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(1987) have presented proportions of classroom talk to illustrate this in their two thirds’ rule: “for about two thirds of the time someone is talking; about two thirds of this talk is the teacher’s; about two thirds of the teacher’s talk consists of lecturing or asking questions” (Edwards & Mercer 1987: 25).

While the actual percentage of teachers’ classroom talk in science classrooms may be expected to be dictated by the content to be learnt or teaching approach, the prevalence and prominence of teachers’ classroom talk suggests that the teachers’ classroom language has the potential of impacting students’ learning in very important ways. This may particularly be argued when the analysis, perhaps the most comprehensive so far, of general purposes of the science teachers’ classroom talk is considered (see Scott 1998). While this was an analysis of a “teaching performance mediated by talk, through which scientific ideas are introduced and explored on the intermental plane of the classroom” (Mortimer & Scott 2000:132), it has revealed more explicitly the fact that talk is important in all activities associated with effective teaching and learning of science (see also Fensham 2003: 208). This article is about the need to recognise the role of the science teachers’ talk as it might impact on students’ learning of science concepts.

The components, nature and difficulty of science teachers’ language

The language used in teacher’s classroom talk has two parts: technical component and non-technical component. The technical component is made up of technical words or terminologies specific to a science subject; these may also be referred to as technical terms, scientific terms/terminology, or simply science terms. The science words form the distinctive body of concepts which mark out science from other subjects, or between the different school science subjects, for example, physics, as may be distinct from biology or chemistry. Regardless of the base language, the meanings of these words must be as known in the international science community circles, for example, the International Union of Physical and Applied Physics (IUPAP) or Chemistry (IUPAC). The technical/science words are everyday words “deliberately” (Miller 1999:11) used as science words and have new (scientific) meanings in addition to their every day meanings (Sutton 1992).

…technical words include such things as physical concepts (mass, force…) names of chemical elements, minerals, plants, organs, processes, apparatus etc. (Gardner 1972: 7)

Wellington (1994) has classified these to fall into four different categories with regard to how they acquire their meanings: into naming words, process words, concept words and Mathematical words and symbols.

The non-technical component of the science teachers’ classroom language is made up of non-technical words. It is this part of the science teachers’ classroom language that may be referred to as the medium of classroom instruction or interaction as separate from the technical terms. This component of the science teachers’ classroom language thus becomes recognisable to be the same as the language in which a science text book is written. In addition to words which, in science education research literature relevant to
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This article, have often been referred to as non-technical words, metarepresentational terms (Wilson 1999) and logical connectives (Gardner 1977a, 1977b) as two distinct categories of words in the non-technical component of the teacher’s classroom language are also referred to as non-technical words in this article. The non-technical component of classroom language of instruction/interaction therefore consists of three categories of non-technical words: non-technical words in the science context (Gardner 1971), metarepresentational terms and logical connectives.

Gardner (1972) used the following sentence to illustrate examples of ‘non-technical words in the science context’:

Gas molecules display random motion; we may predict their behaviour from theoretical considerations: the actual volume of the molecules may be neglected. (Gardner 1972:7)

The four words: random, predict, theoretical and neglected, though not ‘technical terms’, remain key words in the sentence, with regard to the understanding of the behaviour of the gas molecules, on the assumption that the meaning of the (technical) term molecule is known to the learners. Each of these words embodies certain concepts important to the process of learning specific science subjects but in different way to when everyday words are used as science words, when they become distinct science concepts.

Wilson (1999) has explained that metarepresentational terms (considered in this article as a special category of non-technical words) consists of metacognitive and metalinguistic words:

Metalinguistic verbs are words which take the place of the verb to say (e.g. define, describe, explain, argue, criticize, suggest), while the metacognitive verbs are words which take the place of the verb to think (e.g. infer, calculate, deduce, analyse, observe, hypothesize, assume, predict). (Wilson 1999: 1069)

Gardner (1977: v) referred to logical connectives are “words or phrases which serve as links between sentences, or between propositions within a sentence, or between a proposition and a concept”. Examples include conversely, if, moreover, because, therefore, in order to, consequentely, by means of, since, etc. As evident from these examples, logical connectives are “words that are commonly used in the oral or written discourses of science to link observation to inference, theory to explanation, hypothesis to experiment, experiment to findings etc,” (Fensham 2003: 202).

In summary, the science teacher’s classroom language consists of technical and non-technical words, similar to the specific register of any particular science subject. The general value of the all words in the science teachers’ classroom talk, hence of the language characteristic of science teachers’ classroom talk may be evident in the following reference to the term ‘register’ by Edwards and Westgate (1994).
...registers associated with particular school subjects can be seen as containing both the terms embodying concepts essential to their practice, and markers of academic boundaries between one subject and another, and between school knowledge. (Edwards & Westgate 1994: 20)

This reference to the term ‘register’ suggests that the words in the science language serve to mark out the different science subjects by illuminating and being illuminated in return by the same subjects. In other words, these words are involved in a kind of symbiotic relationship with the science subject in question, with regard to identity provision and acquisition.

The general difficulty of words in the science teachers’ classroom language

The general difficulty of science words/concepts, science content and therefore school science, is well known world over. Evidenced in TIMMS reports and as had earlier been asserted by George (1999), the extent of general difficult of school science only varies depending on the specific circumstances in different countries. In addition to that of the science words, all categories of words in the non-technical component of the science teachers’ classroom language are difficult. This claim is based on the finding in a review of cross-national studies of students’ understandings of these words (Oyoo 2004), in which the focus was on the influence of students’ proficiency in the language of instruction (English) on levels of understandings of the words. The general outcome as the conclusion in this review is that ‘students encounter difficulties with everyday words common in science teachers’ classroom language irrespective of whether they learn science using their first language or not (linguistic circumstances ) and whether they are females or males (their gender)’. This general outcome, would serve as a caution in explaining students’ difficulties with these words, on their perceived levels of proficiency in the language of instruction – every day words when use in science or as science words cease to be mere English words (Marshall, Gilmour 1991; Marshall, Gilmour & Lewis 1991). An important revelation in the review based on the types of difficulties students encountered with these words was that the students need to recognise the words first before they can tell the meanings of these in the context of use. Students’ understanding of the meanings of everyday words, when used as science words and in science context would result in enhanced students’ understanding or internalisation of the concepts taught. This is argued on the basis of the now long established role of language in all learning (Vygotsky 1998) and the justifiable need for teacher intervention in successful learning of school science (Driver 1989; Hodson & Hodson 1998; Hodson 1999).

THIS STUDY

Based on the prominence and prevalence of science teachers’ classroom language as already argued in the introduction and overview section of this article, the general difficulty of the science teacher’s classroom language, may also be expected to stem from teachers’ approaches to use of language in the classroom. Appropriateness of this language to the level of schooling and general background of the learners (as the teacher may be expected to know), may therefore be of utmost importance. Evidence of neglect of the vital role of science teachers’ classroom talk on learning (Mortimer & Scott 2003),
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hence the only explanation for the availability of scanty literature in this area to date (see also Fensham 2003; Yore, Bisanz & Hand 2003), is the fact that “manner of use of language of instruction in the classroom by the science teachers as a source of the difficulties students encounter in learning and retention is still a rare focus in science education research” (Oyoo 2004: xi). This article is therefore a direct contribution to populate the current void in the literature; it draws from an exploratory study (Oyoo 2004) that sought to answer the question: How is the manner of use of language of instruction in the classroom by the science teachers a source of the difficulties students encounter in learning and retention of scientific concepts? The findings presented in this article are based on data from direct classroom observations and teacher interviews; some of this data was unobtrusively obtained using content analyses (Krippendorff 2004) of transcripts of verbatim teachers’ classroom utterances. The focus therefore was on one of the specific aims in the larger study as stated below.

To explore whether teachers of physics/science are aware that differences in word meanings in everyday parlance to when used in the science context, is a source of the difficulties in learning science to their students? If so, then how do they respond or what are they doing about it? (Oyoo 2004:86)

The context of the study

The study on which this article is based drew its participants from secondary schools in Kenya, a country where all school teaching takes place in English, though a second language to both teachers and students (Republic of Kenya (1964-1965). In Kenya, the secondary schools are broadly classified as either public or private. The public secondary schools are the majority and these are further categorised as National, Provincial or District schools. The primary school pupils usually progress to the secondary level upon satisfactory attainments on the end of the primary cycle examination, the Kenya Certificate of Primary Education (KCPE). The quota system used in the selection of pupils into the secondary schools ensures that the National school and the majority of the Provincial secondary schools always get students with higher KCPE scores than the District schools. In spite of this outcome of the method of selection into the secondary schools all students at entry into the public secondary schools in Kenya, at Form One level, will generally have attained satisfactory levels in the skills of writing, arithmetic, creativity and communication skills of listening and self expression – skills necessary for smooth transition to secondary education (Republic of Kenya 1999). In the study, nine physics teachers, from six secondary schools (1 National school, 3 well established provincial schools and 2 District schools, from rural and the most urban locations in Kenya) participated. All the teacher participants were graduates of Kenyan universities; all the participant teachers were therefore appropriately qualified. Only 2 of the physics teacher participants were females. 5 were teachers at three girls’ only schools, and 4 at three boys’ only secondary schools. The lengths of teaching service of these teachers ranged from 2 to 23 years. At the time of this study, 6 participant physics teachers were serving heads of science or physics departments in their respective schools; the majority of them then were therefore very senior teachers.
DATA ANALYSIS

“As ever, your research questions drive the form of analysis which you choose” (Robson 2002: 450)

The section of the study that is the focus of this article was essentially qualitative; hence the approaches to analyses of this data also had to be qualitative in nature. Generally, an interpretive approach was used in the analyses of the interview responses and the field notes (see Fontana & Frey 2003: 87). In line with the stated aim of the study, the whole process of analysis was guided by the specific concerns in the direct classroom observations and the broad areas investigated in the teacher interviews. The specific concerns that guided the direct classroom observations included the following.

1. What approach to language use do science teachers actually use?
2. Is the communication patterning in the classroom largely one of one-way transmission from teacher to student, or do students have opportunities to engage in conversation with the teacher and with fellow students?
3. Are terms/words used explicitly without explanations or provision of alternative meanings presented?
4. Are the metarepresentational terms (metacognitive and metalinguistic words) implicitly or explicitly made reference to?
5. Does the teacher explain or provide the contextual meanings of non-technical words when used in the science context? If so, then is there a clear approach in doing this?
6. In sharing the contextual meanings of non-technical words used during teaching, does the teacher explore the other possible meanings of these words? Any other approaches used?

Classroom observations of each teacher shaped more specific questions with regard to how each individual teacher used language in class, including a focus on the teacher's opinions on any words (used explicitly or implicitly) that had particularly been found to be difficult in past studies. Consequently, the broad areas revealed in the interviews with the participant teachers and which have been used in the analyses included the following.

• What teachers considered good practice in use of language in the classrooms during teaching,
• How the teachers had changed their teaching approaches with regard to language use in classrooms with time and why,
• Whether there had been specific constraints encountered by the teachers in their classroom teaching, particularly with regard to use of language,
• Awareness of functional value of non-technical words in the school physics register,
• What they learnt as a result of their participation, significance and benefits of this study to practice of teaching school physics.
RESULTS AND DISCUSSION

In the following paragraphs a synthesis of analyses of individual participant physics teachers’ approaches to classroom use of language during teaching is presented. Since focus was in use of language of instruction/quality of explanations given during teaching, excluded in the findings are any specific issues with regard to the accuracy of the lessons’ contents. The nine teachers, for the sake of neutrality, are not given names; they are referred to simply as T1, T2…T9. General descriptions of the teachers’ approaches to classroom use of language based on both classroom observations and content analyses of transcripts of teachers’ classroom utterances/talk are first presented. This is followed by explanations of the observations, based on interviews with teachers to present understandings of their approaches to use of language during teaching. Although the participants were physics teachers, the word physics need to be recognised to represent science; the selection of physics teachers was only because the researcher has specific expertise in school physics curriculum.

General approach to use of language in classrooms

Generally, there were explicit and implicit references to the words, and apart from the technical terms, the everyday words special to the register of school physics in the topics covered were used. In all of the lessons observed, the teachers did most of the talking and the students in most instances, talked only when they were expected to respond to teachers’ questions. Examples of the participant teachers’ approaches to generally control the talk during the lessons included: selecting who to talk among those whose hands would be raised up to answer a question, students not being expected to verbalise any concerns but to instead raise up the left hand for the teacher to know when there is a difficulty, teachers refusing to give answers to questions asked, teachers rushing through the lessons hence giving no time for any questions, and teachers deciding who to ask a question irrespective of whether a student had his/her hand raised up. This was in addition to teachers deliberately ignoring to explain meanings of certain words in the context as used during the lessons observed. The mode of communication was generally one-way from teacher to students; this style of communication could be taken as a reflection of the teachers’ preferred general teaching approach, apparently influenced by their conceptions of the nature of and teaching of physics. This manner of control of the lessons is considered a style of classroom management in the face of the amount of content in the science curricula that teachers have to cover in a given time. Within these constraints on teachers of physics, the teacher-student interactions in the (secondary school physics) classrooms in this research were reflections of understandable modes of classroom interaction that may be prevalent in similar classrooms across the country.

Explanations of meanings of non-technical words used in the science context

While five teachers clearly favoured explaining to the students, the meanings of words in the context of the lessons, in all cases meanings of some words which had been detected as difficult in studies of students’ difficulties with non-technical words were not explained. Convention and Characteristic are the problem words whose meanings in the context of use had not being explained by T3, T4, and T8. This served as an indicator of
the possible role of the teachers in the difficulties students encounter with these words. In instances where the teachers provided the meanings of the words in the context of use, different approaches to explaining the meanings of certain non-technical words to the students were used. Salient among these included 1) being precise with word meanings or avoidance of ambiguity in word use, 2) teachers using simple language in the classrooms, and, 3) teachers announcing at the end of a lesson, difficult words expected in the lessons to follow so that students could look for their meanings in advance; 4) one teacher, coincidentally, the one with the longest experience of the nine who participated, stood out in clear favour of making word meanings accessible by using examples from the students’ immediate environment, including examples from the students’ dominant local culture.

As evident in the individual lesson analyses, the language the teachers used, in many cases, seemed to be constrained by requirements of the assessment of content learnt. Teachers clearly stressed the meanings of certain words only as they gave tips to the students on how to respond should they meet the concepts/words in the examinations. TI, for example cautioned his students that “the moment you see the word ‘specific’, then we are talking about a unit mass.”

The frequency of explanations given by the teachers apparently depended on length of teaching experience, with those new to the profession explaining the least. The teachers, who were newer to the profession still tended to operate in very abstract terms. In other words, their general approaches did not include moulding the content in the physics course book to make it more understandable to their students – they in effect taught textbook physics. The newer teachers in addition, displayed impatience and uncoordinated presentation of the concepts during their lessons, apparently in attempts to get through all work planned for the lessons observed; this approach could be taken to have been unhelpful to students’ understanding of concepts taught including non-technical words.

In almost all cases where metarepresentational terms (metacognitive and metalinguistic words) were used by the participant teachers during the lessons observed, these were exclusively when numerical questions (problems) were being solved; their meanings were generally only minimally explained by the teachers. Most participant teachers had observed during the interview that their students lacked understanding of word problems (questions) and were also often unable to interpret word questions. While lack of understanding of content may have been the main reason behind these difficulties, the non-explanation of the meanings of the metarepresentational terms may have also been another factor. This approach in language use was therefore illustrative of an “inadequate introduction to the students to the language associated with science” (Rodrigues & Thompson 2001: 936). It potentially presented the students some difficulties in learning physics, and therefore was not helpful in facilitating students’ understanding of the characteristic classroom language of science teachers.
Understanding relative ease with which the teachers gave explanations

Generally, it was apparent that the relative ease with which the teachers gave explanations of any words they used in their teaching and the amount and quality of explanations, depended on teachers’ relative mastery of the subject matter content in the school physics curriculum. This mastery apparently came with experience, as may have been implicit in the observation that the newer teachers still appeared to struggle while explaining the content, including key words in the classrooms. This seemed to lend support to the claim that new teachers may appear incompetent teachers because on starting on as teachers, they need to first adjust to the teaching demands of teaching (Asoko 2000). In addition to length of teaching experience, the level and scope of training also seemed to have been a factor in the quality of explanations the teachers gave. The two physics teachers (T6 and T8) who had given quality and extensive explanations of the meanings of non-technical words in the context as used in their lessons had undertaken more than four years of teacher education. In addition to the 2 years to qualify with a Diploma in Science Education as the initial teaching qualification, they had also studied for the 3 year Bachelor of Education (Science) degree.

Fast speech and level of abstractness

The observed relative difficulty of physics teachers’ adjustment to school students’ levels, in terms of speed of talking and level of abstractness during teaching was, apparently the result of these teachers’ setting too high standards for the school students. This may be interpreted from the following.

Actually during training, we cover physics … at very high levels and therefore we use harder and very abstract words… So when you come back to do school physics, things are very simple then you think everybody is seeing it that way. (T1)

This approach called for the need for the teachers to adjust in order to fit in with the opinion of teacher T5 during interview, on what it has to take to be an effective teacher of physics – the need for a teacher to put her/himself in the learner’s shoes. The apparent message conveyed by this opinion with regard to adjusting to the school students’ levels was that teachers should avoid displaying too much content; instead they should take more notice of the basics. Giving meanings of everyday words in the context of their lesson, especially on the fact that they mean different things when used as science words or in science as already discussed in this article may be considered as one aspect of taking note of the basics.

Teachers’ awareness of value of non-technical words in their classroom language

The teachers who participated in the research generally seemed to view students’ difficulties in learning physics to stem only from the difficulty of the subject and not from difficulties encountered with the contextual meanings of the non-technical words when used in the science context. Non-explanation of the meanings of non-technical words may have been the first indication of the participant teachers’ level of awareness of the extent of the difficulty of the non-technical component of their classroom language.
Perhaps glaring evidence was the opinion of one of the participant teachers, T5, who even suggested that the non-technical words would become known by the students after being used repeatedly for two to three years.

The students know most of the words in English and some of these need not be explained to them. Some words like the, ‘illustrate’, ‘define’; they will come to know after being taught for two or three years. (T5)

While this conveyed the message that there was therefore no need to explain the words, T5 may have been influenced by the general ability of his students, all of whom were of above average academic ability, apart from having attained only ‘A’ grades in KCPE English. Other opinions served as more evidence of general teachers’ unawareness of the functional value or difficulty of words in the non-technical component of their classroom language. For example, there were opinions to suggest that those who had not recognised the value of these words would not explain them during teaching of physics. The following T7’s, opinion in regard to this was in response to the question “…do you think there is a way in which the science teachers can make sure students are not getting problems with those words like ‘basic’, fundamental etc.?“ (R).

This could be if we recognise these terms as physics terms and to be explaining the meanings of these terms each time they are used so that they know the other meanings of the words. (T7)

This opinion by T7 seemed to tally with another one from T1, a more experienced teacher participant in response to the question: “So for those words whose meanings you’ve still not gotten the view that they confuse the students, you still don’t explain those ones?”

I don’t explain and may be up to now I have not discovered that they have a different meaning for that word or they don’t have a meaning for it. But as I mark the exams, I come to meet certain words whose meanings they misuse…. (T1)

Teachers’ apparent assumption that the difficulty of physics could not stem from difficulty of non-technical words that describe its register, but only from that of technical terms (physics terminology) was considered as evidence of their unawareness of the value of non-technical words. This was particularly evident in one participant teacher’s response regarding the role of language in students’ understanding of physics; the response was to the question: “Do you think that it [the students’ language problems] can be classed as a factor in making the students not to like physics?”

In physics there are not too many terms like in biology and chemistry, yet they find physics to be difficult. Can it be a major factor? I doubt whether it is a major factor because there are some subjects where terms are so new but still they like it. (T7)

While T7 went ahead to argue that mathematics was the major factor in the difficulty of physics, his response as above revealed his level of awareness of the place of non-
technical words in students’ enhanced understanding of the science concepts. This response could also be considered to reveal existence of an apparent conception of ‘terms’ as difficult everyday English words and terms as science words at the same time. While such a conception may be expected with those who teach in a second language – to them, both categories of words may well be seen as basically English words, participant teachers were aware of the differences. This was revealed in the following opinion by one of the participant teachers, an opinion that seemed to suggest that it was not necessary for science teachers to talk in science classrooms.

Flowery language goes against teaching science since it will make learners not get the feel of what science is. … Science language gives little latitude for use of a lot of English words. … The science teacher has no time to explain the English words as this is best explained in English lessons; the teacher has to be simple though. (T4, Emphasis added)

This opinion also revealed participant teachers’ unawareness of their responsibility to explain the meanings of non-technical words in the context of use in their classrooms as well as serving as evidence that due recognition to the functional value of the words in the non-technical component of their language was lacking. As evident from the opinion by T4 (in the quote immediately above), with regard to functional value of non-technical words in the subject registers, these are considered as mere English words. T4, in stating that the “science teacher has no time to explain the English words as this is best explained in English lessons”, represented his (and possibly other teachers’) disregard for, and hence unawareness of, the character of the non-technical words in the language typical of science teachers talk. Evidence that this unawareness was also with regard to words in the language of science texts was in the opinion by T1 below, also recognised as an explanation many a teacher would give, of the participant teachers’ tendency of not explaining all the words’ meanings during their teaching as so far reported in this article.

I believe that in every lesson there is a word that goes unexplained which in my belief is simple and assume they know the meaning and I believe that many of us science teachers still don’t explain words and expressions… I believe there are many of such teachers who don’t explain these things. Not because they don’t want to... it is not their fault. They also think … the meaning is normal and if it is put like that in our textbooks, then every person should just understand. That is what we think. (T1)

The attempt by T1 to explain away the tendency of many words passing with their meanings in the context of use unexplained also served as evidence of their level of unawareness of the role of these words on the basis of their having been unquestioning of the potential difficulty of everyday words as used in the course textbooks.

**Understanding participant teachers’ approaches to use of language in classrooms**

Given the levels of training of these teachers, their grasp of the subject matter content was clearly to the appropriate level; their grasp of the language of instruction (English) was also not in question. Interviews with teachers helped to shed light on these
A key observation already mentioned in this article is that, the newer teachers appeared to have more problems when it came to explaining the physics and certain key words in the specific register of the subject than the more experienced ones. This was mainly because the need to be particular about the meanings of non-technical words in the register of school physics and common in language of instruction as used during teaching was not stressed during their training. This submission was made by all participant teachers. Evident in the opinions in the interviews, the teachers who had developed the habit of explaining the meanings of the non-technical words did so because of their teaching or other experiences, including:

To meet the marking standards of the Kenya National Examinations Council (common with the teachers who were examiners with the national examinations’ council); To counter the English language problem of the students; To enhance the understanding of the students, and To counter student misconceptions of the word meanings.

Within the need to enhance students’ understanding of the concepts taught, peer influences also played a part in making one of the teachers, T6, be more particular about the word meanings during her teaching. T6 had been influenced by the practice of biology colleagues. Based on the observed teachers’ classroom practices and interview responses, it may be inferred that what guided their approaches in giving or not giving the meanings of these words were pointers to their teaching circumstances: the quality of their physics students, their teaching experience and how well endowed with science teaching facilities their schools were.

CONCLUSION AND WAY FORWARD

It has become particularly evident from these analyses so far presented in this article, that participant teachers lacked explicit awareness of the functional value of non-technical words in the specific register of the science subjects, separate from the science terms (technical words). This was evident in how they generally seemed to undervalue explaining the meanings of the normal English words when used in the science context, including metarepresentational terms. The everyday words in science context were not thought to be sources of difficulties, despite the fact that, when used in science context, these could assume different meanings; there are implications of these conclusions and findings.

All the words in the science teachers’ classroom language are generally difficult so as a general approach, teachers may need to always providing meanings of non-technical words in the context of use. In order for teachers to be aware of students’ needs or the particular words that are potentially difficult, they may need to give more assessments and be keener during the marking of these. In this study, and despite their lack of explicit awareness of the functional value of these words, most of the teachers who really explained the word meanings in the context of use were examiners with the National Examinations Council in addition to having been teachers in schools for long.
While it has become apparent from the observations in this study that the practice of being particular with word meanings during teaching develops with time, the length of time for this to take root can be shortened. Generally, teachers need to be researchers of their own classroom practices; in other words, teachers need to reflect on and evaluate their own practice. Involving students in evaluation of classroom use of words may also be considered; this is especially because by listening to what the students say, we get to learn how they learn (Shaffer 2002). The need to revise the school science curricula with a view to reducing the number of topics taught is evident and would go along way in releasing more time for school science teachers to more efficiently explain the science in the classrooms. As established in the study, language use in the classroom is a problem common to all teachers involved in the study, albeit a greater or lesser problem depending on individual experiences. Collaboration between science/physics teachers, new and more experienced, and/or with teachers of other subjects may therefore be a means of raising awareness on some of the potentially difficult words or similar words that may have been found to be difficult. Action research in classrooms may also be used (see Macintyre 2000), with a friendly teacher sitting through the lessons of a new teacher and sharing observations on language used during teaching, similar to the direct observations used to collect data in this research. To counter a situation where there may be only one science teacher in a school, collaborations may be in the form of membership and participation in subject associations and groups to enhance their specific subject content and professional knowledge including identifying problem words.

In the research reported in this article, the root cause of teacher unawareness of the need to be very particular about word meanings was, at least in significant part, how they were initially prepared as teachers. What this has suggested is the need to stress during teacher education, the importance of making central the offering of explanations of words/concepts, just as teacher education has always stressed the importance of practical work in learning science. A space for this may introduce a need to reorganise the teacher education curriculum, including the specific curricula of the teaching subjects. While introduction of this new focus will have the immediate benefit of helping the science teacher education graduates to use language appropriate to the circumstances of the school students, there is an urgent need to conduct in-service courses for the teachers currently in service, to update them on the potential impact of their classroom language.

A distinct difference in classroom approaches to use of language was detected between the female and male participants in the study. Despite the need for caution in any interpretation of this on the basis of the size of the sub sample having been was very small (N=2) and their unique preparation in comparison to the other participants, this is recognised as an issue for further research.

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