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Review Article

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Terminology as an Obstacle to Specialized Knowledge Comprehensibility

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Abstract

Numerous factors have always been adduced for students' poor performance in the sciences at all levels of education in Nigeria. Frequently mentioned among these factors are those like lack of qualified teachers, non-availability of ecologically valid textbooks, lack of laboratory equipment, linguistic problems, etc. Though the linguistic factor, of recent, has been given some attention, terminology, which is a major feature of the language of science, has hardly been given the deserved attention The main thrust of this study is that terminology has a great deal of influence on the way students understand and perform in the various science subjects. This, study was carried out to validate this claim. To do this, some explanatory/introductory Biology lessons in a Secondary School in Keffi, Nasarawa State in North Central Nigeria were observed. It was found that, among other linguistic challenges, a good number of students were at a loss when they came in contact with some terms: they were not able to engage with the abstract nature of these terms, neither did they possess the formal reasoning required to support understanding. Findings of this research can be replicated within the teaching context in order to support students in developing better ways of understanding specialized fields.

Keywords: Science; Biology; Terminology; Understanding; Concepts; Disciplinary concepts; Traditional/indigenous knowledge

Introduction

The teaching of western science is usually characterized by a perpetuation of a certain harmful 'mystique of science' that tends to make science seem very difficult. For many students, in the words of Lemke [1] science is "dogmatic, authoritarian, impersonal and even inhuman". For a very long time, western scientists have rejected the traditional knowledge of indigenous peoples as anecdotal, non-quantitative, and unscientific. Scientists are viewed as being geniuses that students cannot identify with. Such views alienate students from the sciences. Analyzing how teachers and students talk science in the classroom can help us to understand how this mystique is perpetuated, why it is harmful, and what we can do about it. Generally, in communication, we communicate better with people who are already members of our own community (of speech), that is, those who have learned to use language in the same ways that we do. When we communicate with people who use language differently than we do, communication becomes much more difficult. This is always the scenario in a science classroom: science teachers belong to a community of people who already speak the language of science, while their students, for a very long time, do not. Though there have been such arguments that the difficulty of understanding science lies more with its grammar than the vocabulary [2], we intend to argue and demonstrate here that vocabulary too has a vital role to play, especially against the backdrop of the fact that it is impossible to separate vocabulary with grammar. Even among the seven factors advanced by Halliday as being responsible for the difficulty in understanding science, some fall in the domain of terminology (interlocking definitions, technical taxonomies, special expressions, etc.). Of recent there has been a focus on the identification of those concepts that have a particular significance in contributing to students understanding within particular subject areas. Such concepts have been described as "threshold concepts". A threshold concept, according to Meyer and Land [3], is a disciplinary concept that is assumed to be particularly significant in opening up a new and previously inaccessible way of thinking about something. Though research on students' conceptual understandings has been relatively little, we can still find works that have studied students' interpretative and analytical awareness of threshold concepts [4,5]. In the immediate section that follows, we will look at what terminology is, and its usefulness.

Terminology and Science

Terminology as a domain of study is concerned with the study and compilation of terms. That is, it deals with the process of compiling, describing, processing and presenting the terms of special subject fields in one or more languages [6]. Cabre explains that although the systematization of terminology and its scientific status are recent developments, activities in the field started much earlier. According to her "….it was due to the growing internationalization of science in the 19th century that the need for scientists to have at their disposal a set of rules for formulating terms for the respective disciplines became apparent" [6]. In a language like English, for example, 60 percent of its words come from Latin, either directly or by way of Old French. In biology and other fields with rich technical vocabularies, most terms come from Latin and Greek. Literacy in both languages used to be a prerequisite for university admission in Europe. This is why from the Middle Ages to as recent as the sixties, students probably found the language of science a lesser barrier than they do now, for they were merely learning new words in an already-familiar language. Now, however, for lack of a background in Greek, students find them more perplexing.

The Language Factor in Science Teaching/Learning

One of the greatest difficulties confronted by science students at all levels of education is the profusion of terminology and the strangeness of many of the terms. It is a well-known fact that each field has its unique language, usually referred to as the jargon of such a field; science is no exception. Again, we know that the major role played by language in society is to enhance communication. But in the case of language of science, often times, rather than enhancing communication, it inhibits it. Why is it so?

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The kind of language used in the science class is completely different from the language the students are used to, and this creates a problem. As an example, let's consider the use of the term *Pneumonoultramicroscopicsilicovolcanoconiosis* by a teacher in a beginners' medical class. This term is most likely going to scare students! One way of helping them to gain a better understanding of the term is by 'dissecting' it into discrete units. Let's try the dissection. First, we talk of the prefix *pneu-* or *pneumo-* which means lung. Then there is ultra meaning extreme, and *microscopic,* meaning small. We proceed to silico- which refers to silicon, and volcano which refers to the mineral particles that make up a volcano. Then we have *coni-*, a derivative of the Greek word konis meaning dust. Finally, we have the suffix *-osis* which means affected with.

With this dissection, the students will understand that the prefix *pneumo-* and the suffix –*osis* suggests that the lungs are infected with something. A further study of the other components of the term will reveal that it is a disease of the lungs resulting from the inhalation of very fine silicate or quartz dust [7].

Many scholars of language for special purposes (LSP) have advanced reasons for this inhibition [8]. Halliday, for example, refers to the problem as 'alienation'. It must, however, be made clear that each field has its peculiar language; as we talk of language of science, so do we also talk of language of literature, economics, architecture, etc. And oftentimes, the peculiarity of disciplinary language is even a source of prestige to people in those fields. Such disciplinary language is characterized by technical terms and peculiar grammars. Lemke (1990: 135) has listed nine stylistic features (rules) of language that are problematic in science teaching/learning. Out of these three have a direct bearing on the scope of this research: 1. avoid colloquial forms of language, and use, even in speech, forms closer to those of written language, 2. use technical terms in place of colloquial synonyms or paraphrases, including specialized usage of words that also have colloquial meanings and spoken symbols, and 3. avoid reference to fiction and fantasy. One of the reasons that students fail to come to terms with science is that science terms are not presented to them on their own terms. In most cases, in the teaching of science in Nigerian Secondary Schools, for example, students learn science by parroting, which negates the principles of learning,

With such strict regulation of language use in science teaching, it often succeeds only in 1 convincing students that science is inherently so much more complex and difficult than other subjects that most students will never really understand, and 2. It also tends to pit science against common sense and undermine students' confidence and judgment. The impression is always given that in science, ordinary judgments and reasoning are irrelevant. Science, right from time, has been so mystified that students have the belief that scientists are extraordinary humans. Prigogine and Stengers [8] express their worry about the disturbing paradox between humanist origins of natural science and its contemporary usage as something natural and dehumanizing:

Science initiated a successful dialogue with nature. On the other hand, the first outcome of this dialogue was the discovery of a silent world. This is the paradox of classical science. It revealed to men a dead, passive nature, a nature that behaves as an automation which once programmed, continues to follow the rules inscribed in the program. In this sense, the dialogue with nature isolated man from nature, instead of bringing him closer to it. A triumph of human reason turned into a sad truth. It seemed that science debased everything it touched [8].

Lemke [1] has also lamented about how science is construed in highly technical language. Her words: "how does science teaching alienate so many students from sciences? How does it happen that so many students come away from their science in school feeling that science is not for them, that it is too impersonal and inhuman for their tastes, or that they simply 'don't have a' head for science?"

The technical terms or the peculiarity of the grammar of science are both sources of difficulty in students' comprehension of science. Even in the face of the argument that the language of science is more than a matter of special vocabulary: it is also a matter of the ways these special words are used together [1], we still venture to make the point that knowledge is locked in these terms. This is so because students will, as a necessity, have to learn to master the interconnected use of particular terms and their thematic patterns (semantic relations) to be able to understand what they are learning. In the next section, we will describe our observation of some teaching sessions to measure students understanding or otherwise of science terms.

Procedure

An observation and analysis of some teaching sessions in a Senior Secondary Three classes was carried out to shed light on the nature of students' understanding. Two Biology teaching sessions were observed in Government Secondary School (GSS), Kofar Hausa in Keffi, Nasarawa State. An observation of the details of the flow of students' engagement with each moment of the lessons to gauge moments that students are either "turned off" or show some enthusiasm by the use of the mystique/ordinary language of science was carried out. The first lesson was taught the usual way of using science language. After this teaching session, the teacher was instructed by the researcher to make efforts to break away from the formal language of science, and try as much as he could to use ordinary language in teaching the same lessons taught earlier. The same topic was taught by the teacher after one week.

Correlation of degrees of engagement of the students at any given times with the language of the lessons at that point was measured along the following indices:

- Staring at the teacher
- Staring at the board
- Writing in the notebook
- Talking to their neighbors
- Staring outside the class

Data Analysis

Teaching session 1

In the first lesson observed on the 12th June, 2012, the traditional way of science teachers projecting science as simple description of the way the world is rather than as a human social activity was manifest. In an introductory lesson on 'Forms in which cells exist' the teacher stated the forms in which cells exist: simple and free living, independent, filamentous, and colonial forms. At this stage, the students seemed to have no problem in following what the teacher was saying. Using the five indices listed above to measure the students' degree of engagement, the researcher noticed that the students showed a high level of concentration on their lesson. The situation was, however, to change when the teacher moved to the next stage of the lesson and started mentioning some types of cells, and associated terms like 'ecology'. 'Autotrophs', 'cytokinesis', 'eukaryote', and 'hydrophilic'. At the mention of these terms, the expression on the students' faces changed: the air of concentration in the class disappeared. Students started looking at one another. The teacher did not even make efforts to explain the five terms above. His attempts at explaining the cells and their forms left the students more confused. For example, the teacher uttered the following explanation (which did not help in deepening understanding):

Independent cells are capable of self-existence, though are unicellular carrying out all life processes e.g. amoeba. Colonial cells are similar cells massed together and cannot be differentiated e.g. pamdorins, while filamentous are identical and joined end-to-end to form unbranched multicellular filaments capable of self-existence e.g. spirogyra.

At the end of the lesson, the researcher interacted with the teacher and raised the issue of the possibility of using ordinary language instead of the highly scientific language. Through the interaction, the researcher observed that even the teacher himself was not at home with those terms. The researcher at this point decided to explain the terms to him. The meanings of the five terms mentioned in the course of teaching in teaching session 1 ('ecology'. 'autotrophs', 'cytokinesis', 'eukaryote', and 'hydrophilic') were given to the teacher. The terms were dissected in this way:

a. autotrophs.

- *auto* means 'self', while *troph* means 'nourish'. *Autotrophs* will, therefore, mean organisms capable of self nourishment.

b. cytokinesis.

- *cyto* means 'cell', while *kinesis* means 'movement'. *Cytokinesis* refers to the movement of the cytoplasm that produces distinct daughter cell divisions.

c. eukaryote.

- *eu* means 'true', while *karyo* means 'nucleus'. A *eukaryote* is an organism whose cells contain a 'true' membrane bound nucleus.

d. hydrophilic.

- *hydro* refers to water, while *phylic* means 'love'. *Hydrophylic* therefore, means water loving (organisms).

e. ecology.

- the root base *eco* is derived from Greek *oikos,* meaning 'house', while the suffix *logy* means study of living environments. *Ecology* means the study of organisms in relation to their habitat.

Teaching session 2

The following week, after the first teaching session (19th June, 2012), a second teaching session was organized. The same teacher was asked to teach the same lesson he had taught on the 12th of June. He was specifically instructed to teach the lesson using ordinary language to explain those scientific terms he had problems in explaining. Using the five indices listed out in the procedure for this study, a noticeable improvement in the flow of students' engagement as the teacher broke away from the mystique of science language was observed. A high level of concentration was noticed. The expression on their faces showed that they were more at home with what the teacher taught in the first teaching session.

The observation of these teaching sessions showed that helping students to conceptualize properly (by way of, for instance, explaining the interrelationships of terms, and doing some etymological analysis) will go a long way in helping students to understand specialized terminologies.

Dynamics of Terminology Conceptualization

A concept is defined variously as the "mental structures representing what words represent" [9] "an element of thought, a mental construct that represents a class of objects" [6]; "a mental construct for classifying individual objects of the outer and inner world by means of a more or less arbitrary abstraction" [10]. Sager explains that "the relationships of the objects of the real world are diverse and manifold." He continues that "in a knowledge structure divided into special subject fields, groups of concepts are more or less closely related to each other whether they belong to the same or different subsets. Inside subject fields, concepts are also related by their nature or by the real-life connections of the objects they represent."

A look into how concepts are organized in a given subject will be useful in aiding students' understanding. Sager has identified three types of conceptual relationships: generic, partitive, and polyvalent relationships.

Generic Relationship: This type of relationship, according to him, establishes a hierarchical order: it identifies concepts as belonging to the same category in which there is a broader (generic) concept which is said to be superordinate to the narrower (specific) superordinated concept or concepts. He illustrates the generic type of relationship with the superordinate term 'publication' (Figure 1).

As explained by Sager [10], in this type of relationship, all objects which have the characteristics of the superordinate concept (publication) are its subordinate concepts. He explains further that generic relationship entails both vertical and horizontal relationship and can also have several sub-types, as represented in the above tree structure. At each lower level, the degree of specificity becomes higher and, hence, the intension of the concept becomes narrower.

Partitive Relationships: These relationships are also called 'whole-part' relationships by Sager. They serve to indicate the connection between concepts consisting of more than one part and their constituent parts. This is illustrated in Figure 2.

The tree structure in Figure 2 shows that one thing is a part of a whole. For instance, 'physics', 'chemistry' and 'biology' are parts of the whole 'natural sciences'. In the same way, the 'physics' that was a part at a point has become a whole at another point and 'pure' and 'applied' has become its parts. The same can be seen with 'chemistry' and 'biology'.

Polyvalent Relationships: This is when a concept is placed in more than one hierarchy within a given subject field. Sager's illustration will shed light (Figure 3).

In the illustration in Figure 3, 'buses' have been classified both as road vehicles and passenger vehicles; 'buses' belong to the two subtypes.

Thagard [9] in his treatment of concepts looks at conceptual relations in terms of 'kind' and 'part-whole' relations. In his schema, there are five kinds of links in conceptual organization. He lists them as kind links, instance links, rule links, property links, and part links [9]. By Thagard's explanation kind-relations and part-relations generate hierarchies. He gives an example of kind-relations with a certacean being a kind of a mammal, which is a kind of an animal which is a kind of a living thing. He gives an example of part relations with a toe being part of a foot, which is part of a leg, which is part of a body (Figure 4). He illustrates his description of concept relations about animals in the following way:

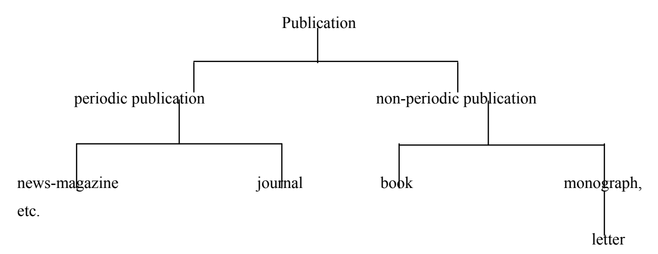

Figure 1: Generic relationship as illustrated by Sager, 1990.

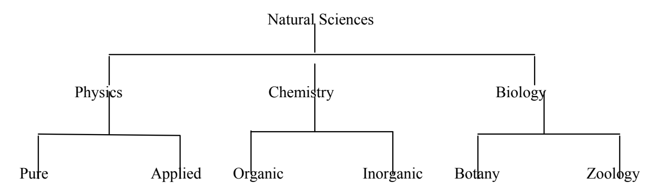

Figure 2: An illustration of partitive relationship by Sager, 1990.

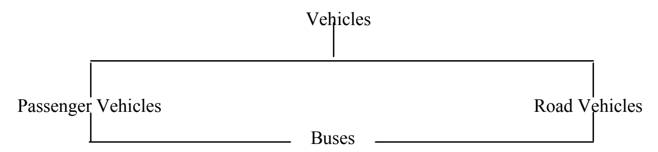

Figure 3: Sager's (1990) illustration of polyvalent relationship.

1. *Kind links* (marked K) – Those links indicate that one concept is a kind of another e.g. canary – bird - animal

2. *Instance link* (I) – This is when an object is an instance of a concept e.g, Tweety is a canary. Tweety is also an animal

3. *Rule links* (R) – Rules that are general (but not universal) to certain concepts e.g. canaries are yellow

4. *Property links* (H) – An object has a property e.g. tweety is yellow

5. *Part links* (P) – A whole has a given part e.g. a beak is a part of a bird

Thagard's description of concept relations is similar to Sager's. In both descriptions, there are noticeable cases of objects superordinating over subordinate ones, or the links/hierarchies moving from generic to specific, as the generic (superordinate) term/object continues to divide itself into subsets.

Dahlberg has also done a description of conceptual relations. In her classification, she has three types of links, which are, by the way, not too different from what Sager and Thagard have done. She has formal, form-categorical, and material relationships. Dahlberg's classification is based on logical relationship based on similarities, and ontological relationships, based on proximity. It is in a similar perspective that Ausubel [11] discusses the understanding of human knowledge. He explains that "in understanding the nature of knowledge and the processes used in making new knowledge, the human mind must follow logical rules for organizing information into respective categories." He illustrates this with a Chinese puzzle box in which "all the smaller boxes, ideas and concepts are tucked away inside of a larger box" [11].

These conceptual relations are fundamental to the organization of terms because the hierarchies generated by such relations will help in understanding how terms will be organized in the terminology of any given field. For instance, knowledge of the class associations that exist amongst concepts will show that terms are not created arbitrarily; their creation follows conventions.

Thematic Patterns

Lemke also discusses this semantic interrelatedness but terms it 'thematic patterns'. She defines a thematic pattern as "a way of picturing the network of relationships among the meanings of key terms in the language of a subject". A thematic pattern typically describes a shared pattern of semantic relationships. Lemke gives us some examples of such semantic relationships. They include nominal relations, taxonomic relations, transitivity relations, circumstantial relations, and logical relations [1]. Examples of each will shed some light.

Nominal relations

(attribute, classifier, quantifier)

Attributive: The apple is red (Attribute/carrier); *red* – attribute, *apple* – carrier.

Taxonomic relations

(token, hyponym(y)/hypernym(y), meronym(y), synonym(y), antonym(y))

Hyponym/Hypernym

Any dog is a mammal. *Hyponym* – dog, *Hypernym* – mammal (name of a category that fits inside some more general category)

Meronyms/Holonyms

The drawer of a desk. *Meronym* – drawer, *Holonym* – desk (name of a part belonging to some whole)

Transitivity relations

(agent, target, medium, beneficiary, range, etc.)

Agent

The man built the house. *Agent* – man, *Process* – built (the entity that does or acts, the cause or instigator of a process)

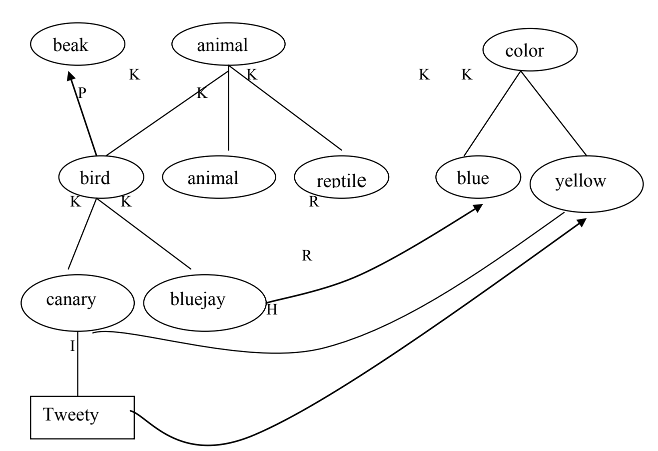

Figure 4: Example of conceptual hierarchy (adapted from Thagard, 1992: 31).

Circumstantial relations

(location, time, material, manner, reason)

Location

The pen is in the box. *Located* – prn, *Location* – box (expresses the relationship of entities or processes)

Logical relationships

(elaboration, addition, variation, connection)

Elaboration

"A i.e. B", "A e.g. B", "A viz B". In these three examples "B" is playing the role of exposing, clarifying, and exemplifying. *Item* – A, *Elaboration* – B.

The above illustrations on the conceptual/thematic relations and interconnections will help us in gaining a deeper global understanding of the terms we are dealing with. For instance, in the teaching and learning of science, which is the focus of this study, we would not want students to simply parrot back the terms they encounter: we would want them to construct meanings in their own words.

African Indigenous Knowledge and Science Learning

There is always the belief that when talking about major advances in science and technology, Africa has no position there. But Dillard [12], like many other African scholars, has argued on the contrary. She cites the examples of debates about genetic diversity by Africans, African roots of human origin, iron works, etc. as pointers to the existence of indigenous science in Africa. She has tried to rationalize this stand by looking at the definition of science by the *Blackwell's Dictionary of Sociology:* "a body of knowledge about the natural world and a method for discovering such knowledge, and a social institution organized around both. As a method, science rests on the idea that reliable knowledge of the world must be based on systematic, objective observations of facts that will lead everyone who considers them to the same conclusion" [12].

Traditional or native knowledge can be defined as knowledge which is acquired and preserved through generations in an original or local society, and is based on experience in working to secure subsistence from nature. According to Berkes [13], traditional ecological knowledge (TEK) is "[a] cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationships of living beings (including humans) with one another and with their environment."

Dillard's argument is that if science is to be understood through the *Blackwell Dictionary's* definition, the Africans have also been involved in scientific practices as they have been involved in the use of herbs in treating certain health conditions: physical, spiritual and psychological. Ker [14] also argues that African communities have been generating and transmitting knowledge over time in an effort to cope with the prevailing agro-economic environment. The knowledge is generated and transferred through a systematic process of observing local conditions, experimenting with solutions and re-adapting particularly identified solutions to modified environmental, socio-economic and technological solutions. The teaching of science must also be based on the indigenous knowledge of the child. Using traditional knowledge in science lessons, activities, and class projects gives added depth and meaning to difficult concepts. Science taught in conjunction with local traditional knowledge brings not only a sense of place, but also helps to make science less foreign to students. This approach may find expression in some learning theories [11,15,16].

In an attempt to improve on the orientations in teaching and learning, Ausubel [11], for instance, contends, in his learning theory, that to learn meaningfully, learners must relate new knowledge to what they already know. He uses the term 'subsumption' (the central idea running through his learning theory) to illustrate how learning takes place. He says that "new learning material becomes incorporated into cognitive structures so far as it is subsumable under relevant existing concepts" [11]. Ausubel and Robinson [15] stress that "a first prerequisite for meaningful learning is that the material presented to the learner be capable of being related in some 'sensible' fashion. The new information must be fitted into a large pattern or whole; the learner must possess relevant ideas to which the new idea can be related or anchored; the learner must already have appropriate subsuming concepts in his or her cognitive structure; and the learner must actually attempt to relate, in some sensible way, the new ideas to those which he previously knows." In summary the point they seek to make is that meaningful learning can only take place when the learner understands the interrelationships that exist between two or more ideas – old and new. Vosniadou [16] sums it in this way: "learning is better when material is organized around general principles and explanations, rather than when it is based on the memorization of isolated facts and procedures."

It has been argued that terms imply taxonomies which organize reality differently to common-sense. This does not, however, mean that common-sense knowledge is always useless – it could serve as building blocks. Common-sense knowledge could be improved on to arrive at more meaningful specialized taxonomies. The example in disease taxonomies by Martin supports this. The common-sense taxonomy of diseases looks like shown in Figure 5.

And the specialized disease taxonomy will look like as shown in Figure 6.

Martin explains that the main difference between common-sense taxonomies and specialized ones is that common-sense classification is based on what can be directly observed with the senses. As can be seen in the above taxonomies, in Figure 5, diseases are classified according to symptoms and effects, while in the specialized taxonomies, as can be seen in Figure 6, disease classification is based on their causes. This does not, in any way, suggest that the common-sense classification is useless and does not serve any purpose. It provides the basis for improvement by way of reorganizing, adding, deleting, etc. of certain nodes in the specialized classification. For example, in Figure 5, the branches were five, while in Figure 6, they have been reorganized into four. Nodes like 'general', 'childhood', 'AIDS', etc. have been deleted in Figure 6, while new ones have been added: 'viral', 'herpes', 'coxsackie', etc.

As seen in this example of the medical taxonomies of diseases above, the formation of terms in biology is also rule-governed. Take the rule of form-relatedness as an example, which can be seen in the Linnaeus' binomial system of nomenclature. Hyan and Pankhurst [17] explain that this is a formal system of naming species of living things by giving each a name composed of two parts. The first part of the name identifies the genus to which the species belongs; the second part identifies the species within the genus. Vines and Rees [18] report that it was Carolus Linnaeus, a Swedish naturalist in his *Systema Naturae*, was the first to frame principles for defining genus and species of organisms (binomial system), and to create a uniform system for naming.

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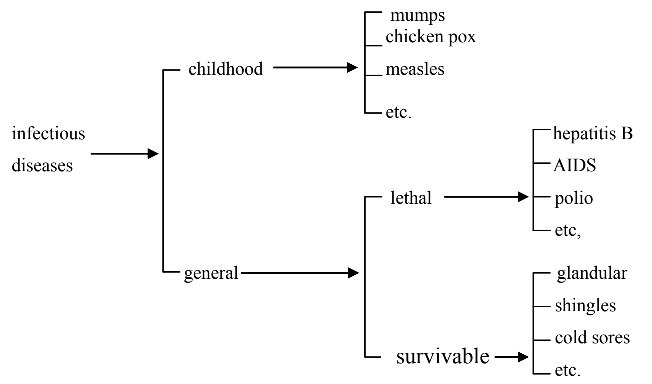

Figure 5: Commonsense Taxonomy of Diseases (adapted from Martin, 1993: 205).

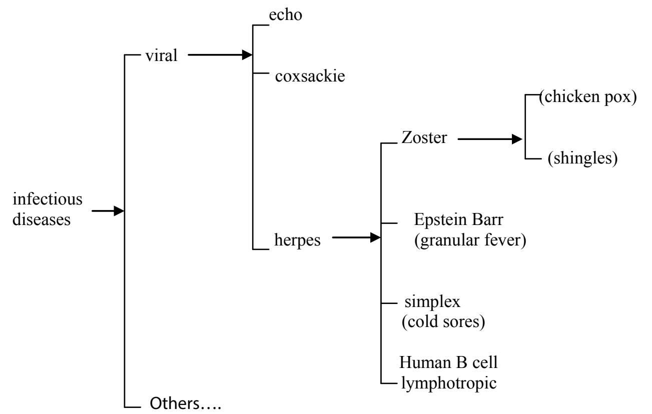

Figure 6: Medical Taxonomies of Diseases (adapted from Martin, 1993: 206).

The structure of this naming system shows that the first part of the name (the genus), which identifies the genus, must be a word which can be treated as Latin singular in the nominative case, while the second part of the binomial may be the adjective [19]. The adjective modifies the genus, and must agree with it in gender. In Latin, there are three genders: masculine, feminine and neuter, shown by varying endings to nouns and adjectives. For instance, the 'house sparrow' has the binomial name *Passer domesticus* (domestic) which simply means 'associated with the house' [20]. The 'sacred bamboo' is known as *Nandina domestica* rather than *Nandina domesticus* since *Nandina* is feminine whereas *Passer* is masculine. The tropical fruit 'langsat' is a product of the plant *Laurian domesticum* since 'Laurian' is neuter. The second part may also be a noun in the nominative case. Example, the binomial name of the 'lion' is *Panthera leo*. Grammatically, the noun is said to be in opposition to the genus name and the two nouns do not have to agree in gender in this case. *Panthera* is feminine and *leo* masculine [21].

Conclusion

In this study, we set out to demonstrate how terminology can be a major obstacle in acquiring specialized knowledge. Through the two Biology teaching sessions, we have been able to do this. Three ways through which we can make the teaching and learning of western science meaningful are 1. Incorporating our traditional knowledge into western science. In the US, for instance, it has been shown that teaching methods and curricula which incorporate indigenous knowledge and ways of knowing into the formal education system show an increase in student achievement scores, a decrease in drop-out rates, and an increase in university attendance [22]. 2. Helping students to come to terms, with science terms, preferably on their own terms (using ordinary language), and 3. Inclusion of terminology studies in the curricula of our higher institutions where specialists are trained. All the three recommendations here will facilitate a better understanding of terminology. As we have earlier said, each field of study possesses its peculiar language which is part of the discipline. This presupposes that the terminology of a discipline is also part of what people who are being initiated into such a discipline need to acquire, but not to the detriment of knowledge. The initiation into the science speech community, for example, can be done through ordinary language. Whatever we do will ultimately be geared towards making the new entrants into the discipline gain the disciplinary knowledge. Technical language will still be part of the discipline, but could be systematically explained as outlined in our exposition on conceptual and thematic relations.

This study has shown that students' ways of thinking about disciplinary concepts would provide the foundation for successful curriculum implementation. The entire processes outlined in this study could be replicated in the teaching of specialized subject fields in order to expose students to different ways of thinking about disciplinary concepts. As for future research, there would seem to be rewards in pursuing the lines evident in this work. A look into the role terminology plays, and how it plays it, in the various fields of life will help us in accessing more information and, thereby, gaining more knowledge.

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