TEACHING SCIENTIFIC CONCEPTS IN KALABARI: A PARADIGMATIC APPROACH

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Abstract

Scientific concepts, which often translate into technological inventions, require a medium for their expression and proper assimilation. More often than not, that medium is language.However, it has to be a language that is best understood by the recipients of the scientific concepts being conveyed. Most language experts (cf. Sapir, 1928; Bloomfield, 1933; Crystal, 1969; Bamgbose, 1976) agree that the language best suited to such a purpose is the mother tongue. In this paper, efforts are made to see how scientific concepts which exist in the African environment but which are most often expressed in a foreign tongue, can be taught to the African child using his mother tongue. Kalabari, an African language spoken in the South eastern part of Nigeria, has been chosen to illustrate this. A paradigmatic approach is hereby proposed whereby lexical items conveying scientific thought are presented in paradigms as a teaching model for young learners who would assimilate them better in their indigenous language. It is expected that this method of teaching will make it easier for the young learner to visualize the scientific concepts being taught in his indigenous language and thereafter motivate him to translate learnt concepts into technological inventions.This would in part, be in tandem with Andah's (1992:131) proposal of an 'African scientific system' which can be put in place, through indigenous language engineering, to take care of the continent's technological needs.

Key words: Scientific concepts, technological inventions, African environment, mother tongue, scientific vocabulary, paradigms.

Introduction

Scientific concepts, leading to technological inventions, are a *sine qua non* for any nation wishing to develop technologically in the modern era. The modern world gets more sophisticated every day and the boundaries of science are being pushed further beyond the known frontiers at a rapid pace. Although the laws of science are natural laws and can be observed in operation in every environment, they need to be expressed and formulated in order to be identified and applied. A classic illustration of this is John Newton's observation of an apple falling from a tree and his formulation of the law of gravity, following correlations with other observed phenomena in his environment. That law serves as the basis for man's many explorations in space today.

However, observing scientific phenomena is one thing, expressing them using language is another. In the present 21st century, the worldwide medium of expression for the observations and recordings of science can be said to be English. Could this be attributed to the fact that mother tongue speakers of English are so numerous the world over? David Crystal (2007: 360) informs that, according to conservative estimates, mother tongue speakers of the English language have now reached around 400 million, and that a further 350 million use English as a second language, while a further 100 million use it fluently as a foreign language.

What we might need to retain from the above figures which attempt to explain the world dominant position of English is that, education and linguistic expression in the mother tongue are crucial for the appropriation of thought, especially scientific thought. This would be lending credence to the Sapir-Whorf Hypothesis that speakers visualize best objects and concepts for which there are words in their native languages. In particular, Edward Sapir, quoted by Crystal (2007:15) affirmed that: "We dissect nature along lines laid down by our native languages".

The Kalabari child who is fully brought up in the Kalabari environment presumably has Kalabari as his mother tongue. It is his language of first contact and so it is the language in which he is most competent to convey his thoughts and to perceive phenomena, scientific or otherwise, in his environment. What then is the Kalabari environment?

1 The Kalabari environment

The Kalabari people can be mostly found in the Niger-Delta area of South East Nigeria, specifically in Rivers State. Harry (2004: 2) identifies the Kalabari linguistic area as spreading over three major islands and twenty-five other smaller islands. The major islands are Buguma, Abonnema and Bakana. Traditionally, the economic activities of the Kalabari centrearound fishing and trading. In modern times, however, the Kalabari are seen to be influential politically and so occupy strategic positions in government cabinets. Quite a few are also well-placed in the private oil sector of the state. This implies that there are a number of technocrats among the Kalabari and many are well travelled. Interestingly, Jenewari (1984, 1989) reports that the Kalabari were among the first West Africans to come in contact with the European traders in Southern Nigeria.

Linguistically speaking, the Kalabari language is one of the ijoid languages of the Niger-Congo family of languages. More specifically, it belongs to the East Ijo group. According to Williamson and Timitimi (1983) and later Jenewari (1989), other members of this group are Okrika, Ibani, Bille and perhaps Nkoro. Dapper (2003) likewise affirms that Kalabari is one of the Ijaw tribes that live in the Niger-Delta region. Among these languages, we have Izon, Nembe, Bille, Kula, Ibani, Tombia, Okrika, etc.

Concerning the orthography of Kalabari, Harry (2004) informs that the first individual attempts in this direction were in 1949 when B.A. Harry published a primer with the title "*Kalabari tari godiri"(Kalabari Primer),* followed by another primer, this time written by N.T. Akobo in 1953 with the title "*Wanimin'ibiai"(Things we ought to know).* It was only after these individual efforts that the government sponsored orthography projects in indigenous languages, thereby paving the way for primers in Kalabari written by erudite scholars like Berepiki (1971), Williamson (1972) and Jenewari (1972).

2 Scientific literacy in Kalabari

According to Jenewari (1984:10), the written word in Kalabari apparently appeared as early as 1668 through a Dutch traveler who wrote numerals one to five in the language. This is an aspect of the counting system which later progressed along conventional lines until it evolved into counting large numbers, the highest being eight thousand expressed as *"poku"*.

There are actually what can be considered landmark numerals in the counting system of Kalabari. Ngiangia*et al* (2015:3) identify them as *sii*(20); *ẹndẹ*(400); and *poku*(8,000). Young-Harry (2002:8) offers an excellent presentation of the traditional Kalabari counting system in his book: *Kalabari dirikẹẹbarana Kalabari ye kiẹnbara*(Kalabari Orthography and Counting System). There we see the reference points deriving from *sii*(20) in numerals like 16 (*inifasii);* 17 *(tẹrẹifasii);* 18 *(main fasii);* 19 *(gberiefasii);* 20 *(sii).* And then for the reference points deriving from *ẹndẹ*, we have: 500 *(ẹndẹsọnọasiifinji);* 600 *(ẹndẹoyiasiifinji);* 700 *(ẹndẹjieasiifinji);* 800 *(maaẹndẹ).*

The peculiar thing about this counting system is that, first there are additions, and then there are subtractions around the focal reference numerals. A translated example of '16' in Kalabari into English reads thus: 'four removed from twenty'. One could say that such a counting system does not really make for concision in thought and it does not make for easy retention. As we shall see further on in this paper, technical and scientific speech possess certain characteristics which would need to be respected by any language wishing to achieve a rendition of scientific thought. Equally important is an understanding of scientific language to facilitate technological inventions.

Understanding scientific language

To teach science language effectively, one needs to understand the attributes of scientific language. One of the first attributes, according to David Crystal (2007: 384), is that scientific vocabulary requires continual updating in the light of the process of discovery. He adds that science is actually the birth place for new words in a language.

Another point to note about scientific language is that it portrays an impersonal aspect of communication which entails a reduction in personal forms and the frequent use of impersonal forms (Vigner and Martin, 1976:19). This is an interesting aspect to note in the light of the fact that the Kalabari, like many other African tribes, often personal objects and address them in a subjective manner. For example, Young-Harry (2002:16) renders the indigenous term (or phrase) for the number 397 as: "tẹradirifadiriẹndẹ", meaning "three books taken away from four hundred books". It could also be rendered as "tẹraburuoforiburuẹndẹ", which means "three yams absent from four hundred yams".

This phrasal method of counting leads us to another attribute of scientific language that appear to be lacking in the counting system of many African languages, that of concision. Vigner and Martin describe this attribute as one which allows for precision in technical speech and makes for complex lexical units. Crystal (2007:384) sums up these attributes by stating that, in the methodology of science, there is an overriding concern for impersonal statement, logical exposition, and precise descriptions.

Curriculum for teaching science in Kalabari

One could safely say that Nigeria, like many former colonies of the Western world, has come a long way in asserting herself linguistically. This fact is reflected in the country's policy on education where, at least on paper, teaching and learning in Nigerian indigenous languages are much favoured. For instance, concerning primary education, section 19, sub-section b (i) of the National Policy on Education (2004:8) states as follows: "Curriculum for primary education shall include (a) Language of the environment"

For those living in the Kalabari local government areas of Akuku-Toru, Asari-Toru and Degema, the language of the environment is Kalabari. Going by the recommendations of the National Policy on Education, this is the language that should be taught to all children residing in these areas, whether they are of Kalabari origin or not.

At the junior secondary level (now Basic 7 – 9), the National Policy on Education (2004:12) advocates in Section 24, sub-section (a) (iv) that the language of the environment should be taught as L1 (where it has orthography and literature); and in sub-section (a) (v), it recommends one major Nigerian language other than that of the environment to be taught as L2 (with emphasis on oralcy).

For the above to be implemented, the orthography of the indigenous language to be taught needs to be fully developed and numeracy established in it. To achieve this, at least as far as Kalabari is concerned, certain notable scholars have made significant efforts to develop a functional orthography in the language. Worthy of note are scholars like Kay Williamson who wrote *Reading and Writing in Kalabari* in 1972, and Charles Jenewari who wrote *Kalabari Orthography* in 1974, with a second edition appearing in 1978. Recently, in 2011, the Nigerian Educational Research and Development Council published some manuals on the *Orthographies of Nigerian Languages.* The manual on Kalabari orthography appears in Volume III.

The foregoing can be termed very commendable efforts. But then, the question could be asked: what is the impact of these efforts on the learners, specifically on those of Kalabari origin? For example, how easy would it be to teach the traditional counting system to modern-day Kalabari children who have grown up with computer-assisted learning, smartphones and digitalized manuals? How can

interest in learning the language be sustained? And if the language is not properly acquired, how can scientific thought be concisely conveyed in it?

A modern approach to science teaching in Kalabari

It is heartening to note that, in recent times, there have been concerted efforts to simplify the counting system in Kalabari by some concerned speakers of the language. A case in point is the recent effort by the writers of a book with the title: *Counting in Kalabari made easy: an innovative and simplified approach.*

In the book, the writers propose a simplified approach based on the decimal system which has a base of ten. Their system provides a straightforward unitary method that would be easy for young learners to retain. They propose what they termed landmark figures, namely *Zero (yofori), Ten (oyi), Hundred (ondira), Thousand (tawa), Million (miliya), Billion (biliya), Trillion (tiriliya),* and even *Zillion (ziliya).* Whereas the traditional method has almost no provision for counting beyond 8,000 (*poku),* the proposed model aims to synchronise with modernity by providing a paradigm that can operate *ad infinitum* - an important principle in science.

Young learners are enticed by the familiarity of the counting method while teachers of the language have a simple teachable model to work with. This would also be in keeping with the goals of science education as enunciated in Section 39, sub-section b(i) of the National Policy on Education (2004: 19) where it states that: "The goal of science education shall be to: (i) cultivate inquiring, knowing and rational minds for the conduct of a good life; and (iv) provide knowledge and understanding of the complexity of the physical world".

There are many other scientific concepts of naturally occurring phenomena that could be taught to Kalabari children using their indigenous language. For example, the concept of heat from the sun could lead to teaching terms that relate to solar and thermal power. In Kalabari, the sun is called 'irua'. To refer to harnessing the power of the sun for heating purposes therefore, where the English language uses the Latinized adjectival form 'solar', the Kalabari teacher could propose the indigenous term 'irua ye', and then use compounding to make it one word: 'iruaye', that is, 'pertaining to the sun'. Other collocations could then be introduced, such as 'solar powered' which can be rendered as 'iruakẹmẹnjiye' in Kalabari. These are all familiar words expressing scientific concepts and causing young learners who speak Kalabari to be aware that they need not have recourse to foreign words before they can express that which they can perceive in the environment. The sun certainly does not shine only in the Western world!

The concept of cooling, as opposed to heating, could equally be taught using the indigenous term 'oboku' which means 'cold'. A cooling apparatus like the refrigerator could be rendered indigenously

as ‘ye-obokumaye’. Following the dictates of scientific language however, the teacher should aim at concision by proposing the compound term achieved through vowel deletion (cf. Harry, 2004:8): ‘yobokumaye’ (something or a unit that cools). In the same vein, a drying unit would follow the same lines of lexical formation and be rendered as ‘ye-samunọmaye’ (something or a unit that dries).

Paradigms for teaching scientific concepts

The above already points the way to the possibility of establishing terminological banks in Kalabari using paradigms. And what are paradigms? The Longman Dictionary of Language Teaching and Applied Linguistics (2012) defines a paradigm as a set or list of all the inflectional forms of a word or of one of its grammatical categories. In this paper, we use it in the sense of establishing a list of possible adjectives or nouns that a given term could collocate with. We therefore talk of adjectival paradigms and nominal paradigms. And so, to develop Kalabari scientific vocabulary and facilitate the teaching of scientific concepts to the Kalabari child, the teacher could establish paradigms with the natural phenomenon of the sun. Derivative terms could then serve as materials for a paradigmatic approach in an adjectival category. An illustration is given below in Table I:

English	**Kalabari**
Solar power	Iruakur*ọ*
Soar dryer	Iruasamun*ọ*maye
Solar car	Iruakẹmẹnjiaru
Solar wear	Iruasuasuaye
Solar cooker	Iruakẹyes*ọ*ye

Table I: Adjectival paradigms

It should be understood that though the lexeme or word ‘sun’ is adjectivized in English (i.e. ‘solar’), it is nominalized in Kalabari (i.e. ‘irua’ – ‘sun’) but it still plays the role of an adjective in Kalabari in its collocation with other nouns in the language.

Another paradigm could be established for nominal constructions using the concept of energy, another scientific concept that is abundant in the African environment. One could then have terms like: solar energy, wind energy, thermal energy, fossil energy, renewable energy, biomass or ligneous (wood) energy, etc. as in the table below:

English	**Kalabari**
Solar energy	Iruakurọ
Wind energy	Ferukurọ
Thermal energy	Kiri-ofirikurọ
Fossil energy	Kiribubẹkurọ
Renewable energy	Ojudinmakurọ
Biomass (ligneous) energy	Sinbubẹkurọ

Hydro power (energy)	Minjibubẹkurọ

Table II: Nominal paradigms

An interesting observation is that the scientific terms appear more explicit in the indigenous language than in English, a foreign language. For example, biomass or ligneous energy in the above tabular is rendered more explicitly in Kalabari where it is translated as 'energy from plants or wood' (sinbubekurọ). 'Thermal energy' is rendered as 'heat from the ground' in Kalabari, while 'renewable energy' is translated as 'energy that renews its body'. The concept of energy from plants (an abundant resource in the Kalabari child's native environment) that can be harnessed to supply the energy needs of electricity, water pumping, combustion for cooking, etc., will thus be easy for the young learner to visualize and to work with. We find here a confirmation of the Sapir-Whorf Hypothesis quoted earlier on that we find it easier to visualize objects for which there are names in our native languages.

Conclusion: A paradigmatic approach to science teaching

A paradigmatic approach to teaching scientific concepts in Kalabari would basically entail the development of a scientific vocabulary by way of a rich and finely attuned lexicon. This is possible in every human language. As Afolayan (1980:29) notes and states: "[every language is] rich enough to meet any new demands (scientific, mathematical and technological) that may be made upon it".Fromkin and Rodman (1998:14) affirm as much when they state that no language or variety of a language (that is, a dialect) is superior to any other in a linguistic sense. As far as they are concerned, every grammar is equally complex and logical and capable of producing an infinite set of sentences to express any thought.

The above represents our view in carrying out this study and outlining our thoughts in this paper. The Kalabari language, like every other African language, is quite amenable to technical and scientific discourse, and scientific concepts can easily be taught in it. What is basically required is the patriotic zeal and dedication to study the linguistic structure of one's mother-tongue well enough to unravel the linguistic treasures that such a language enfolds.

The scientific concepts of energy and technological inventions using science (solar-powered car, wind turbines, solar dryers and cookers, etc.) can be taught in the indigenous language such as Kalabari as demonstrated in our paper using a paradigmatic approach. Paradigms are established using the internal grammatical resources of the language, and terms are generated along the lines of the linguistic competence of the native speakers. The latter point no doubt, corroborates Noam Chomsky's linguistic competence which he defines in *Aspects of the Theory of Syntax* (1965) as the unconscious knowledge of grammar that allows a [native] speaker to use and understand a language.

In this paper, we have been able to establish paradigms for indigenous Kalabari terms with scientific import such as (in the order presented in Table II): *iruakurọ; fẹrukurọ; kiri-ọfirikurọ; kiribubẹkurọ; ojudinmakurọ; sinbubẹkurọ; minjibubẹkurọ, etc.* We believe that these terms, which are presented in an explicit manner in Kalabari, will go a long way in bringing about an early scientific awareness in the Kalabari child who, without having to pass through some foreign tongue, will be linguistically motivated to carry out technological inventions through his acquired scientific knowledge in his native language.

We wish to conclude by observing that the proposals made for teaching scientific concepts in Kalabari can be extended and carried out in every other African language. This would be a necessary step to take so that the African continent can be free, through indigenous language engineering, from technological dependence which the erudite BasseyAndah (1992: 122) defines as: "the inability to generate, adapt and use technological systems, indigenous and introduced, to meet [our] needs".

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