A THEORY OF SCIENTIFIC TERMINOLOGY

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By

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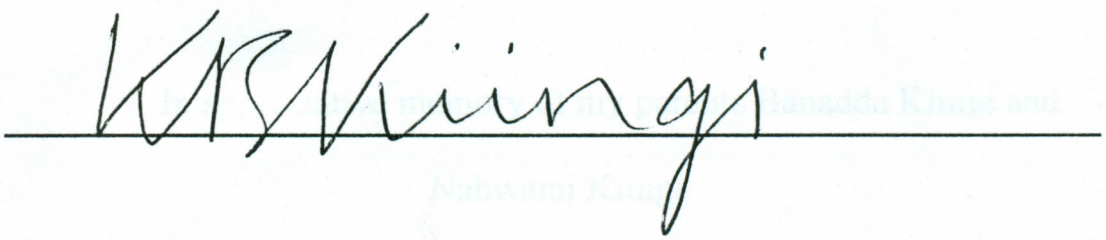
DECLARATION OF ORIGINALITY

This thesis is my original work and has not been presented for a degree in any other University.



In appreciative memory of my parents Banadda Kiingi and Nabwami Kiingi.

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ABSTRACT

The central aim of the study is twofold. First, a well-grounded theory of scientific terminology is to be formulated and argued for. Secondly, the theory is to be applied to the problem of terminological elaboration of a Bantu language Luganda, whereby conceptual formalisation is the main point of departure. The study is conducted in four stages.

First, a periodic system of conceptual elements is originated taking a general conceptual structure of formal and natural science into account. A conceptual calculus is developed on the periodic system. The calculus and criteria for scientific terminology are fused into a theory of scientific terminology.

Secondly, the scope and nature of conceptual and expressional sharing which is necessary for the terminological elaboration of Luganda are explored with a view of setting the stage for the extrapolation of Luganda expression formation processes.

Thirdly, terminological systems in physics, chemistry, biology, geology and medicine are articulated in Luganda. English and German materials in these fields together with logic and mathematics are translated into Luganda.

Finally, a group of Primary and Secondary school teachers of science and mathematics, and a group of Luganda–speaking linguists are confronted with and exposed to the terminological systems articulated in Luganda together with techniques of coining Luganda expressions. Since the systems and techniques constitute an apparent chasm separating present-day Luganda and full-fledged scientific Luganda, it would be methodologically disputable to test for their acceptability *per se*. Logically speaking, successful learning of a problem–solving system is not necessarily tantamount to acceptance of its principles. Nevertheless, the teachers and linguists critically receive the systems and techniques to such an extent that they eventually collaborate with the researcher on a compilation of a school dictionary of science and mathematics.

LIST OF SPECIAL SYMBOLS AND ABBREVIATIONS

SYMBOLS

$\rightharpoonup$	conceptual inclusion
$\rightleftharpoons$	conceptual equivalence
~	alternant variant
/	negative e.g., X ≠ Y
/	correlative nominal classes
→	transforms into, becomes
+	concatenation
—	truncation
o	noun without initial vowel (i.e. preprefix)

LANGUAGES

E.	English
F.	French
Ger.	German
Lgd.	Luganda
Gk	Greek
Ind.	Indonesian
Lat.	Latin
Ksw.	Kiswahili

Morphological Abbreviations

A	adjective
N	(1) noun
	(2) nasal consonant
Prn	pronoun
C	consonant
V	(1) verb
	(2) vowel
S	stem e.g. SV verbal stem
	SN nominal stem
D	suffix
P	prefix e.g. PN nominal prefix
D'	suffix involving sound change
U	archiphoneme for o and *u*
I	archiphoneme for *e* and *i*

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I. INTRODUCTION TO THE PROBLEMS OF THE ENQUIRY

I.1 The Essence of Scientific Terminology and Terminological Elaboration.

I undertake to conduct a bifurcate study in which a theory of scientific terminology is to be formulated and its application to a hypothetically accelerated elaboration of the scientific lexicon of Luganda is to be set up and examined. Historically, the need for terminology has always been a response to cognitive growth and, therefore, conceptual articulation. Picht and Draskau report:

> *The 19 th century was remarkable for the giant strides with which scientific progress advanced and found practical application. This situation led to the vast need for terminology, and it soon came to be realized that these explosive developments likewise called for the organization of knowledge, if progress was not to be neutralised by stagnation. At this time another development occurred which was to have importance for terminology: the standardization of objects, for example, the gauge of railway tracks or certain types of screwthreads.*
>
> *But parallel to the standardization of objects-measurements, units, sizes etc. – there arose the problem of linguistic realization, that is to say, the problem of terms.*
>
> *In the second half of the last century, the necessity of ensuring professional communication became increasingly urgent, especially in respect of the mutual*

> *comprehensibility of experts within the same subject field but from different linguistic backgrounds.*
>
> Picht & Draskau (1985: 24)

Every natural language has two major categories: one for general purposes and the other for special purposes. The LGP (Language for General Purposes) category is used by all members of the language community, whereas the LSP (Language for Special Purposes) category, or categories, to be more exact, are used by groups of the community in their professional communication on matters pertaining to hunting, animal husbandry, science, technology or divinity. Terminological elaboration, i.e. the development of special expressions for LSP, consists in assigning an expression to an entity. When an expression is clearly delimited in terms of its meaning content, we talk of a term. The sum total of terms in a subject field or the study of those terms in a particular subject field or all subject fields is what is generally conceived of as (a) terminology. As I have stated, terminological elaboration is always a response to cognitive growth. Versalius (1514 – 64; anatomy), Lavoisier and Berthollet (18 th century; chemistry), Linnaeus (1707 – 78; botany and zoology), Frege (1848; mathematics, logic and philosophy) and Eugen Wüster (20th century; engineering) are some of the most acclaimed terminologists or terminological elaborators in the documented history of terminology.

In order to distinguish LSP from LGP let the following statements serve as examples:

(1) Newton's law of universal gravitation states that

any two bodies attract one another with a force which is proportional to the product of their masses and inversely proportional to the square of the distance between them.

(2) $NH_3 + CO_2 + H_2O \rightarrow (NH_4)HCO_3$

$NaCl + (NH_4)HCO_3 \rightarrow NaHCO_3 + NH_4Cl$

$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

(3) A broad taxonomy of the housefly (*Musca domestica*) is:

Animalia	(Kingdom)
Chordata	(Phylum)
Insecta	(Class)
Diptera	(Order)
Muscidae	(Family)
Musca	(Genus)
domestica	(Species)

In (1) 'law', 'bodies', 'attract', 'force', 'masses', and 'distance' are expressions which, even when used in their various senses like the legal, political, administrative or ideological sense, are not likely to present considerable problems to the LGP user. The expressions 'proportional', 'product', 'inversely' and 'square' are likely to have been met at the upper primary school level (at least in the Kenyan educational system). Nevertheless, one would have to have had some lower secondary school physics if the appreciation of Newton's law of universal gravitation were to be ensured. All the concepts occurring in the law are precise to the physicist and are systematically interconnected in the expressionally economical formula

(4) $\mathbf{F} = [-G\, m_1\, m_2 / r^2]\mathbf{u}_r$

where **F** is the force, m_1 and m_2 are the masses, r is the distance, G is the gravitational constant and $\mathbf{u}_r$ is the unit vector along the line of force. That the value of G in the Système International d'Unités [SI] is $6.67 \times 10^{-11}\ Nm^2kg^{-2}$ bears out the internationally sanctioned convention among physicists which regulates the system of units in mechanics.

Statement (2) hardly presents any problem to an upper secondary school pupil. He will have learnt about the Solvay process used for the manufacture of sodium carbonate decahydrate. Even if in German Na_2CO_3, $10H_2O$ is *Natriumkarbonat-10 Wasser,* the internationality of chemical symbolism and the systemicity of the suffix - *at* (E.-*ate*) are left intact.

Statement (3) goes to underpin the internationally binding nature of biological taxonomy. The seven broad taxa are rendered in neo-Latin. Irrespective of the natural language in which a biologist may write a scientific paper, he will be required to refer to the housefly (Ger. *Hausfliege,* Lgd. *ensowera*) as *Musca domestica* in order to facilitate communication in just the same way as the chemist will use formulae which are understood the world over.

In the forgoing I state my intention of pursuing the double-pronged problem of a theory of scientific terminology on the one hand, and applying the theory to the lexical extension of Luganda on the other hand. Statements 1-4 deal at a preliminary stage with some

of the criteria for terminology. These are precision , economy, internationality and systemicity. Before taking up the issue of criteria for terminology again , let me set the background to the second strand of the study.

Writing on the problem of expressional elaboration of African languages, Bernd Heine claims:

> *Up to now the dimension of modernisation has not yet been attained by any African language. It is true that some of these languages, which, like Arabic, Swahili or Hausa, are backed by the state, are on the way to modernisation, but further efforts are required before the goal is achieved..*

This is my translation of

> *Die Dimension der Modernisierung ist bisher von keiner afrikanischen Sprache erreicht worden. Zwar befinden sich einige dieser Sprachen, die von staatlicher Seite unterstützt werden, wie Arabisch, Swahili oder Hausa, auf dem Wege zur Modernisierung, jedoch bedarf es weiterer*
> *Anstrengungen, bis dieses Ziel erreicht ist.*
>
> Heine (1979: 11)

In a footnote Heine quotes what another linguist, Charles A Ferguson, understands by "modernisation".

> *the development of intertranslatability with other languages in a range of topics and forms of discourse characteristic of industrialized, secularized, structurally differentiatiated, modern societies. (ibid).*

In Heine's view and, by implication, Ferguson's view, Luganda has not yet reached the dimension of elaboration. This is indeed true for it is not yet intertranslatable with English , Greek, French ,

Japanese, Italian, Spanish, Portuguese, Russian, Hungarian or Finnish in a serious range of topics and forms of discourse. Modern science, technology and economics cannot be articulated in Luganda. Hence, only a small portion of human knowledge is impartable in Luganda. As Heine observes, Swahili is backed by the state: it is accorded official status in Tanzania and Kenya. Nevertheless, at the secondary and tertiary levels of education Swahili is not the medium of instruction, especially in the sciences.

It would be interesting to merely imagine that it were not only an economically but also socially, demographically, politically and culturally sound proposition to turn any of the languages explicitly mentioned by Heine into a full-fledged vehicle of modern science, technology and economics at the University level of education. How would this be brought about in the shortest time possible? To answer this question I sketch a four-premise argument.

First, the last three centuries have witnessed very remarkable cognitive growth. Talking about this 'knowledge explosion', John Ziman writes:

> *...the 'size' of science has doubled steadily every 15 years. In a century this means a factor of 100. For every single scientific paper or for every single scientist in 1670, there were 100 in 1770, 10,000 in 1870 and 1,000,000 in 1970.*
>
> Ziman (1976: 56-57)

Second, I stipulate that the desire for linguistic autonomy among the speakers of the language concerned is overt. In Tanzania, for example, the National Swahili Council *Baraza la Kiswahili la Taifa* (*BAKITA*) and the Institute for Swahili Research *Taasisi ya Uchunguzi wa Kiswahili* (*TUKI*) at the University of Dar-es-Salaam are charged with the task of developing Swahili to a level of expressional maturity in the sciences and humanities.

My third premise is constituted by the time factor. If one were to characterise the pace at which the lexicon of Swahili or Arabic is growing, one would most probably find that it is revolutionary at the primary and secondary levels of education on the one hand, and evolutionary at the tertiary level of education on the other hand. If, then, we bear in mind that literally millions of expressions are required to name natural phenomena, chemical substances, living organisms, and diseases, it will probably take a long time for Swahili or Arabic to be adequately rich in the requisite terminology. To date there is no plan to turn Swahili into a medium of University education by the year 2000.

The fourth premise is a set of criteria for specialised terminology. Nybakken (1959: 15-23) presents a good account of the criteria. The most important criterion for specialised terminology is precision. By precision of an expression X′ in a target language in relation to a term X in a source language I shall understand a relation of mutual semantic inclusion which I shall symbolise as

$X \rightleftharpoons X'$ (following Wessel (1977: 7))

Thus, for a sample of German and English expressions:

(5) *Gleichrichter* ⇌ *rectifier*
Beschleunigung ⇌ *acceleration*
Kernreaktor ⇌ *nuclear reactor*
Schnittmenge ⇌ *intersection set*
Alkan ⇌ *alkane*

For a language whose scientific lexicon is being expanded it is of cardinal importance to ensure that this criterion is satisfied. An interesting example of expressional imprecision could be taken from one of the word-lists that have recently been compiled in Dar-es-Salaam and published by the BAKITA. There, 'hydrotropism' is rendered into Swahili as *ubadilihali* as reported by C.W. Temu, the then Director of TUKI, in his '*Taasisi ya Kiswahili na Uundaji wa Maneno Mapya ya Kiswahili – Kichocheo cha Mjadala*' (p.4).

The expression *ubadilihali* means 'change of state'. It is obtained by dropping the particle of relationship in the nominal phrase

(6a) *ubadili wa hali* 'change of state'

Since besides hydrotropism, geotropism, phototropism and other tropisms are also changes of state i.e. processes, *ubadilihali* is imprecise. Symbolically,

(6b) *hydrotropism* ← *ubadilihali*
hydrotropism ≠ *ubadilihali*

In chemical and biological nomenclature systems the criterion of systemicity of expressions is absolutely fundamental. In chemical

nomenclature groups of compounds are assigned generic names and systemic indicators.

(7) General formula	generic name	(morphemic.i.e systemic indicator)
C_nH_{2n+2}	alkanes	-ane
C_nH_{2n}	alkenes	-ene
C_nH_{2n-2}	alkynes	-yne
$C_nH_{2n+1}OH$	alcohols	-ol
$C_nH_{2n+1}NH_2$	amines	amine
C_nH_{2n+1} _____	alkyls	-yl
____$CO.NH_2$	amides	amide

Similarly, in biological nomenclature, the biologist divides all living things into the Plant and Animal Kingdoms. For each Kingdom six broad taxonomic categories stipulated are as follows.

(8)		
	Kingdom	K
	Phylum	P
	Class	C
	Order	O
	Family	F
	Genus	G
	Species	S

where K,…., S are descending taxonomic categories of membership such that

$P_i \subset K_j$ (a Phylum is a subset of a Kingdom)

$C_i \subset P_j$ (a Class is a subset of a Phylum)

$O_i \subset C_j$ (an Order is a subset of a Class)

$F_i \subset O_j$ (a Family is a subset of a Order)

$G_i \subset F_j$ (an Genus is a subset of a Family)

$S_i \subset G_j$ (a Species is a subset of a Genus)

Larger or smaller sets can be formed so that categories like Superfamily, Subfamily and Infrafamily become applicable. It is still a big task to coin neo-Latin expressions with systematic indicators that capture the concepts of order and set inclusion, especially in zoological nomenclature.

Phonographic consistency of co-shared expressions is related to the criterion of systemicity. Consider, for example, the following expressions which have been co-shared by Swahili during the last fifteen years.

(9)

atom	→	*atomi* ~	*atomu*
geography	→	*jiografia* ~	*jografia*
chromium	→	*kromi* ~	*kromiamu*
chromate	→	*krometi* ~	*kromati*
chloride	→	*kloraidi* ~	*kloridi*

Clearly, there seems to be some inconsistency as to how the expressional elements

(10) *geo-*
-ium
-ate
-ide

are to be co-shared through swahilisation. The third criterion for terminology is that of expressional internationality. Expressional internationality manifests itself, for instance, in the use of symbols and abbreviations irrespective of the natural language of the scientist. The following symbols and abbreviations are used internationally:

(11) $\forall, \exists, \neg, \wedge, \vee, \rightarrow, \Box$ (in logic)
$\surd, \pi, \int, \partial/\partial_x$ (in mathematics)
g, F, A, m, ms^{-1}, Nm, J, (in physics)
NaCl, H_2O, Xe (in chemistry)

The fourth criterion may carry the label 'antitaboo criterion.' What is to be ensured here is the strict avoidance of so-called taboo words which, otherwise, hamper the process of terminologisation. In Luganda and Swahili these are words connected with the uro-genital extremities and the anus. Expressional modernisers of Luganda would find it more rewarding to avoid

(12) *vagina* ⇌ *emmana*
penis ⇌ *embolo*
anus ⇌ *ekinÿo*

as terms. Even in all Luganda translations of different versions of the New Testament (Rev. 2:17), sensitivity to taboo words is shown, for we find

(13) Aramaic *man hu* "what is it?" →

Gk *manna* → Lat. *manna* → E. *manna* → Lgd. *emmaanu,*

where the arrow signals a transformational process. So, even translation from English would have *emmaanu,* for *manna* can only be Lugandised as *emmana.* This accords with the Meinhof-Ganda Law. Another example to show the avoidance of taboo words is

(14) Sw. *kufuli*→Lgd. *ekkufulu* "padlock"

Here *ekkufuli* would be suggestive of *enfuli* 'labia majora'

Expressional productivity, as a criterion, is related to terminological systemicity. An expression or expressional element that occurs in many expressions is said to be productive. In pure and applied physics, for instance, the expressional element 'electr (o)' is known to be very productive, for it occurs in more than 900 words, cf. Dorian (1978: 367-378). It is therefore employed so as to articulate a large term cluster.

Expressional economy, as a criterion for terminology, has to be viewed in terms of the language concerned. By expressional economy I mean the tendency to use as few expressions for a term as possible; or if it is a word for a term, the tendency to prefer

short to long expressions. While "Civil Air Travel Insurance Company" and "oversea range television direction radio connection" are not intolerably too long, their German equivalents *Zivilluftfahrtversicherungsgesellschaft* and *Überseereichweitenfernsehrichtungsfunkverbindung* are considered to be unbearably too long.

Expressional transparency, as a criterion, is of interest to a certain group of language users. In Swahili *elimunyota* is generally more transparent than *astronomia*. The former is undoubtedly transparent to most Swahili speakers whereas the latter is only transparent to those who know the Greek expressional elements *astr (o)-* and *nomia*. *Elimu* - "knowledge, study" and *nyota* "stars" are everyday expressions. At the primary school level one expects the use of *elimunyota* (Ger. *Sternkunde*) while at higher levels of education *astronomia* (Ger. *Astronomie*) is perhaps to be expected. The propensity of German to form expressions from its own expressional stock rather than assimilating from Greek and Latin results in welcome transparency of expressions especially to the less tutored. *Sternkunde* (i.e. 'star knowledge') is transparent to all German speakers: not so *Astronomie* (from Greek).

The last criterion for terminology is that of language-relative acceptability of expressions.

I.2 The PEGITOSCA Criterion

Precision (P), economy (E), generativity (G), internationality (I), transparency (T), (antiobscenity) (O), systemicity (S), consistency (C) and language - relative acceptability (A) of terms can be acronymically captured as PEGITOSCA. Let it be contended with due circumspect that any theory of scientific terminology and any method or set of methods of terminological elaboration that may ensue from the theory mainly hinge upon the fulfilment of the overall PEGITOSCA criterion for scientific terminology. This is the yardstick of which terminological elaborators of Hebrew, Indonesian, Icelandic, Arabic Amharic, Hindi, Somali, Kinyarwanda or Kiswahili are to varying degrees cognizant. I formulated the criterion for the first time in Kiingi (1989) when I was working on the terminological modernisation of Luganda. I would like to consider three main sources of data for its revised formulation here. The primary source of data are the disciplines of logic, mathematics, physics, chemistry and biology. Then I make contact with some of the leading terminologists of this century: Wüster (1979), Werner (1972), Flood (1961), Cahn and Dermer (1959, 1979), Jeffrey (1968), Savory (1970) and Picht and Draskau (1985). The third source entails keen monitoring of the work done at *Taasisi ya Uchunguzi wa Kiswahili* (TUKI); the work assumes its definitive shape in TUKI (1990).

It is common knowledge that whenever we define a term, we aim at its conceptual precision. For the purpose of this inquiry I

define the term 'term' as the union of a concept and the sign (or expression) which represents the concept. For instance, in (15) we have three terms but only one concept of mechanics, namely acceleration.

(15) *acceleration* (E.)
Beschleunigung (Ger.)
mchapuko (Ksw.)

All the scientific terminologists regard conceptual precision as the most important criterion for the term status of a linguistic sign. The economy of a term in terms of subjective length of the expression is language-relative. The term in (16) is bearably long in German.

(16) *Acetessigsäureethylesterdinitrophenylhydrazon.*
We gain easy access to the term by dissecting it into *acet-, essig, "yeast", säure, "acid", ethyl, ester, di-, nitro-, phenyl, hydrazon*
It should be borne in mind, however, that even chemical English has very often to tolerate long expressions. Consider, for example, the substance we call DDT in colloquial parlance.

(17) *dichlorodiphenyltrichloroethane*
$(C_6H_4Cl)_2 : CH . CCl_3$

The use of "DDT" is a clear attempt at economy.

Productivity (or generativity) is defined as the potentiality of forming expressionas on the basis of relatively few morphemes in a language. The German expressions in (18) exhibit both generativity and systemicity.

(18) *Telefon Fernsprecher* "telephone"
telefonieren fernsprechen "to telephone"
Telefonat Ferngespräch "telephone conversation"
Telefonist "telephone operator"
telefonisch "by telephone"
Telefonie "telephony",
where *tele-* ⇌ *fern-* "far".

By recasting (15) as (19)

(19) $d^2\ \mathbf{r}\ /dt^2 = \mathbf{a}$

we invoke the subcriterion of internationality. It is important to differentiate between Eurocentric and global internationality. Statement (19) conforms to a global convention among mathematical physicists, for the symbolic usage is independent of the natural language of a given physicist. Eurocentric internationality is not necessarily identical to global internationality as (20) clearly reveals.

(20)	hydrogen	H	
	Wasserstoff	H	(Ger.)
	oxygen	O	
	Sauerstoff	O	(Ger.)
	lead	Pb	
	Blei	Pb	(Ger.)

The names for the three chemical elements in (20) are not globally international, although their symbols are. The German terms *Wasserstoff* "water stuff" and *Sauerstoff* "acidic stuff" are far more transparent in German LGP than *hydrogen* and *oxygen*. Failure to distinguish Eurocentric from global internationality has led to unnecessary compromising of transparency of modernised Indonesian. Alisjahbana, probably the undisputed architect of scientific Indonesian, reports and opines:

> *Modern European languages are already to a very high degree a unity, since the essential scientific economic, technological and to a certain extent also to the other modern terms expressing the same modern concepts, in most cases use words based on the same Greco-Latin words. In the development of the new modern languages of Asia and Africa, thus also of the Indonesian and Malaysian language which followed a parallel course of vigorous anti-Western nationalism, there was and is a tendency to avoid international words. In the coining of the Indonesian modern terms during the Japanese occupation in Indonesia, for example, the preference in the determination of Indonesian modern terms was as follows: first to look for an existing Indonesian word; if there was no adequate Indonesian word for that concept a search should be made in the various local languages. If there was also no fitting word in local languages either, an attempt would be made to find an Asian word. The internationally used terms came last. Fortunately in the deliberations at that time this rule was never applied literally. But on the whole there were three tendencies discernible: a preference for Sanskrit words from the side of the Javanese whose culture has been deeply influenced by India, for Arabic words from the Muslim side and for international words mostly based on Greco-Latin from the modernised younger groups.*

> *On the assumption that science, technology and economics are based on universal concepts and that the world has become more and more a unity because of the modern system of transportation and communication, the most logical and efficient decision in the determination of modern terms should, of course, be the choice of international words, mostly based on Greco-Latin. In the context of the controversy of East and West during the last [sic] century, however, this decision is not a pleasant one for many Asians and Africans. But viewed from a long range, closer co-operation in the modern world for scientific, economic and technological progress and other common interests, it is the best decision. There is very little that Sanskrit and the Arabic language can contribute to twentieth century scientific, technological terminology.*
>
> Alisjahbana (1976: 28)

If Alisjahbana takes the view that transparent Indonesian terms should be jettisoned or not coined on a large scale, then he has to reckon with a situation in which scientific Indonesian will be as unintelligible to "ordinary" Indonesian speakers as scientific English is to "ordinary" English speakers. An optimised solution to his problem could be to emulate Germans by ensuring a two-track lexicon consisting of native and foreign words (*Fremdwörter*) as the list in (21) shows.

(21)

native German	"foreign" German	English
Überschallgeschwindig-keit		"supersonic speed"
Fachausdruck	*Terminus*	"term"
Strahlung		"radiation"
Umstand		"circumstance"

Schwingung	*Vibration*	"vibration"
Zerfallsgesetz		"law of decay"
Zerlegung	*Analyse*	"analysis"
Zustandsgleichung		"equation of state"
Widerspruch		"contradiction"
Gegenbeispiel		"counterexample"
Bedeutungslehre	*Semantik*	"semantics"
Lautlehre	*Phonetik*	"phonetics"
erzeugen	*generieren*	"generate"
Briefwechsel	*Korrespondenz*	"correspondence"
Übermensch		"superman"
erdkundlich	*geographisch*	"geographical"
Volkswirtschaftslehre	*Nationalökonomie*	"national" "economics"
Völkerkunde	*Ethnologie*	"ethnology"
Fernrohr	*Teleskop*	"telescope"
Feuchtigkeit		"humidity"
Fliehkraft	*Zentrifugalkraft*	"centrifugal force"
Gleichung		"equation"
Grenzwert	*Limes*	"limit[ing]value"
Halbleiter		"semiconductor"
Wissenschaftler		"scientist"
Sonnenfinsternis		"solar eclipse"
Halbkugel	*Hemisphäre*	"hemisphere"
Halbinsel		"peninsula"
Fernsehen		"television"
Frauenheilkunde	*Gynäkologie*	"gynaecology"
Luftfahrt		"aviation"

Mengenlehre		"set theory"
Himmelskörper		"celestial body"
Salzbildner	*Halogen*	"halogen"
Lehrsatz	*Theorem*	"theorem"
Kräftevieleck		"force polygon"
Strom		"current"
Kernspaltung		"nuclear fission"
Schwere	*Gravitation*	"gravitation"
Kernladungszahl		"atomic number"
Reibungszahl		"coefficient of friction"
Beiwert	*Koeffiezient*	"coefficient"
Brechungsgesetz		"law of refraction"
Widerstand		"resistance"
Ableitung		"derivation"
Drall		"rotational impulse"
Gattung	*Genus*	"genus"
Art	*Spezies*	"species"
Druck		"pressure"
Durchmesser		"diameter"
Beziehung	*Relation*	"relation"
gerichtlich	*forensisch*	"forensic"
Abstammungslehre	*Evolutionstheorie*	"theory of evolution"
ursächlich	*kausal*	"causal'
Bücherei	*Bibliothek*	"library"
Stamm		"phylum"

Volksherrschaft	*Demokratie*	"democracy"
Werkzeug	*Instrument*	"instrument"
Scheinwissenschaft		
Pseudowissenschaft		"pseudoscience"
Gelenkentzündung	*Arthritis*	"arthritis"
Ursprache		"proto-language"
Sprachwissenschaft	*Linguistik*	"linguistics"
Entsalzungsanlage		"desalination plant"
Wörterbuch		"dictionary"
Säure		"acid"
Blutarmut	*Anämie*	"anaemia"
Kohlenstoff		'carbon'
Stickstoff		'nitrogen'
Rundfunk	*Radio*	'radio'
bestmöglich	*optimal*	'optimal'
Forderung	*Axiom*	'axiom'
Volksversammlung	*Parlament*	'parliament'
Ausschuss	*Komitee*	'committee'
Rechnung	*Kalkül*	'calculus'
Häufigkeit	*Frequenz*	'frequency'
Reihe	*Serie*	'series'
Vergleichend	*komparativ*	'comparative'
Teilchen	*Partikel*	'particle'
Verneinung	*Negation*	'negation'
Vorbild	*Modell*	'model'
Sprachlehre	*Grammatik*	'grammar'
Winkel		'angle'

Wertigkeit	*Valenz*	'valency'
gleichwertig	*äquivalent*	'equivalent'
Widerspruchsfreiheit	*Konsistenz*	'consistency'
Grundsatz	*Prinzip*	'principle'
Aussage	*Proposition*	'proposition'
Voraussetzung	*Prämisse*	'premise'
Geschwindigkeitsmesser	*Tachometer*	'speedometer'
waagerecht	*horizontal*	'horizontal'
senkkrecht	*vertikal*	'vertical'
Bewegungsgröße		'momentum'
Erkenntnislehre	*Epistemologie*	'epistemology'
Wiedergeburt	*Renaissance*	'renaissance'
Erscheinung	*Phänomen*	'phenomenon'
Versuch	*Experiment*	'experiment'
Sternwarte	*Observatorium*	'observatory'
Wetterkunde	*Meteorologie*	'meteorology'
Krankheitszeichen	*Symptom*	'symptom'
Maschinenbau		'mechanical engineering'
Erdneuzeit	*Känozoikum*	'Cenozoic (Era)'
Erdmittelalter	*Mesozoikum*	'Mesozoic Era)'
Erdaltertum	*Paläozoikum*	'Paleozoic (Era)'

What should be clearly noted here is that although German uses and is compelled to use Eurocentric terms like *Atom*, *Mathematik*, *Geometrie*, *Topologie*, *Literatur*, *Physik*, *Nitrat*, *Karbonat* and *Elektron*, there is a conspicuous predilection for terms based on its native lexical stock. If the concept

Unschärfebeziehung created by the German-speaking physicist Schrödinger was to be rendered later into English as the *uncertainty relation* (we take note of the Latin roots), the English term did not attain more precision and global internationality. It did, however, achieve Eurocentric internationality.

Picht and Draskau (1985: 116-7) offer a catalogue of criteria for terminology by recommending that an ideal term

(a) must be well-motivated [T]
(b) should be systematic [S]
(c) must accord with the syntactic rules of the language [A]
(d) must be potentially productive [G]
(e) must avoid pleonasm [E]
(f) should not contain superfluous elements [E]
(g) should be as short as possible without adversely affecting its clarity [E]
(h) should preferably not have synonymous, homonymous nor polysemous term [P]
(i) should preferably not present orthographical or morphological variations. [C]

They conclude their catalogue of criteria by asserting:

> *Every one of these rules and norms is founded upon observation and investigation. Their practical value is not under discussion, however, it should be remembered that they are not all applicable at once or in all possible combinations. In creating, analysing or evaluating a term,*

> *these recommendations should be borne in mind, and a pragmatic and realistic decision reached, which take account of :*
>
> *- sociolinguistic factors which determine a possible rebuff for the user*; [A]
>
> *- consideration of the difficulties and advantages connected with the revision of a terminology which, though defective, is well-established;* [A]
>
> *- the degree of "internationalness"* [I]
>
> Picht & Draskau [ibid.]

They insist on the word order in the language exemplified by them according to (22); and criticise inconsistency according to

(22)	*Dieselmotor*	Ger.
	moteur Diesel	F.
	diesel engine	E.
(23)	*labour*	*labor*
	centre	*center*
	theatre	*theater*

In the course of monitoring problems of the terminological modernisation of Kiswahili , I realise that the subcriterion of acceptability should be analysed into nine infracriteria: purpose, receptor-friendliness, ecology, social system, cutural system, language, antecedence, style and speech–act. Let me show how we gain access to these infracriteria by posing relevant questions in the order of presentation.

(a) What is the purpose of introducing the terminology ?

(b) Is the terminology suitable for the receptor group being targeted?

(c) Are we discoursing on animals, plants and land features familiar to the receptors?

(d) Can we relate our terminology to the social system of the receptors?

(e) Do we take the cultural system of the receptors into account?

(f) Do we take the phonological, morphological and syntactical structure of the receptor language as sacrosanct?

(g) Is a trend in expression formation or assimilation already manifest in the receptor language?

(h) Is the style of the texts in which the terminology is to. feature formal, informal polite or familiar?

(i) Is a given term appropriate in the execution of illocutionary and perlocutionary acts?

I surmise that my presentation of the PEGITOSCA Criterion could erroneously be construed as a proposed theory of scientific terminology. It is rather a mere but pivotal component of my theory of scientific terminology that I advance in Chapter II.

My theory is formalised on the basis of axioms, basic and defined concepts. The PEGITOSCA Criterion relates the calculus of the formalised theory to the real world of terms. It is therefore, what a philosopher of science calls a bridging rule.

The Criterion, by itself, does not lead the terminologist to an expression. It is, rather, a yardstick for the terminologicality of the expression previously generated or found. I now submit that an expression for term status in whatever language fulfills the criterion such that

$$\tau = \phi (P, E, G, I, T, O, S, C) + \psi (A),$$

where ϕ and ψ are functions, is maximised as the degree of terminologicality τ. For the subcriterion A, I coin another well–motivated acronym so that

$$\tau = \phi (P, E, \ldots, S, C) + \psi (p, r, e, s, c, l, a, s,^* a^*),$$

I now assign discrete values to the terminological factors as follows:

$$P = p = r = l = \pm 3$$

$$E = G = I = S = C = a = \pm 2$$

$$T = O = e = s = c = s^* = a^* = \pm 1$$

I stipulate that in logic, mathematics, physics, chemistry, biology and medical science the subcriteria precision, economy and generativity be obligatory. Internationality and systematicity should be additionally mandatory in physics, chemistry, biology and medical science.

I conclude this Section with a review of the *Kamusi Sanifu ya Biolojia, Fizikia na Kemia* published in TUKI (1990).
The *Kamusi* is an alphabetically arranged unidirectional (English-Kiswahili) dictionary encompassing about 4,000 entries. It will be reviewed by reconstructing the structure of an

entry article and the style manual for its compilers. Subsequently, the PEGITOSCA criterion will be applied to a cross-section of entries with a view of determining serious violations of the criteria for scientific terminology.

Should it emerge from the discussion that the target group for the *Kamusi* is not ascertainable, and that the G, T ,O ,C, and A were grossly violated while the too frequent kiswahilisation of English terms apparently accommodates the criteria P, E, I and S, then the inescapable conclusion will be that the *Kamusi* is in need of a radical overhaul.

In order to reconstruct the style manual used in the compilation and writing of the *Kamusi* , we first profitably exhibit two typical entries and then traverse the *Kamusi* searching additional elements of the style manual.

(a) *Pesticide* n kiuavisumbufu (vi-): kitu kinochoua visumbufu, aghalabu dawa. Viuavisumbufuvu vyaweza kuwa viuawadudu, viuamagugu viuakarina, viuakonokono, viuapanya, viuandege, viuakuvu, viuaminyoo, n.k. [Kem]

(b) *Planck's constant* (h) n kibaki planki (h): namba ya uwiano kati ya uwiano kati ya fotoni na marudio ya nuru. Ina thamani ya 6.63×10^{-34} J**S** [Fiz] .

It clearly emerges that a typical entry article manifests the general components:

(a) the English entry term.

(b) a symbol or abbreviation e.g. h (Planck's Constant)

(c) The lexical category of (a) e.g. n (noun)

(d) The Kiswahili equivalent

(e) the plural form of (d) e.g. *vi*-in (1)

(f) a definition of (d) in Kiswahili

(g) a field label [Bio] for Biology
[Kem] for Chemistry
[Fiz] for Physics.

It may well be conceded that the above-reconstructed general structure of an entry article is adequate for users who are already competent in mainstream English and Kiswahili such that, for instance, issues of pronunciation and etymology are rendered redundant. Nevertheless, there are lexicographical inadequacies, three of which should be specifically recorded.

First, abbreviations like ATP, DNA, TNT (see pp.3 and 167) are introduced in their pertinent articles but do not themselves feature as entries. Note, however, that RNA, EMF, EMU, STP, ESU and NTP are not only introduced under their relevant entries but they, in turn, are also entries. Secondly, although affixes and affixoids like *kilo-*, *giga-*, *nano-*, *milli-*, *trans-* and *phyto-* are included, it is outright inexplicable to exclude all generative suffixes and suffixoids and to ignore one of the most generative morphemes in physics: *electr (o)-*.

Thirdly, and the most unfortunate of all, apart from lists of abbreviations and symbols on pp. viii and ix [under *Maelezo kwa Mtumiaji* "Using the Dictionary"] and the *Jedwali la*

Elementi "A Table of [Chemical] Elements", the following staple series entries in any natural scientific pedagogical dictionary of reasonable format are totally missing:

(a) the periodic table of chemical elements
(b) the Greek alphabet
(c) the SI units and symbols
(d) the biological nomenclature
(e) important constants and standards (with their symbols and values in SI units)
(f) the chemical nomenclature
(g) the solar system.

I anticipate and appreciate the endeavour on the part of the *Kamusi* compilers to economise dictionary space and thus keep production costs to a minimum. That state-of-affairs notwithstanding, it is hardly pretentious to pose the question: for whom was the *Kamusi* prepared? Concomitant with this question is the question whether the PEGITOSCA criterion for terminology has been fulfilled.

The work of a terminologist, consists in optimising the two functions φ and ψ while bearing in mind how a certain given subscriterion may militate against another subcriterion or infracriterion. This should become clear as we proceed gauging selected Kiswahili terms from the *Kamusi* against the PEGITOSCA Criterion.

In (24), conceptual precision of a term remains elusive.

(24) "astronomy" *unajimu*

Unajimu cannot be "astronomy"and "astronomy"

simultaneously.

The zeal for expressional economy may lead to a questionable Kiswahili rendition as (25) shows:

(25) "sodium chloride" *natiri kloridi*
French "chlorure de sodium"
German "Natriumchlorid"

We surmise that some of the more careful speakers of Kiswahili would prefer *kloridi ya natiri* to (25).

Generativity, as prompted by the English in (26), is a welcome move towards the extrapolation of the lexical morphology of Kiswahili.

(26) "magnet" *sumaku*
"magnetism" *usumaku*
"magnetise" *sumakisha*

Compliance with internationality of terminology does not merely entail kiswahilisation of the English terms derived from Greco - Latin but, rather, the adoption of internationally stipulated symbols as in

(27) "xenon" *zenoni* Xe

The term equivalent to "xenon" may even be entirely native; but the symbol for the chemical element xenon is the internationally binding "Xe".

The *Kamusi* compilers are inconsistent in their attempt to meet the subcriterion of transparency. I cannot discern any terminological reason why in (28) presumably with the exception of (28a) expressional transparency is incomplete.

(28a)	"quantised"	*iliyokwantishwa*
(28b)	"univalent"	*-a valensimoja*
	"pentavalent"	*pentavalenti*
(28c)	"phytophagy"	*ulajimimea*
	"saprophyte"	*saprofiti*
(28d)	"photolysis"	*uvunjikajikimwanga*
	"hydrolysis"	*majimvunjo*
	"dialysis"	*dialisisi*
	"electrolysis	*elecktrolisisi*
	"pyrolysis"	*pirolisisi*
	"glycolysis"	*glikolisisi*
	"plasmolysis"	*plazimolisisi*
	"thermometry'	*upimaji halijoto*
	"pyrometry"	*pirometri*
	"calorimetry"	*upimaji joto*
(28e)	"hydrophyte"	*kimeamajini*
	"halophyte"	*mmeachumvi*
	"xerophytes"	*zerofita*
	"xerophytic"	*-a zeromofi* *(sic)*
(28f)	"sulphuric"	*sulfuriki*
	"sulphurous"	*sulfurasi*
(28g)	"petrology"	*petrolojia*
	"zoology"	*zuolojia*

	"optics"	*elimunuru*
(28h)	"inert"	*ajizi*
	"inertia"	*ineshi*
(28i)	"venom"	*sumu*
	"toxicology"	*toksikolojia*
(28j)	"kingdom"	*ufalme*
	"phylum"	*kabila*
	"class"	?
	"order"	*oda*
	"family"	*familia*
	"genus"	*jenasi*
	"species"	*spishi*

It is highly doubtful if taboo words as in (29) can ever be accepted as Kiswahili terms.

(29)	"penis"	*mboo*
	"vagina"	*kuma*
	"anus"	*mkundu*

Apart from the vacillation in terms of transparency we saw in (28), there is vacillation in terms of the source language from which expressions are to be kiswahilised (if that is the only option available). Consider the kiswahilisation of Greek and anglicised Greek in (30)

(30)	"dyne"	*daini*
	"cytology"	*sitolojia*
	"psychrometry"	*usaikrometri*
	"microbiology"	*mikrobiolojia*

"micrometre" *mikrometa*

From our foregoing analysis, we can now draw conclusions as to how the functions ϕ and ψ in the PEGITOSCA Criterion have been handled by the *Kamusi* compilers.

Excessive kiswahilisation of English terms has ensured precision, economy, generativity and systemicity. At the same time, the uncontrolled prospensity towards kiswahilisation has made it difficult to ensure transparency and also to ground the terminology (at least biological nomenclature) in the general socio-cultural system of Kiswahili users. The adoption of taboo words militates against style, which is inherent in the speech-act infra-criterion.

I.3 The non-Existence of a Theory of Terminology

Hitherto, I have employed the term 'theory of scientific terminology' tacitly. For the sake of formulating my pure problem and its practical or applied upshot, it is deemed proper to sketch an ideal theory. Let me take the Newtonian theory of (classical) mechanics in (31) and comment on its structure.

(31a) Basic concepts: space, time, mass.

(31b) Defined concepts: particle, force, energy, displacement, work, velocity, acceleration.

(31c) Principles:

(i) vector algebra such as addition

$$\mathbf{AB} + \mathbf{BC} = \mathbf{AC}$$

(ii) Axiom 1: If $\mathbf{F} = 0$, then $\mathbf{v} = 0$ or $\mathbf{v}$ = constant.

(iii) Axiom 2: $\mathbf{F} = k\, d/dt\, (m\, \mathbf{v})$

(iv) Axiom 3: $\mathbf{F}_1 = -\mathbf{F}_2$

(v) Axiom 4: $\mathbf{F} = [-G\ m_1m_2/r^2]\mathbf{u}_r$

(31d) Theorems: $T = 1/2\ mv^2$, ...

(31e) Bridge rules:

(i) if a string is light, then its mass $m = 0$

(ii) The mass of an extended body is concentrated at its centre of mass.

From basic (i.e. undefined) concepts we obtain defined concepts. Principles include those from mathematics (vector algebra and calculus) and axioms or postulates. Well-formed formulae in this theory will conform to the principles. Theorems are obtained as a result of applying the principles as transformational rules. Bridge rules relate the theory to the real world of physical objects. Finally, it should be borne in mind that velocities are low compared to that of light.

Picht & Draskau (1 985: 32-33) assert:

> *The terminological needs of the Third World should not be ignored. Here,... greater efforts are being devoted to forging effective instruments for professional communication from natural languages which are at present terminologically underdeveloped or only partially developed. The organisation of symposia in African and South American countries, intensified contacts with the Arab world and the Far East (China) are indicative of this trend. These languages will in future influence the development of the theory of terminology, enriching it with new knowledge and correcting many misapprehensions.*

Without stating explicitly who would "ignore" the needs of the so-called Third World, Picht and Draskau are hopeful that valuable impulses to the theory of terminology will emanate from the languages being elaborated. This hope notwithstanding, the cardinal question is whether there is what can, in the strict sense of the term , be referred to as a theory of terminology. A clear–cut answer to this question is given by Picht and Draskau themselves.

> *It would be going too far at present to postulate the existence of a generally recognised basis for the theory of terminology, although there is no doubt that the same basic elements may be discerned, in one form or another, in the attitude of all the movements and schools of thought.*
>
> Picht & Draskau (1985: 31)

There is, therefore, no theory of terminology. From this lack of a well-ground theory of terminology issues a plethora of *ad hoc* approaches to terminological elaboration.

The approaches are characterisable as:

(a) language identity-preserving principles
(b) sememic or conceptual methods
(c) expression formation methods in the language concerned
(d) affix-inventing moves
(e) source-defining for expressions

Criteria for terminology are not treated systematically and yet terminological elaboration is essentially PEGITOSCA-optimisation. *Ad hoc* approaches to terminological elaboration

brings with it the unfortunate transient nature of many suggested terms. A quick comparison of TUKI terms published in BAKITA (1976, 1978, 1980) with terms in TUKI (1990) reveals that many suggested terms have either been changed or discarded altogether. In (32) the transient nature of terms in Kiswahili is brought to light.

(32)

Earlier TUKI term	Current TUKI term	Gloss
elimumwili	anatomia	'anatomy'
tonoradi	atomu	'atom'
hamirojo	kabohidrati	'carbohydrate'
chembe	seli	'cell'
chembeuzi	selulose	'cellulose'
umbijani	klorofili	'chlorophyll'
kisadifu	jene	'gene'
uzaosafu	spishi	'species'
kiinichembe	nuklia	'nucleus'
kipeleanguvu	-nururishi	'radioactive'
-safu	jenusi	'genus'
insekta	mdudu	'insecta'
mimbapweke	pathenojenesisi	'parthenogenesis'
peteo	spektra	'spectrum'
kiungo	organi	'organ'
wikizangaomwili	chanjo	'vaccination'
nguvu	nishati	'energy'
fusi	sementi	'cement'
chocheo	homoni	'hormone'
mgwangwajuko	albino	'albino'

fumbatio	jifa	'abdomen'
upapachi	simbiosi	'symbiosis'

It is therefore valid to infer probabilistically that the time which will elapse up to terminological maturity will be long if not very long - perhaps fifty years?

I.4 Towards the Problems of the Inquiry.

At this juncture Zygmunt Stoberski poses a dilemma, with a piece of advice, for he contends:

> *To protect their respective languages against foreign words, philogists (sic) and writers point to their desire to defend native tongues and their purity as a form of cultural heritage. The argument holds true when it comes to a conversational or literary language, but is inadmissable (sic) with regard to specialist terminologies for two reasons: first, specialist neologisms do not constitute one's cultural heritage as they are being created now in various languages. And second the economic backwardness of many African countries has to be taken into account. That is, one would have to decide whether it is more patriotic to quickly make knowledge of science and technology available for ones (sic) own nation in order to protect it against catastrophic dangers, or to stick to the illusory conviction that patriotic feelings can be satisfied with translating into his (sic) native language of hundreds of thousands or even millions of foreign terms*
>
> Dagne & Gemeda (1987: 87)

Stoberski's reasoning is invalid for two reasons. First, specialist neologisms do betray a bias towards the cultural heritage of the terminlogical coiner; biological nomenclature affords a good example: the zoologist classifies living

organisms in Kingdoms, Phyla, Classes, Orders, Families, Genera and Species. Clearly, a social conceptual system is transposed to label hierarchical groups. It is conceivable to take a totally different conceptual system as a basis of labelling the same groups; for example, numerical magnitude with 10^6, 10^5,..... 10^2, 10^1, 10^0, instead of Kingdoms, Phylum ... Family, Genus and Species. Second, Stoberski cynically assumes that L2 cannot be made internally self-reliant in order to articulate the millions of concepts already expressible and expressed in L1. In the contemporary world, Stoberski assigns a special L1 role to Indo-European Languages, for he surmises that

> *a term may be considered to be international if it is used in any of the official UN languages and in 10 other smaller languages, or two world languages plus three or four smaller languages.*
>
> Dagne & Gemeda (1987: 89)

Among English, French, Russian and Chinese, Chinese is in the minority on the Security Council. English, French, Spanish, and Portuguese may well be the major world languages. 'Smaller languages' would most probably include German, Arabic, Japanese, Italian, Polish, Dutch, Turkish, Modern Greek, Hindi, Korean and Bahasa Indonesia. Clearly, on either alternative, the Indo-European (IE) languages English, French, Russian, Spanish, Portuguese, Hungarian German, Italian, Polish, Dutch, Modern Greek and Hindi would tip the balance with regard to terminological internationality. If it should be true that

> *... ... it is virtually impossible to form millions of new terms from native morphemes whose resources are not that rich, but also (that) this tendency erects barriers which hamper the swift flow of scientific and technical information.*
>
> Dagne & Gemeda (1987: 88)

then terminological modernisers who speak non-IE languages could be overawed into terminological submission to IE speakers. That this state-of-affairs need not materialize is dimly corroborated by the Chinese experience, for Forrest establishes:

> *The real difficulties were met with when the Chinese began not merely to adopt the superficial products of European science, but that science itself. Distinctions fine enough for the practical purposes of everyday life had to be refined far beyond that point, and in many cases as in the distinctions of chemical elements, the differences were too subtle to be expressed by compounds of manageable length. In this difficulty Chinese was, of course, not alone; European languages are reduced to using Latin, or artificial Latin, constructions for the exact definition of natural species, and the names of many chemical elements are hardly more parts of the languages which employ them than the biological names. But it must be allowed that the embarrassment was greater in Chinese than in polysyllabic languages which found no difficulty, in assimilating such words as 'iridium', or 'zoophyte'. In the realm of chemistry Chinese has to a large extent met the problem by the coinage of new words.*
>
> Forest (1973: 257)

The immediate inference from all this is that the monosyllabic nature of Chinese has ensured its elaboration without mere assimilation of IE terms. Unlike Stoberski, Ohly recommends:

> *Accommodate a foreign term only as the last resort, i.e. when you have exhausted all possibilities to coin an equivalent.*
>
> Ohly (1987: 243)

In a nutshell, Stoberski poses us a pseudo-dilemma. Neither in Picht & Draskau (1985) nor in Dagne & Gemeda (1987) do we discern a clear objective of setting up a general conceptual taxonomy for the terminologist or terminological elaborator. Admittedly, Picht & Draskau do advocate the construction of systems of concepts but in special subject fields or disciplines like physics. They regard a system of concepts as "an indispensable aid in the elaboration of a terminology" (for it ensures):

> *(a) the reconnaissance of the structure of the inventory of concepts of a subject field as a preliminary to a systematic elaboration*
>
> *(b) the recognition of the exhaustiveness of an inventory of concepts*
>
> *(c) the comprehension of the relationship between concepts which may be important for the formation of terms*
>
> *(d) the recognition of the degree of congruence between the systems of concepts of different languages; this in turn is indispensable for the recognition of equivalence*
>
> *(e) the representation in a systematically organized dictionary of the results of terminology work... "*
>
> Picht & Draskau (1985: 92)

A general conceptual taxonomy along lines similar to those of thesaurus compilers like Ballmer & Brennenstuhl (1986) would be of advantage to the terminologist.

The researcher sees his problem as residing in four factors:

(a) lack of a general conceptual taxonomy
(b) *ad hoc* approaches to terminological elaborateness
(c) lack of a well-formulated theory of terminology
(d) long-term terminological elaborateness

The problem may be stated as follows:

(a) What is the general logical structure of the mode of thinking of a terminologist or a terminological elaborator?
(b) How can the lexicon of Luganda be extended such that
    (i) the lexical extension is PEGITOSCA optimised and
    (ii) the time interval up to terminological elaborateness is minimised?

The problem to be tackled in this study is justifiable on two fronts: an ideological one and an academic one. Two contemporary African thinkers have provided the ideological stimulus for the problem. In a seminal paper "Failure in the Obligatory Use of a Policy of Linguistic Independence" Kahombo Mateene writes:

> *It is said that African languages are* [terminologically] *underdeveloped, and it is true; it is also true that they are developable. But what has been done to develop them? Almost nothing. It depends upon our free will to develop and enrich our languages by means of*

> *translation. Instead of dropping our languages in favour of European languages in the vain hope of making up for our scientific and economic lateness, we should make science and world technology assimilated into our languages of origin. Our African languages also must and can assimilate science and adapt themselves to modern life as Japanese and Chinese have done. The West has not yet completely assimilated us, our languages have the possibility of assimilating science, which is the pride of Europe.*
>
> OAU/BIL (1973-80: 25–26)

Although he gained access to University-level linguistics in French and English, Kahombo Mateene would like to see future generations of Africans assimilating science and technology in African languages among which one would possibly and probably find his Lingala. The fundamental role of the language of origin in scientific and technological progress is also well recognised by Dani W. Nabudere who, in a review of Bernal 1987, urges that

> *African children must be made aware of what we have achieved as the world's first civilisation to regain our self-respect and dignity, and to retrieve our culture from destruction from the machinery of "European progress". This does not mean turning our backs on modern developments. It means that modern development has to be reshaped to accord with the African self-image based on his own heritage. Any notion of "progress" or "modernisation" that does not start from a people's culture is tantamount to genocide. Japan has shown that it is possible to develop one's potentiality on the basis of one's culture.*
>
> SAPEM July 1991: 44-49

On the academic front, the study is motivated by the desire to contribute to:

(a) the theory of terminological elaboration in general,

(b) the theory of terminological elaboration of a Bantu language,

(c) the terminological elaboration of Luganda,

(d) the movement ofAmharic, Kinyarwanda, Kiswahili, Hausa, Wolof and of all other African languages whose terminological elaboration is being supported and promoted by the states in which they are spoken.

The first component of the research problem will be tackled by advancing a theory of scientific terminology based on a general taxonomy of scientific concepts and the PEGITOSCA Criterion. The second part of the problem will be solved by applying the theory to Luganda. A solution to the second part of the problem posed will be confirmed or refuted in conjunction with the following six assumptions which the reader will be urged to entertain for the sake of argument:

(a) A society that uses a foreign language as its main medium of scientifico-technological education can hardly advance scientifico-technologically.

(b) A majority of Luganda speakers favour the terminological elaboration of Luganda to such a degree that it becomes a medium of scientifico-technological discourse at all levels of education.

(c) The overwhelming majority of Luganda speakers are opposed to large-scale assimilation of foreign expressions. In other words, they prefer a situation in

which Luganda is expressionally as self-reliant as possible.

(d) There is no acknowledged source language of scientifico-technological terminology for Luganda; English and possibly Kiswahili are mere prompting languages.

(e) Probably well over 10 million expressions are required for full-fledged articulation of science, technology and economics in Luganda.

(f) Any Luganda expression for term status will have to fulfil the so-called PEGITOSCA Criterion.

The scope of the study will be determined by the following factors:

(a) We confine ourselves to the formal and natural sciences because it is here that problems of terminology are acute.

(b) We take English, German, Latin, Greek, Kiswahili and Luganda as the sources of expressional data.

(c) Issue of languages policy in Uganda are entirely outside the scope of this inquiry.

(d) The literature on the scientific lexicon of Kiswahili is relatively scanty; on Luganda it hardly exists.

(e) The period of time required for testing for appropriateness of the hypothetically extrapolated lexicon of scientific Luganda is extremely short.

(f) The linguistic and scientific competence of the referees under cannot be expected to be always reliable.

I.5 Structure of the Inquiry

As a conclusion to this introductory Chapter, I display an outline of the next Chapters together with Appendixes. In Chapter II a conceptual taxonomy in form of a periodic system of conceptual elements is presented. The taxonomy serves as a basis for the construction of a conceptual calculus which, in turn, is fused with the Pegitosca Criterion to advance a theory of scientific terminology. The first application of the theory consists in the systematic classification of conceptual characteristics that are articulated by means of Greco-Latin suffixes in biological and general terminology.

In investigating the marking of scientific concepts in Luganda I adumbrate in Chapter III the nature of extrapolation of expression formation that would become necessary if Luganda were to undergo a hypothetically accelerated terminological elaboration.

The extrapolation of expression formation which is conducted in Chapter IV culminates in the articulation of that problematic core of scientific terminology, i.e. chemical and biological nomenclature, in Luganda.

In Chapter V I translate and annotate English and German texts into Luganda. The texts are taken from the fields of logic, mathematics, physics, chemistry and biology.

Chapter VI is devoted to field work. In Chapter VII pointers to further research are inferred from what purports to be a contribution of this study to scientific terminology and terminological elaboration of a Bantu language apart from Luganda.

Rules of sound change which are directly relevant to the appreciation of expression formation processes in Chapters III-VI are summarised in Appendix A. During translation in Chapter V I make intensive contact with Appendix B in which a long glossary of Greco-Latin affixoids in European scientific terminology is presented. In Appendix C I present a questionnaire that was developed for the final collaborative workshops conducted in December 1995 in Kampala.

II. A THEORY OF SCIENTIFIC TERMINOLOGY

II.1 A Periodic System of Conceptual Elements

What is the general logical structure of scientific thinking? This is the question to be tackled in this Chapter which is the cornerstone of the inquiry.

I regard the following concepts (which I symbolise for the task ahead) as scientifically universal and fundamental:

A	(a) predicate or property (in the logical sense)	Q
	(b) space	L
	(c) matter	M
	(d) change	C
	(e) time	T
	(f) forces (gravitational interaction)	K
	(g) electric currents (electromagnetic interaction)	A
	(h) heat (thermal energy)	W
	(i) light (optical energy)	B
	(j) plants	F
	(k) animals	Z
	(l) humans	H
	(m) material objects	R
	(n) non-material objects	X
	(o) numbers	N
	(p) propositions	P
	(q) systems	S
B.	(a) possession	h
	(b) conjunction	j
	(c) disjunction	d

(d) mutation	v
(e) gradation	g
(f) similarity	s
(g) equality	e
(h) relativity	m
(i) direction	y
(j) perception	w
(k) will	l
(l) attempting	u
(m) thinking	k
(n) initiation	i
(o) augmentation	q
(p) affecting	a
(q) causation	c
(r) repetition	f
(s) possibility	p
(t) necessity	n

A formal logician studies systems (S) of propositions (P) which, in turn, are obtained by ascribing properties (Q) to theoretical objects. A pure mathematician concentrates on spaces (L) and numbers (N). A pure physicist is interested in forms of matter (M), changes and states of matter (C), time (T) forces, (K), electric currents (A), thermal energy (W), optical energy (B) and material objects (R). A pure chemist studies transformations of matter. A pure biologist studies plants (F), animals (Z) and the special animal the human being (H).

In order to establish a connection between the concepts of both lists, I introduce the symbols π and Ω to represent them. The symbol π stands for what I will call conceptual periods, i.e. Q, L, M,...N, P, S. The symbol Ω stands for what I label conceptual bonds, i.e. h, j, d,...f, p, n. Whenever the mind relates (or bonds) two entities from one or two conceptual periods, a conceptual union takes place according to the conceptual equation in (1).

(1) $\pi_1 \Omega \pi_2 = \pi_1 \eth_1 + \pi_2 \eth_2$

where $= \pi_1 \eth_1$ and $\pi_2 \eth_2$ are conceptual elements. The equation in (1) can be read as "Pie-one omega pie-two equals pie-one gamma-one plus pie-two-gamma-two". Taking the bonds one at a time, we write down equations (2)–(24)

(2) for the possessive bond

π_1 h $\pi_2 = \pi_1$ h + π_2 o

(3) for the conjunctive bond

π_1 j $\pi_2 = \pi_1$ j + π_2 o

(4) for the disjunctive bond

π_1 d $\pi_2 = \pi_1$ d + π_2 o

(5) for the mutative bond

π_1 v $\pi_2 = \pi_1$ v + π_2 r

(6) for the gradative bond

π_1 g $\pi_2 = \pi_1$ g + π_2 o

(7) for the similative bond

π_1 s $\pi_2 = \pi_1$ s + π_2 o

(8) for the equative bond

π_1 e $\pi_2 = \pi_1$ e + π_2 o

(9) for the relative bond

π_1 m $\pi_2 = \pi_1$ m + π_2 o

for the directive bonds (10) – (13)

(10) π_1 y $\pi_2 = \pi_1$ y + π_2 o

(11) for the perceptive bond

π_1 w $\pi_2 = \pi_1$ w + π_2 o

(12) for the volitive bond

π_1 l $\pi_2 = \pi_1$ l + π_2 o

(13) for the probative bond

π u $\pi_2 = \pi_2$ u +π_2 r

(14) for the cogitative bond

π_1 k $\pi_2 = \pi_1$ k +π_2 r

(15) for the initiative bond

π_1 i $\pi_2 = \pi_1$ i + π_2r

(16) for the augmentative bond

π_1 q $\pi_2 = \pi_2$ q + π_2r

(17) for the affective bond

π_1 a $\pi_2 = \pi_1$ a + π_2 b

(18) for the causative bond

π_1 c $\pi_2 = \pi_2$ c + = π_2 r

(19) for the repetitive bond

π_1 f $\pi_2 = \pi_1$ f + π_2 r

(20) for the possibility bond

π_1 p $\pi_2 = \pi_1$ p + π_2 r

(21) for the necessity bond

$$\pi_1 \, n \, \pi_2 = \pi_1 \, n + \pi_2 \, r$$

In (1) $\eth_1$ and $\eth_2$ are variables for conception groups.

Consequently,

$\pi_1 \, h, \, \pi_2 \, o, \, \pi_1 \, j, \, \pi_1 \, d \ldots \, \pi_2 \, r, \ldots \pi_2 \, b \ldots \ldots \pi_2 \, n$ are conceptual elements.

Let these elements be systematised in Table 1.

PERIODIC SYSTSEM OF CONCEPTUAL ELEMENTS

Group / Period		1 h	2 o	3 j	4 d	5 v	6 r	7 g	8 s	9 e	10 m	11 y	12 w	13 e	15 k	16 i	17 q	18 a	19 b	20 c	21 f	22 p	23 n
I	Q	Qh	Qo	Qj	Qd	Qv	Qr	Qg	Qs	Qe	Qm	Qy				Qi	Qq	Qa	Qb	Qc	Qf	Qp	Qn
II	L	Lh	Lo	Lj	Ld	Lv	Lr	Lg	Ls	Le	Lm	Ly				Li	Lq	La	Lb	Lc	Lf	Lp	Ln
III	M	Mh	Mo	Mj	Md	Mv	Mr	Mg	Ms	Me	Mm	My				Mi	Mq	Ma	Mb	Mc	Mf	Mp	Mn
IV	C	Ch	Co	Cj	Cd	Cv	Cr	Cg	Cs	Ce	Cm	Cy				Ci	Cq	Ca	Cb	Cc	Cf	Cp	Cn
V	T	Th	To	Tj	Td	Tv	Tr	Tg	Ts	Te	Tm	Ty				Ti	Tq	Ta	Tb	Tc	Tf	Tp	Tn
VI	K	Kh	Ko	Kj	Kd	Kv	Kr	Kg	Ks	Ke	Km	Ky				Ki	Kq	Ka	Kb	Kc	Kf	Kp	Kn
VII	A	Ah	Ao	Aj	Ad	Av	Ar	Ag	As	Ae	Am	Ay				Ai	Aq	Aa	Ab	Ac	Af	Ap	An
VIII	W	Wh	Wo	Wj	Wd	Wv	Wr	Wg	Ws	We	Wm	Wy				W	Wq	Wa	Wb	Wc	Wf	Wp	Wn
IX	B	Bh	Bo	Bj	Bd	Bv	Br	Bg	Bs	Be	Bm	By				Bi	Bq	Ba	Bb	Bc	Bf	Bp	Bn
X	F	Fh	Fo	Fj	Fd	Fv	Fr	Fg	Fs	Fe	Fm	Fy	Fw	Fl		Fi	Fq	Fa	Fb	Fc	Ff	Fp	Fn
XI	Z	Zh	Zo	Zj	Zd	Zv	Zr	Zg	Zs	Ze	Zm	Zy	Zw	Zl		Zi	Zq	Za	Zb	Zc	Zf	Zp	Zn
XII	H	Hh	Ho	Hj	Hd	Hv	Hr	Hg	Hs	He	Hm	Hy	Hw	Hl	Hk	Hi	Hq	Ha	Hb	Hc	Hf	Hp	Hn
XIII	R	Rh	Ro	Rj	Rd	Rv	Rr	Rg	Rs	Re	Rm	Ry				Ri	Rq	Ra	Rb	Rc	Rf	Rp	Rn
XIV	X	Xh	Xo	Xj	Xd	Xv	Xr	Xg	Xs	Xe	Xm	Xy	Xw	Xl	Xk	Xi	Xq	Xa	Xb	Xc	Xf	Xp	Xn
XV	N	Nh	No	Nj	Nd	Nv	Nr	Ng	Ns	Ne	Nm	Ny				Ni	Nq	Na	Nb	Nc	Nf	Np	Nn
XVI	P	Ph	Po	Pj	Pd	Pv	Pr	Pg	Ps	Pe	Pm	Py				Pi	Pq	Pa	Pb	Pc	Pf	Pp	Pn
XVII	S	Sh	So	Sj	Sd	Sv	S	Sg	Ss	Se	Sm	Sy	Sw	Sl	Sk	Si	Sq	Sa	Sb	S	Sf	Sp	S n

The 341 conceptual elements in the periodic system of conceptual elements are arranged according to increasing conceptual complexity or dependence. As soon as we agree to start with properties (Q), we must posit space (L). Matter occupies space. When matter undergoes change (C), the concept of time (T) becomes possible. Force (K) presupposes or depends on L, M, C and T. Electric currents are electrons (M) in motion. Electrical energy is transformable into thermal energy (W). Biotic periods F, Z and H depend on changes in the preceding periods. H is more complex than Z; and Z is more complex than F. Matter (M) manifests itself in objects R. The human mind produces non-material objects X, numbers N, propositions P. Finally, there are natural and human-made systems S.

The left-hand side of (1) can be used to formalise propositions in a calculus, which I am presenting here. Prior to examples of formalisation in (22)–(121) let me present the conceptual periods, the conceptual bonds together with their mode of reading and, to facilitate the learning of the symbols, the motivation of the choice of the letters.

Symbols	Mode of reading	Motivation	
Q	property	"quality"	
L	space	"length"	
M	matter, mass	"mass"	
C	change		"change"
T	time		"time"
K	force	Ger. *Kraft*	"force"

A	electric matter		"ampere"
W	thermal energy	Ger.*Wärme*	"heat"
B	optical energy		"brightness"
F	plant	Ger.*Pflanze*	"plant"
Z	animal	Gk *zoon*	
H	human	Lat. *humanus*	"human"
R	material object	Lat. *res*	"thing"
X	non-material object	(to be specially noted)	
N	number		"number"
P	proposition		"proposition"
S	system		"system"
h	has, is		"has"
j	and		"joins"
d	or		"disjoins"
v	becomes		"varies"
g	is greater than		"greater"
s	is similar to		"similar
e	equals		"equals"
m	is in		"medium"
y	faces.....	[according to usual practice in mathematics and physics]	
w	perceives	Ger.*wahrnehmen*	"to perceive"
l	likes (to)		"likes"
u	attempts to		"undertakes"
k	thinks that		"cogitates
i	begins to		"initiates"
q	intensifies		"quickens"
a	acts on		"affects"

c	brings about	"causes"
f	repeats	"-fold"
p	can	"possibility"
n	must	"necessity"

Groups 2, 6 and 19 are the groups of bearer, result and affected respectively; but they are not required at this stage of the exposition. To be particularly noted are the following modified and logical symbols:

(a) $\Omega^{\cdot}$ is the contradictive of Ω .

(b) $\exists$ $\forall$ are logical quantifiers.

(c) π' is a non -π ; $\pi^{\cdot}$ is the contradictive of π .

(d) Ω' is the negated Ω.

(e) $\Omega^{\breve{}}$ is a contrapositive of Ω such that if $\pi_1\ \Omega\ \pi_2$ is a union, then $\pi_2\ \Omega^{\breve{}}\ \pi_1$ is the same union; i.e. $[\pi_2\ \Omega^{\breve{}}\pi_1] =$ def.$[\ \pi_1\ \Omega\ \pi_2]$

(f) $[\pi_1\ \Omega^0\ \pi_2)] =$ def.$[[\ \pi_1\ \Omega'\ \pi_2]$ j $[\pi_1\ \Omega^{\cdot\prime}\ \pi_2]$ i.e. Ω^0 is the neutral of Ω.

(g) π^0 is the neutral of π .

(22) Ali is in the house.

H m L

(23) Kaguta's car is red.

R h Q

(24) The road widens here.

$[[L_o\ h\ Q']\ v\ [L_o\ h\ Q\ ]]\ m\ L$

(25) This crucible contains molten steel.

R_1 m R_o

(26) Ice is frozen water.

R_1 h R_2

(27) The workmen spoiled the carpet with their boots.

$[R_1$ h $Q']$ v $[R_1$ h $Q]$

R_2 c $[[R_1$ h $Q']$ v $[R_1$ h $Q\ ]]$

H c $[R_2$ c $[[R_1$ h $Q']$ v $[R_1$ h $Q]]]$

(28) The liquid boiled.

$[R$ h $Q']$ v $[R$ h $Q\ ]$

(29) John boiled the liquid.

H c $[[\ R$ h $Q']$ v $[R$ h $Q]]$

(30) John opened the door with the key.

$[R_1$ h $Q']$ v $[R_1$ h $Q]$ (The door opened.)

R_2 c $[[R_1$ h $Q']$ v $[R_1$ h $Q]]$ (The key opened the door.)

Thus, Hc $[R_2$ c $[[R_1$ h $Q']$ v $[R_1$ h $Q]]]$

(31) A thief broke my mother's bowl.

H c $[[R$ h $Q']$ v $[R$ h $Q]]$

(32) My mother's bowl was broken by a thief.

$[[R$ h $Q']$ v $[R$ h $Q]]$ c^{-} H

(33) The hammer smashed the glass.

R_2 c $[[R_1$ h $Q']$ v $[R_1$ h $Q]]$

(34) The hammer struck the glass.

R_2 a R_1

(35) Caesar was assassinated in Rome.

$[H_1$ h $Q']$ v $[H_1$ h $Q]$ (Caesar died.)

H_2 c $[[H_1$ h $Q']$ v $[H_1$ h $Q]]$ (H_2 assassinated Caesar.)

$[[H_1\ h\ Q'] \vee [H_1\ h\ Q]]\ c^{-}\ H_2$ (Caesar was assassinated by H_2.)

$[[[H_1\ h\ Q'] \vee [H_1\ h\ Q]]\ c^{-}\ H_2]\ m\ L$

(36) The terrorists sent the Prime Minister a letter bomb.

$H\ c\ [[\ R\ m'\ H] \vee [R\ m\ H_1]]$

(37) Ruth knitted Bryan a sweater.

$[H_1\ c[R' \vee R]]\ j\ [H_1\ c\ [[H_2\ h\ R'] \vee [H_2\ h\ R]]]$

(38) Ali bakes .

$H\ c\ C$

(39) Ali bakes in the kitchen.

$[H\ c\ C]\ m\ L$

(40) John believed that he would win .

$H\ k\ [[H\ h\ Q'] \vee [H\ h\ Q]]$

(41) He (H_1) and his wife (H_2) are coming.

$[[H_1\ j\ H_2]\ m\ L'\ ] \vee [[H_1\ j\ H_2]\ m\ L\ ]$

(42) The farmer loaded the truck (R_2) with hay (R_1).

$H\ c\ [[R_2\ j\ R'_1] \vee [R_2\ j\ R_1]]$

(43) The farmer loaded hay (R_1) onto the truck (R_2).

$H\ c\ [[R_1\ m'\ R_2] \vee [R_1\ m\ R_2\ ]]$

(44) The eclipse of the sun is tomorrow.

$C\ m\ T$

(45) $7 + 9 = 16$

$[N_1\ j\ N_2\ ]\ e\ N$

(46) $7 < 9$

$N_1\ g\ N_2$

(47) 7 is a prime number.

$N\ h\ Q$

(48) Germans are Europeans.

$\forall$ H [H h Q]

(49) Professor Walusimbi is a member of the Faculty.

H h^{-} X

(50) The helium atom has two electrons.

R h [R_1 j R_2]

(51) $9 > 7$

N_2 g N_1

(52) 3.142 is approximately equal to 22/7.

N_1 s N_2

(53) $\int_0^2 2x\,dx = 4$

N_1 e N_2

(54) The solution turns red.

[R h Q′] v [R h Q]

(55) The earth R rotates about its axis L.

[[R_1 m L_1] v [R_1 m L_2]] m L

(56) A stream of electrons strikes a metal target.

R_1 a R_2

(57) The stream of electrons R causes the emission of x-rays.

R c [B′ v B]

(58) A chemist smells chlorine.

H w M

(59) The cat wants to jump.

Z l [[[Z m L_1] v [Z m L_2]] z L]

(60) The cat tries to jump.

Z u [[[Z m L_1] v [Z m L_2]] z L]

(61) Ali learns Chinese.

H c [H w X]

(62) The piece of litmus paper turns either blue or red.

[[R h Q'_1] j [R h Q'_2]] v [[R h Q_1] d [R h Q_2]]

(63) Frowning is a sign of disapproval.

C_1 e C_2

(64) Kenyans remember the colonial period.

H k [H m T]

(65) The girl prefers the book R_o.

∃ R [[H l R_o] g [H l R]]

(66) The lawyer believes the statement.

H k P

(67) The lawyer withholds the statement.

H k P^o

(68) The lawyer understands the statement.

H w P

(69) The lawyer contrives a statement.

H c [[P′ v P] j [H k P^o]]

(70) Light travels through a vacuum.

[[B m L_1] v [B m L_2]] m L

(71) Sound travels through a copper wire.

[[C m L_1] v [C m L_2]] m R

(72) The volume L of the gas R increases.

[R h L_1] q [R h L_2]

(73) The post office L_1 is to the right of the bank L_2.

$[L_1 \; m \; L] \; x \; L_2$

(74) John climbed up on the mountain R_o.

$H \; c \; [[[H \; m \; L_1] \; v \; [H \; m \; L_2]] \; z \; R_o]$

(75) John climbed the mountain.

$H \; a \; R$

(76) She is happy.

$H \; h \; Q$

(77) The Sahara is hot.

$L \; h \; Q$

(78) Last night was warm.

$T \; h \; Q$

(79) The show was interesting.

$C \; h \; Q$

(80) It is windy.

$[K \; m \; L_1] \; v \; [K \; m \; L_2]$

(81) He was at school.

$H \; m \; L$

(82) She got into the car.

$[H \; m \; R'] \; v \; [H \; m \; R]$

(83) The meeting is at eight.

$C \; m \; T$

(84) He was working.

$H \; c \; C$

(85) She is standing.

$H \; h \; Q$

(86) The wind is blowing.

[K m L_1] v [K m L_2]

(87) It is raining.

[M m L′] v [M m L]

(88) Lighting struck the house.

C a R

(89) He is holding a knife.

H c [H c [R m L]]

(90) She has a car.

H h R

(91) I wrote a letter.

H c [R′ v R]

(92) He has left the town.

[H m L] v [H m L′]

(93) The meeting lasted two hours.

[C m T_1] v [C m T_2]

(94) Time passes.

T_1 v T_2

(95) AB meets CD

L_1 a L_2

(96) He knows the Pythagorean Theorem.

H h P

(97) The variable approaches 0.

[X y N] v [X s N]

(98) The variable assumes the value 0.

[X e′ N] v [X e N]

(99) Ali cooked the rice in a pot.

H c [[[R h Q′] v [R h Q] m R_o]

(100) Ali cooked the rice in the kitchen.

H c [[R h Q′] v [R h Q] m R_o] m L

(101) Fatuma gave the book to Ali.

H_1 c [[H_2 a′ R] v [H_2 a R]]

(102) He turned traitor.

[H h Q′] v [H h Q]

(103) He threw the ball upwards.

H c [[R m H] v [R m L]]

(104) The curtains disappeared.

[[R m L] j [H p [H w R]]] v [[R m L′] j

[H p′ [H w R]]]

(105) The bus seats thirty.

H p [H m R]

(106) They had an argument yesterday.

[H c C] m T

(107) The revolver made her afraid.

R c [[H h Q′] v [H h Q]]

(108) I found it strange.

H k [X h Q]

(109) He resembles his father.

H_1 s H_2

(110) I am taking the bus.

H c [[[H m R] m L_1] v [[H m R] m L_2]]

(111) They treat the birds badly.

[H a Z] h Q

(112) Ten divided by five equals two.

$[N_1 \; a^{-} \; N_2]$ e N_3

(113) The storm drove the ship ashore.

K c [[R m L_1] v [R m L_2]]

(114) He placed it on the shelf.

H c [[R_1 m R'_2] v [R_1 m R_2]]

(115) The sun turned it yellow.

R_1 c [[R_2 h Q'] v [R_2 h Q]]

(116) The will benefits us all.

X I^{-} H

(117) The man fell asleep.

[H h Q'] v [H h Q]

(118) The shop opens at eight.

[[L h Q'] v [L h Q]] m T

(119) He is thinking about his wife.

H_1 k [P m H_2]

(120) He opened the door for his wife.

H_1 c [[[R_1 h Q'] v [R_1 h Q]] m H_2]

(121) My hair dried in the sun.

R c [[R_o h Q'] v [R_o h Q]]

Returning to the periodic system of conceptual elements, we note that some slots in the system remain vacant. The explanation for the empty slots is that only the biotic entities F, Z, H, X (like God) and S (e.g. human institutions) can perceive, like and try to

do something. Further, only H, X and S are mentally endowed and can, therefore, think or ratiocinate systematically.

So far I have generated the periodic system by considering the general conceptual union involving π_1, π_2 and Ω. In (122)–(126) I show how conceptual elements combine to form conceptual molecules.

(122) $\pi_1 \,.\, \Omega\, \pi_2 = \pi_1\, \breve{o}_1 + \pi_2\, \breve{o}_2 = \pi_1\, [\pi_2\, \breve{o}_1]\, \breve{o}_2$

(123) $\pi_1 \,.\, \Omega\, \pi_2 = \pi_1\, \breve{o}_1 + \pi_2\, \breve{o}_2 = \pi_2\, [\pi_1\, \breve{o}_1]\, \breve{o}_2$

(124a) The man sees the bus.

H w R

(124b) the man who sees the bus

H w R = H w + Ro

= H [Ro] w

(124c) The bus which is seen by the man.

H w R = H w + Ro

= R[H w]o

(125a) Der Mann kocht die Suppe.

The man boils the soup.

H c [[R h Q′] v [R h Q]]

(125b) Die Suppe wird (vom Mann) gekocht.

The soup is boiled (by the man).

[[R h Q′] v [R h Q]] c⁻ H

(125c) H c [[R h Q′] v [R h Q]]

= H c [R [Q′o] h v R [Qo]h]

= H c [R[Q′o] hv + R[Qo] hr]

= H c R [R [Q′o] hr Qo] hr

$= H\ c + R\ [\ R\ [Q'o]\ hv\ Qo]\ hr^2$

(125d) der die Suppe kochende Mann

the soup boiling man

the man who is boiling the soup

the soup-boiling man

$H[R[R[Q'o]hv.Qo]hr^2]\ c$

(125e) die von dem Mann gekochte Suppe

the by the man boiled soup

the soup which is boiled by the man

$R[Hc\ [Q'o]hv\ Qo]\ hr^2$

(126a) baker

$H\ c\ C$ (Some person bakes.)

$H\ c\ C = Hc + Cr$

$= H\ [Cr]c$ (baker)

(126b) bakery

$C\ m\ L$ (Baking happens in some place.)

$C\ m\ L = Cm + Lo = L\ [Cm\ ]o$ (bakery)

In (122)–(126), it can now be claimed, I show that my conceptual calculus goes further than standard predicate calculus in formalising the inner logical structure of propositions and objects. In the next Section I wish to formulate the theory of scientific terminology which I have all along been referring to. It should be particularly appreciated that my concept of theory is identical to that of logicians, mathematicians and theoretical physicists. The sketch of

Newtonian theory in Section I.3 springs to mind. The viability of the theory will rest on its power to describe, retrodict, explain, predict and classify phenomena of terminological modernisation.

II.2 A Theory of Scientific Terminlogy

The theory consists of concepts (basic and defined), postulates, formation and transformation rules, principles and a bridging rule.

(a) Basic concepts: concept, expression

(b) Postulate 1: Q, L, M, C, T, K, A, W, B, F, Z, H, R, X, N, P, S are conceptual periods.

Postulate 2: h, j, d, v, g, s, e, m, x, y, z, t, w, l, u, k, i, q, a, c, f, p, n are conceptual bonds.

Postulate 3: h, o, j, d, v, r, g, s, e, m, x, y, z, t, w, l, u, k, I, q, a, b, c, f, p, n are conceptual groups.

(c) Formation rule: If π_1 and π_2 are conceptual periods and Ω is a conceptual bond, then $\pi_1 \Omega \pi_2$ is a well-formed formula.

(d) Transformation rules (TR1–4)

TR1: $\pi_1 \Omega \pi_2 = \pi_1 \breve{o}_1 + \pi_2 \breve{o}_2$

TR2: $\pi_1 \Omega \pi_2 = \pi_1 [\pi_2 \breve{o}_2] \breve{o}_1$

$\pi_1 \Omega \pi_2 = \pi_2 (\pi_1 \breve{o}_1) \breve{o}_2$

where $\breve{o}_1$ and $\breve{o}_2$ are conceptual groups.

TR3: $\pi_1 \Omega \pi_2$ is replaceable with C, Q or π, where π is co-periodic with either π_1 or π_2. Symbolically,

$[\pi_1 \Omega \pi_2] \vdash [C\ d\ Q]\ d\ \pi$

TR4: $[\pi_1 \Omega \pi_2] \vdash \pi\ h\ Q$

(e) Defined concepts: π ϑ is a conceptual element.

$\pi_1 [\pi_2 \vartheta_2]\ \vartheta_1$

and π_2 $[\pi_1 \vartheta_1]\ \vartheta_2$ are conceptual molecules.

(f) Principle 1: A conceptual equation is set up in accordance with the conceptual order of the union.

Principle 2: In a conceptual union, all concepts are conserved.

Principle 3: All scientific concepts are formalisable

in the conceptual calculus based on (a)–(e).

(g) Bridging rule: An expression qualifies for term status if and only if it accords with the Pegitosca Criterion, i.e.

ϕ (P, E, G, I, T, O, S, C) + ψ (A) = τ

II.3 A Principle of Conceptual Marking

In this Section I subject the theory I have just submitted to a test by making and examining a prediction based on it. On what happens before the terminologist crosses the bridge to the world of expressions Picht and Draskau write:

> *the concept ... lends itself to analysis and in this way its characteristics may be discovered... these characteristics have the greatest importance for terminology. Each time a new object is discovered or created, a new concept comes into existence, whose type and configuration in respect of its characteristics require examination with the aid of predications. The sum*

> *of the predications (= characteristics) is equal to the sum of our knowledge about the concept ... In spite of considerable efforts, it has not yet proved possible to establish any uniform classification of conceptual characteristics; there are, however, classifications which are useful in certain subject fields.*
>
> Picht & Draskau (1985: 40-44)

I react to the assertion of Picht and Draskau by hypothesising that a terminological system in whatever natural language is always based on not more than the twenty-one conceptual equations involved in my periodic system of conceptual elements.

Reportedly, Wüster recognises four types of concept formation (cf. Picht and Draskau (1985: 43-44)) :

(a) determination (127) below

(b) conjunction (128)

(c) disjunction (129)

(d) integration (130)

(127) A machine tool is a tool.

$$R\ e\ [\ R_o\ h\ Q] = Re + R_o\ [Qo]\ ho$$
$$= R\ [R_o[Qo\ ]\ ho]\ e$$

(128) Smog is partly smoke and partly fog.

$$R\ e\ [R_1\ j\ R_2\ ] = R\ e + R_1\ [R_2o]\ jo$$
$$= R\ [R_1\ [R_2o]\ jo]\ e$$

(129) A child is either a boy or a girl.

$$H\ e\ [\ H_1\ d\ H_2\ ] = H\ e + H_1\ [\ H_2o]\ do$$
$$= H\ [H_1\ [\ H_2o]\ do]e$$

(130) A man and a woman can form a married couple.

$$H\ p\ [[H\ h\ Q']\ v\ [\ H\ h\ Q]]$$

$$= H\ p\ [H_1\ v\ H_2]$$

$$= H\ p + H_2\ [\ H_1\ v\ )\ r^2$$

$$= H\ [H_2\ [H_1\ v]\ r^2]\ p$$

Picht and Draskau echo a part of the usual account of sense relations:

(a) identity e.g. Ger. *Gesetz E. law*

(b) inclusion e.g. *car, motor vehicle*

(c) intersection e.g. *sword, dagger*

(d) negation e.g. *compression, decompression*

In Dagne and Gemeda (1987: 55-56), Massamba recognises putatively six types of concept formation, namely:

(a) function π c C

e.g. Ksw. *kingamaradhi* "immunity"

(b) state π h Q

e.g. *ubwete* "dormancy"

(c) resemblance π_1 s π_2

e.g. *tumbo* "stomach" *kidole* "finger"

kidoletumbo "appendix"

(d) effect C c^- π

e.g. *kiviza* "inhibitor"

The paucity of the foregoing accounts of a typology of conceptual unions is to be traced back to the general lack of a powerful tool of conceptual analysis similar to the one I am

presenting in this study. The conceptual calculus affords me a deeper insight into conceptual structure.

In (131)-(148) I conduct a conceptual analysis of most of the Greco-Latin suffixes found in biological and general terminology. First, I state the concept that is articulated by the suffix. The inflectional endings are to be omitted. Exemplification is either in neo-Latin or in the anglicised form.

(131) Property, Characteristics, Feature

π h Q = π [Qo] h

-al-	embryonal, vital
-an-	tertianus
-ari-	primary
-ax, -ac-	tenax
-er	glycerin
-il-	juvenilis
-in	adamantin
-n-	paternus, maternus
-os-	gibbosa, cavernosum
-tas, -tat-	tuberositas

(132) Composition

π_1 h π_2 = π_2 [π_1h]o

-e- stratum corneum

-in spermin, dentin, adrenalin, carotin.

-ugo, -ugin-, -igo, -igin-

(133) Femininity

H h Q = H [Qo] h

-ix necatrix, vastatrix

-is, -id

(134) Collective, Taxon

$[\ldots[[\pi_1 \text{ j } \pi_2] \text{ j } \pi_3] \text{ j} \ldots \text{j } \pi_n] \vdash \pi$

-ace-	Fagaceae, Cetacea
-ad-	gonad, tetrad
-an-	Polychrosis botrana
-ari-	Biston pomonarius
-at-	Cheimatobia brumata
-idi-	Daphnidae, Hominidae
-ic-	physics, logic
-in-	Acarina, Murinae
-ism-	organism
-om (at)-	Carcinoma
-on-	Osteon, plancton
-ori-	Locusta migratorius
-os-	biocoenosis
-ot-	Craniota

(135) Direction

$[\pi_1 \text{ y } \pi_2] \text{ v } [\pi_1 \text{ y } \pi_2] = \pi_1 [\pi_1 [\pi_2 \text{o}] \text{y v.} \pi_2 \text{o}] \text{ yr}$

-ad- caudad, dorsad

-al- centralis

(136) Plating, Coating; Possession

$[R_1 \text{ m } R'_2] \text{ v } [R_1 \text{ m } R_2]$

-al- proboscidalis

-isa galvanise

-ar-, -ari-, -at-, -i-, -in-, -it-, -os-, -ot-, -ut-

(137) Diminution

$\pi_1 \text{ g}^- \pi_2 = \pi_1 [\pi_2 \text{o}] \text{ g}^-$

-ari- Hipparion, Otaria, Peltaria

-cul- osculum, musculus

-idi- Coccidium, nephridium

-isc- meniscus

-eli-, ett-, -icul-, -ill-, -is, -id, -it, -i-, -l-, -ol-, ul-, -uncul-

(138) Augmentation

$[\pi_1 \text{ g } \pi_2] = \pi_1 [\pi_2 \text{o}] \text{ g}$

-ascens cinerascens

-escens, -escent- pubescens, senescens

-ior gracilior,longior, major

-ist- Megista, conorhinus megistus

-ita- agitare, palpitare

(139) Function, Pertinence

$\pi_1 \text{ g}^\text{o} \pi_2] = \pi_1 [\pi_2 \text{o}] \text{ g}^\text{o}$

-et- pedetes, colymbetes

-ic- acusticus, opticus

-id- lucidus, horridus

-in erepsin, steapsin

-ma, -mat- dogma, plasma, diaphragma

-ul-, -ist-, -ment-, -men, -min, -on, -ont, or, -or-, -ter

(140) Similarity, Resemblance

π_1 s π_2 = π_1 [π_2o]s

-ace-	rosaceus, violaceus, Crustacea
-ae-	Gastraea, pygmaeus
-ago, agin-, -igo, -igin-, -ugo, -ugin-	Xanthia citrago
-al-	oval, Ossa turbinalia
-ar-	capillaris
-ari-	Placenta zonaria
-at-	lunata
-e-	argenteus, lacteus
-ic-	conicus, cyclicus
-id-	Annelides, Araneida
-ide-	thyreoidea, Arachnoidea
-in-	hyalinus, tigrinus, leoninus
-it-	Ammonites, Sphaerites
-i-	trapezius
-od-	Nematodes
-os-	Os petrosum

(141) Occurrence, Habitat; Container, Place

π m L = L[π m]o

-ace-	arundinaceus
-ae-	Limnaes
-al-	Asterias glacialis, Gastrophilus intestinalis
-an-	montanus, africanus
-ar-	Bufo vulgaria

-ari-	Calandra granaria, Mus agrarius
-atic-	silvaticus, aquaticus
-atil-	aquatilis
-ens-	hortensis
-est-	Arvicola agrestis
ester, -estr-	alpestris, campestris, terretris
-et-	lphidula saliceti
-c-	Fasciola hepatica, rustica, alpinus, salinus, marinus, ovinus, bovinus
-it-	Bufo calamita
-os-	pilosus, sabulosus

(142) Relative Position

π_1 m π_2 = π_1 [π_2 o]m

-ac-	cardiacus. ilicus
-ae-	peronaeus
-an-	medianus
-ior-	anterior
-ar-	articularis, jugularis
-e-	rhomboideus
-ic-	thoracicus
-in-	pelvina. palatinum
-i-	posterius
-os-	arteriosus, venosus

(143) Becoming, Beginning

π i C = π [Cr] i

-escens, -escent-	adolescens, senescens
-sce-	labascere, valescere

(144) The Effected Change, Result

π_1 c $\pi_2 = \pi_2$ [π_1c]r

-io, -ion- localisation, evolution

-at- quadratus

-ur- temperature

-atio, -ativ-, -ator-, -atur-, -or-, -ori-

(145) Means, Tool

H c [π c C] = π [H c. Cr^2] cr

-acul- retinaculum

-an- Organum, Stephanophyes, Cavum tympani

-br cribrum

-bul- stabulum, infundibulum

-cul- tentaculum, gubernaculum

-cr- ambulacrum

-ment- alimentum, vestimentum

-men, -min foramen, nomen

(146) Enzyme

R c [[R_1 h Q'] v [R_1 h Q]] $\vdash$ R c C = R [Cr] c

-ase- maltase, sucrase, transferase, dehydrogenase, oxidase, phosphatase, catalase, urease, zymase, ribonuclease amylase, lactase, peptidase, lipase, esterase, thrombokinase.

(147) Process; State

π c C $\vdash$ Q

Q s π = Q [πo]s

-ias- amoebiasis, elephantiasis

-i, io, -ion-, -it-, -nti-, -or, -u-, -ori-, -os-, -s-, -ul-, -ur-

(148) Possibility, Disposition

π p C = π[C r] p

π p$^-$ C = π [C r] p$^-$

-bil- audibilis, flexibilis

-il- agilis, contractilis, Reptilia

-iti- pungitius, adventitius

-iv- active, generative

-ns, -nt- Rodentia, Culex pipiens

Given that the concepts examined in (131-148) constitute the bulk of concept formation elements in English (or, for that matter, European) scientific conceptology, our hypothesis in this Section cannot be refuted, for the concepts which are realised by means of suffixes are based on palpably simple conceptual unions.

III. THE MARKING OF SCIENTIFIC CONCEPTS IN LUGANDA

III.1 The Marking of Conceptual Periods

All weaknesses of a language in the realisation or representation of scientific concepts are traceable to cases where the Pegitosca Criterion is compromised.

An application of the Criterion is a process of optimising an expression for term status. For instance, indiscriminate adoption of foreign expressions compromises the subscriterion of acceptability , especially in those cases where the assisting language and the language being elaborated do not belong to the same language family. In this Chapter I take a look at the articulation of scientific concepts in Present–day Luganda.

According to TR3 of the theory

$\pi_1 \ \Omega \ \pi_2 \vdash [Q \ d \ C \ ] \ d \ \pi$

Luganda marks Q by *obu-* as in (1).

(1)

obuganzi	"favour"
obusungu	"anger"
obujulizi	"testimony"
obuzaaliranwa	"nature by birth"
obuto	"infancy"
obuntu	"human nature"

C is marked by *oku-* and *en-* as the examples in (2) show.

(2)

okukola	"working"
okugenda	"going"
okubala	"counting"

okusoma	"reading"
okuyigiriza	"teaching"
enkola	"mode of working"
eŋŋenda	"mode of going"
embala	"mode of counting"
ensoma	"mode of reading"
enjigiriza	"mode of teaching"

C (i.e. state of change) and Q (i.e. state of non-change) can also be realised by the suffixes *–a* , *-e* , *-i* , *-o* and *-u*.

If $\pi_1 \Omega \pi_2 \vdash C$, then

$\pi_1 \Omega \pi_2 = \pi_1 [\pi_2 \text{ʊ}_2] \text{ʊ}_1$ *-a*

$\pi_2 \Omega^- \pi_1 = \pi_2 [\pi_1 \text{ʊ}^-_1] \text{ʊ}^-_2$ *-a*

$\pi_1 \Omega \pi_2 = \pi_1 [\pi_2 \text{ʊ}_2] \text{ʊ}_1$ *-i*

$\pi_1 \Omega \pi_2 = \pi_2 [\pi_1 \text{ʊ}1] \text{ʊ}_2$ -o

as the examples in (3) show.

(3)

-yigiriz-	"to teach"	*-yigiriza_*	"teaching"
-yigirizw-	"to teach "	*-yigirizwa*	"being taught"
-somes-	"to make read"	*-somesa*	"making read"
-somesebw-	"to be made to read"	*–somesebwa*	'being made to read"
-(y)agal-	"to love"	*-(y)agala*	"loving"
-limb-	"to deceive"	*-limba*	"deceiving"
-fumb-	"to cook"	*-fumbi*	"cooking"
-(y)agalw-	"to be loved"	*-(y)agalwa*	"being loved"
		-(y)agazi	"loving"

		-limbi	"deceiving"
		-fumbo	"married"
		(extended from *–fumb-)*	
-lokol-	"to save"	*- lokozi*	"saving"
- fug-	"to rule"	*-fuzi*	"ruling"
-kett-	"to spy"	*-kessi*	"spying"
-lwan-	"to fight"	*-lwanyi*	"fighting"
-log-	"to bewitch"	*-logo*	"bewitching"

If, on the other hand, $\pi_1\ \Omega\ \pi_2 \vdash Q$, then

$\pi_2\ \Omega^{-}\ \ \pi_1 = \pi_2\ [\pi_1\ \text{ʊ}^{-}{}_1]\ \text{ʊ}^{-}{}_2$ *-e*

$[\pi_1\ \Omega\ \ \pi'_2\ ]\ \text{v}\ [\pi_1\ \Omega\ \ \pi_2]$

$\pi_1\ \Omega\ \ \pi_2 = \pi_1\ \ [\pi_2\ \text{ʊ}_2]\ \text{ʊ}_1$ *-u*

as in (4).

(4)

-kole	"made"		
-bale	"counted"		
-some	"read"		
-yigirize	"taught"		
-yagale	"loved"		
		-limbe	"deceived"
		-fumbe	"cooked"
		-lokole	"saved"
		-fuge	"ruled"
		-loge	"bewitched"
-swal -	"to be ashamed"	*-swavu*	"shameful"
-sanyuk-	"to be happy"	*-sanyufu*	"joyful"
-jeem-	"to rebel"	*-jeemu*	"rebellious"
-f-	"to die"	*-fu*	"dead"

-myuk-	"to redden"	*-myufu*	"red"
-yig-	"to learn"	*-yivu*	"learned"

With *eri- -lro, ek- -lro, eN- -lro, nna-, obu-, obwa-* Luganda marks L [π m]o.

Hence,

(5)	*-lwal-*	"to fall sick"	*eddwaliro*	"hospital"
	-som-	"to read"	*essomero*	"school"
	-lim-	"to cultivate"	*ennimiro*	"garden"
	-gunjul-	"to educate"	*eggunjuliro*	"educational institution"
	-naab-	"to bathe"	*ekinaabiro*	"bathroom"
	abaana	"children"	*nnabaana*	"uterus"
	omulabirizi	"bishop"	*obulabirizi*	"bishopric, "diocese"
	-wooz-	"to levy"	*eggwoolezo*	"customs house"
	kabaka	"king"	*obwakabaka*	"kingdom"
	-lwan-	"to fight"	*eddwaniro*	"battlefield"

T [π m]o is marked by *ama-, olu-* and *emi-*.

(6)	*-som-*	"to read"	*olusoma*	"school term"
	-zaal-	"to hear"	*amazaalibwa*	"birthday"

Muteesa a king's name *miteesa* 'Muteesa's reign'

F is realised by *omu- /emi-, eki-/ ebi-* as in (7)

(7)	*omuti/emiti*	"trees"
	omumwanyi/emimwanyi	"coffee trees"
	ekitooke/ebitoke	"banana trees"
	ekisubi/ebisubi	"grasses"

Z is realised by *eN-/ eN-*.

(8) *ensolo* "animal(s)"
embuzi "goat(s)"
embwa "dog(s)"
endiga "sheep"
entugga "giraffe(s)"
empanga "cock(s)"

(9) H is realized by *omu-/ aba-*
omuntu/abantu "human(s)"
omusajja/abasajja "man/men"
omuwala/abawala "girls(s)"
omulenzi/abalenzi "boy(s)
omulongo/abalongo "twin(s)"
omusawo/abasawo "doctor(s)"

The periods R, X and P are marked by *eki-* (sg.) *ebi-* (pl.).

(10) *ekintu/ebintu* "things"
ekinywa/ebinywa "bundles"
ekivvulu/ebivvulu "demonstration"
ekiwempe/ebiwempe "carpets"
ekigambo/ebigambo "word(s)"
ekirowoozo/ebirowoozo "thoughts(s)"
ekirabo/ebirabo "gift(s)"
ekivumo/ebivumo "insults"

Luganda uses part of its nominal prefix inventory to mark number N as in (11).

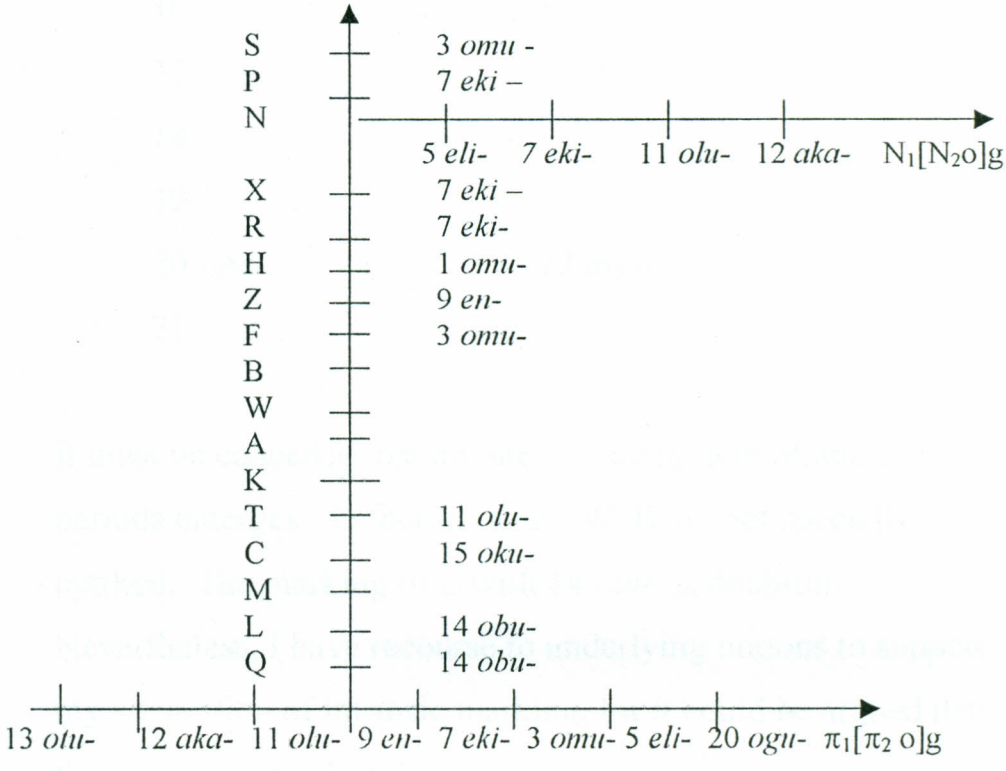
(11) *eri + kumi* *ekkumi* "ten"
ama+ kumi *amakumi* 'tens', "-ty'
eki + kumi *ekikumi* "hundred"
ebi + kumi *ebikumi* "hundred(s) (pl)

olu + kumi	*olukumi*	"thousand"
eN + kumi	*enkumi*	"thousand(s)" (pl)
aka+ kumi	*akakumi*	"ten thousand"
aka+ kadde	*akakadde*	"one million"
obu+ kadde	*obukadde*	"millions" (pl)

If the prefixes were to be deployed in a one-to-one fashion, a neat system of marking conceptual periods would emerge. Comparative evidence from Proto-Bantu [cf. Meinhof (1906) and Guthrie (1967)] would suggest that such a neat system might have existed, only to be disrupted later as a result of class movements of nouns. Let me attempt at assigning the nominal prefixes in Luganda to conceptual periods in a one-to-one fashion. In FIGURE 1, the vertical axis shows the conceptual period of the periodic system of conceptual elements.

FIGURE 1

Marking of Conceptual Periods



The two horizontal axes show the gradation of size and number. The numbering of the prefixes accords with Meinhof (1906). For plural formation, the prefixes correlate as (12) shows.

(12) 1*omu-* : 2 *aba-*

1° *wa-, nna-, sse-, ka-* : 2° *bawa-, banna-, basse-, baka-*

3 *omu-* : 4 *emi-*

5 *eli-* : 6 *ama-*

7 *eki-* : 6 *ebi-*

9 *en-* : 10 *en-~ zi-*

11 *olu-* : 10 *en-*

12 *aka-* : 14 *obu-*

13 *otu-*	:		
15 *oku-*	:	*6 ama-*	
16	:		
17	:		
18	:		
19	:		
20 *ogu-*	:	22 *aga-*	
21	:		

It must be conceded that no one–to-one system of marking periods emerges. In fact M, K, A, W, B are not specially marked. The marking of L with 14 *obu-* is doubtful. Nevertheless, I have recourse to underlying notions to support my suggestion of intrinsic marking, for it could be argued that the relations in (13) hold.

(13)			
	S 3 *omu-*	*omulengo* (Ksw. *mkusanyiko*)	"bundle"
	P, X, R 7 *eki-*	*ekintu* (Ksw. *kitu*)	"thing"
	H 1 *omu-*	*omuntu (*Ksw. *mtu)*	"human being"
	Z 9 *en-*	*ensolo*	"animal"
	F 3 *omu*	*omuti* (Ksw. *mti*)	"tree"
	T 11 *olu*	*olunaku*	"day"
	C 15 *oku -*	*okukola* (*kufanya*)	"to do"
		okubeera (*kuwa*)	"to be"
		okukyuka (kugeuka)	"to change"

L 14 *obu* *Obuganda* (Ksw. *Uganda, Ureno Urusi, Ufaransa*)

Q 14 *obu* (attested in the majority of Bantu languages)

It only remains to contemplate class movement as being determined by the overtone implicit in size gradation. This point is further developed in the next Chapter.

III.2 The Marking of Conceptual Bonds

Below I tabulate conceptual bond markers in Present–day Luganda by correlating the conceptual union in which the bond is involved with the expression formation rule in which the marker occurs.

TABLE 2

Marking of Conceptual Bonds

Conceptual Union	Bond Marker	Expression Formation Rule
π_1 h π_2 π_2 h$^-$ π_1	*nna* *-a*	(PN.(PA (*nna*). N_2)) N_2 PPrn (a) N_1
π_1 j π_2	*nna*	N_1 *na* N_2 (*nna* N)
π_1 d π_2	*oba*	N_1 *oba* N_2
(π h Q′) v (π h Q)	*wal* *w*	(SA. DV (*wal*)) (SA. DV (*w*))

(πHQ′) v (π h Q′)	*uk*	(SA. DV (*uk*))
π_1 g π_2 π_2 g $^{-}$ π_1 π_1 g^0 π_2	*vide* Fig.1 *na*	(P'N. N) (PN. (PA (*nna*).N_2)
π_1 s π_2	*ki*	(P'N. N)
π_1 e π_2	?	
π_1 m π_2 π_1 m π_2 π_1 m π_2	*mu* *Il* *ku* *e, wa*	(PN *(mu)*.N) (SV. D'V (*I l)* (PN (*ku*). N) (PN (*e,wa)* N)
	I l *wa, e*	 (SV. D'V (*I l*) (PN (*e, wa*) . N)
π_1 w π_2 π_1 l π_2 π_1 u π_2 π_1 k π_2	*I l*	(SV. D'V (*I l*)
π I C	*IIIz*	(SV. D'V (*IIIz*))
π q C	*IIII* *UlUl* *IkIk* *UkUk* *UlUkUk* *IIIz* *IkIIIIz*	 (SV. D'V (*IIIz*)

π_1 a π_2	?	
π a π (π_1 a π_2) j (π_1 a π_2)	*(AG)an*	(PV (*e*). SV) (SV. D'V *(AG)an*))
π_1 a $\pi_2 \vdash \pi_2$ a π_1)	*w* *Ibw*	(SV. D'V (*w, Ibw)*
π_1 c π_2 π c (π_1 c π_2) π_1 c ((π_2 h $_Q$) v (π_2 h Q')	*y* *z* *S* *I s* *Ul*	 SV. DV ({*y, z,* s} SV. DV(*I s)* SV. DV (*Il)*
π f C	 *ang*	SV.DA (*a)*(SV.DA(a)) SV. DV (*ang*)
π_1 p $\pi_2 \vdash \pi_2$ p π_1	*Ik*	SV. D'V (*Ik*)

Exemplification will be orientated towards the order of presentation in Table 2.

(14a) *omunnakibiina* "class member"
omunnakenya "Kenyan"
entebe y'omuti "wooden chair"
-nene "big"

(14b) *-nenewal-* "to become big"
-sajja "male"
-sajjawal- "to reach manhood"
-tono "small"
-toniw- "to become small"

-teg-	"to trap"
-teguk-	"to get out of trap"
-zib-	"to stop up"
-zibuk-	"to become unstopped"
-kolong-	"to set in line"
-kolongok-	"to be elongated"

(14c) *omuzigo* "butter" → *otuzigo, akazigo, oluzigo, ekizigo ezzigo, oguzigo.*

omusajja "man" → *akasajja, olusajja, ekisajja, essajja, ogusajja.*

enviiri "hair" → *akaviiri, oluviiri, ekiviiri, omuviiri, evviiri, oguviiri.*

olutalo	'war'	*Ssematalo*	"World War"
-tond-	"create"	*Katonda*	"Creator"
abakyala	"ladies"	*Nnaabakyala*	"Queen"
abasajja	"men"	*Ssaabasajja*	"His Majesty"
amateeka	"laws"	*omunnamateeka*	"lawyer"

(14d) *Kizungu* "in European style"

(14e) *kungulu* "on"
wansi "below"
munda "inside"
e Kampala "at Kampala"
engulu "up, above"
-kyukil- "to turn to"
-somel- "to read at"

(14f) *-kyukil-* "to turn to"

(14g) *-kolel-* "to work for (a given time)"

(14h) *-tandiikiliz-* "to begin gradually"

(14i) *-gendelel-* "to go on and on"

-kemelez- "to cross- question"

-limbiliz- "to impute falsely"

-yogelelez- "to pester with talk"

-saanyiikiliz- "to mitigate"

-bumbulul "to crumble"

-bumbulukuk- "to fall apart"

-gombolol- "to disentangle"

(14j) *-elab-* "to see oneself"

-ekub- "to beat oneself"

(14k) *-lagibw-* "to be shown"

-labagan- "to see one another"

-kubagan- "to beat one another"

-labw - "to be seen"

(14l) *-nenewaz-* "to enlarge"

-sajjawaz- "cause reach manhood"

-tondowaz- "to make sensitive"

-limy- "to make cultivate"

-limis- "to use for cultivating"

-tegul- "to take out of trap"

-zibul- "to unstop"

-kolongol- "to lay at full length"

(14m) *-somasoma* "to read repeatedly"

-somang- "to read habitually"

(14n) *-somek-* "to be readable"

-labik - "to be visible"

-fugik - "can be ruled"

To conclude this Section, I now precise the morphological and conceptual structure of a deverbal noun in Luganda.

Morphologically, a deverbal noun is

N (P'N. SA (SV. D'A)

Conceptually, a deverbal noun is

$\pi_1 [\pi_1 \delta_2] \delta_1$.

Generally speaking, for Luganda, there is coincidental isomorphism as (15) shows

(15) *omu* *-bumb* *-i* "potter" *-bumb-* "to mould"

PN (SV. DA)

H [Cr] c

Further examples of $\pi_1 [\pi_1 \delta_2] \delta_1$ are in (16)-(17)

(16) cf. (3)

omuuyigiriza	"teacher" "instructor"
omuyigirizwa	"disciple"
omusomesa	"teacher"
omwagalwa	"the beloved"
omulimba	"liar"
omwagazi	"lover"
omulimbi	"liar"
omulokozi	"saviour"

omufuzi	"ruler"
omukessi	"spy"
omulwanyi	"fighter"
omufumbo	"married person"
omulogo	"witch"

(17) cf. (4)

omuyigirize	"the learned"
omufuge	"the ruled"
enfumbe	"cooked (food)"
omuloge	"the bewitched"
omujeemu	"rebel"
omufu	"the dead"

In this Chapter I have conducted a diagnosis of concept marking in Luganda with a view of gaining access to the potentialities of the language in terms of expression formation. The stage for the transformation of Luganda into a medium of specialised discourse has been set.

IV SYSTEMS OF TERMINOLOGICAL MODERNIZATION OF LUGANDA

IV.1 Extrapolation of Luganda Expression Formation Rules

Present-day Luganda does not seem to have an economical mechanism, which would enable a physicist to render prefixes which connote size or quantity such as:

(1) *macromacro-, ultramacro-, mega- ~ macro-, maxi-, hyper-~ super-, sub-~ hypo-, infra-, mini-, micro-, ultramicro-, micromicro-*

What would be the most economical, productive, transparent and yet linguistically acceptable set of expressions to render the above prefixes into scientific Luganda?

One could set up the following correspondences:

(2)	*-nene nnyo nnyo ddala*	'very very big indeed'
	-nene nnyo nnyo	'very very big'
	-nene nnyo ddala	'very big indeed'
	-nene nnyo	'very big'
	-neneko	'a bit bigger'
	-nene	'big
	-tono	'small'
	-tonoko	'a bit smaller'
	-tono nnyo	'very small'
	-tono nnyo ddala	'very small indeed'
	-tono nnyo nnyo	'very very small'
	-tono nnyo nnyo ddala	'very very small indeed'

Bearing in mind that scientific expressions tend to deviate from ordinary expressions in that they are often artificial, as the

above English examples indeed evidence (*ultamicro-* is an artificial Greco-Latin hybrid), one would be tempted to fossilise the Luganda expressions indicating the gradation of quantity or size in order to obtain:

(3) *-nnyonnyoddala*
-nnyonnyo
-nnyoddala
-nnyo
-ko

How would one render 'macromolecule' and 'micromolecule' using the above proposal? If *molecule* → *molekyu*, then

(4) *macromolecule* ⇌ *molekyunnenennyoddala*
micromolecule ⇌ *molekyuntononnyoddala*

While *molekyunnenennyoddala* and *molekyuntononnyoddala* would be probably unnecessarily long (i.e. uneconomical), *makromolekyu* and *mikromolekyu* would entail complete opacity to most Luganda-speakers.

In what follows I propose a radical but systematic solution to the problem. The argument which is to lead to the required solution revolves around the simple observation that for almost every semantic feature Luganda nominal prefixes can be arranged on a line such that they form a semantic continuum. For example,
let us consider the semantic feature size (three-dimensional space). If we take the nominal stems *-solo* 'animal', *-zigo*

'butter', *-somero* 'school', *-ti* 'tree', and *–ambe*, 'knife', we obtain:

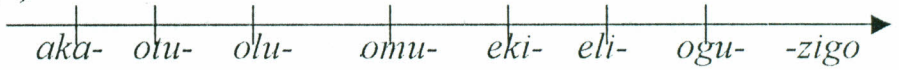
(5) 

aka- otu- olu- eN- eki- omu- eli- ogu- -solo

Thus,

(6) *akasolo, 12/14* 'animal: diminutive'
**otusolo, 13/ϕ*
olusolo, 11/10 'animal: attenuated'
ensolo, 9/10 'animal'
ekisolo, 7/9 'animal: fairly big'
omusolo, 3/4 'animal: big'
essolo, 5/6 'animal: very big'
ogusolo, 20/22 'animal: extremely big'

In respect of *omusolo* some native speakers' intuition could be at variance with mine: that is, whether *omu-*, 3/4 is augmentative when extrinsic. But from *ensimbi, 9/10* 'money' we can obtain *omusimbi, 3/4,* 'huge amount of or far too much money'. Consequently, *omu-, 3/4* is augmentative at least in some extrinsic positions.

(7) 

aka- otu- olu- omu- eki- eli- ogu- -zigo

Thus,

akazigo, 12/14 'butter: little'
otuzigo, 13 'butter: insufficiently little'
oluzigo, 11/10 'butter: spread out'

omuzigo, 3/4	'butter'
ekizigo, 7/8	'butter; massive: fairly big'
ezzigo, 5/6	'massive: big'
oguzigo, 20/22	'butter; massive: very big'

(8)

Thus,

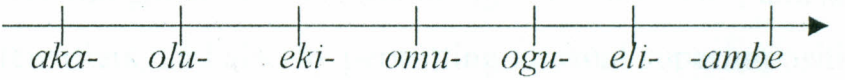
(9)	*akasomero, 12/14*	'school: diminutive'
	olusomero, 11/10	'school: attenuated'
	essomero, 5/6	'school'
	ogusomero, 20/22	'school: augmentative"

(10)

Thus,

(11)	*akati, 12/14*	'tree: diminutive'
	oluti, 11/10	'tree: attenuated'
	omuti, 3/4	'tree'
	ekiti, 7/8	'tree: fairly big'
	etti, 5/6	'tree: big'
	oguti, 20/22	'tree: very big'

(12)



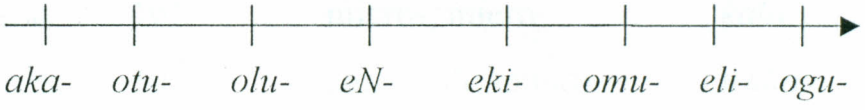
Thus,

(13)	*akambe, 12/14*	'knife: diminutive'
	olwambe, 11/10	'knife: attenuated'
	ekyambe, 7/8	'knife: fairly large'
	omwambe, 3/4	'knife: large'
	elyambe, 5/6	'knife: very large'
	ogwambe, 20/22	'knife: extremely large'

The intrinsic noun is *omwambe, 3/4*

It is observable that whenever the intrinsic prefix of the noun changes, the prefixes have to be rearranged relatively. The gradation, however, remains intact:

(14)



The slot for intrinsic *eN-, 9/10* and *omu, 1/2* is also the slot for any other intrinsic nominal prefix. If it is assumed that quantity varies directly as volume, then the semantic gradation for volume is the same as that for quantity. The scientific English prefixes above are now to be rendered into scientific Luganda by means of Luganda nominal prefixes. I take the following preliminary steps. Firstly, I disregard *otu-, 13/ϕ* for it is not very productive when extrinsic. Secondly, I discard *eN-, 9/10* and *omu-, 1/2* for they are hardly ever extrinsic. Thirdly, I refine the gradation by introducing *wa-*, *nna-*, *sse-*, and *ka-* as intensifiers, and also by permitting unusual superimposition of nominal prefixes on others.

As a consequence, I venture to posit

(15)	E	10^{18}	exa-	*kagu-*
	P	10^{15}	peta-	*ssegu-*
	T	10^{12}	tera-, macromacro-	*nnagu-*
	G	10^{9}	giga-, ultramacro-	*wagu-*
	M	10^{6}	mega-, macro-	*kali-*
	k	10^{3}	kilo-, maxi-	*sseri-*
	h	10^{2}	hecto-, hyper-	*nnali-*
	da	10^{1}	deca-, super-	*wali-*
		10^{0}		
	d	10^{-1}	deci-, sub-	*walu-*
	c	10^{-2}	centi-, hypo-, infra -	*nnalu-*
	m	10^{-3}	milli-, mini-	*sseru-*
	u	10^{-6}	micro-, micro-	*kalu-*
	n	10^{-9}	nano-, ultramicro-	*waka-*
	p	10^{-12}	pico-, micromicro -	*nnaka-*
	f	10^{-15}	femto-	*sseka-*
	a	10^{-18}	atto-	*kaka-*

as the comprehensive rendering to Luganda numerical gradational prefixes used with the International System of Units.

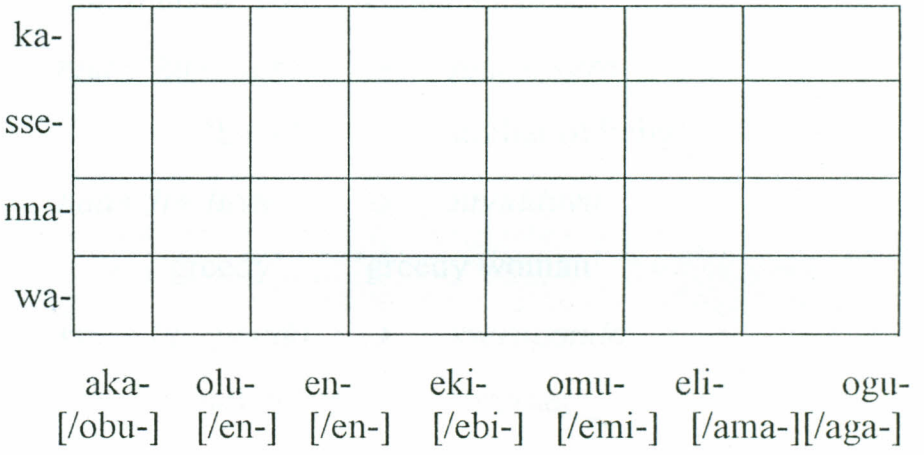
The prefixes immediately next to the decimal factors are the SI numerical prefixes as adopted by the International Union for Pure and Applied Physics (IUPAP). Otherwise, if the physicist is merely interested in the general concept of gradation the juxtaposed prefixes are in currency, for example, an ultramicrobalance is an extremely sensitive balance for

metrological accuracy of the order 10^{-11}kg. For both general and numerical gradation I propose two sets of prefixes in Luganda (cf. Table 3).

In my proposal I have refined the basic gradation in Fig.2.

FIGURE 2

Gradative Nominal Prefixes in Scientific English



Some of the compound prefixes in (15) are attested in Present-day Luganda. Let me consider their attestation beginning with *sseri-*.

(16) *sse+ li+ kadde* → *ssekkadde*
'old' 'venerable old man'
sse+li+ wanga → *sseggwanga*
'cock' 'big cock'
sse + l i+ anyi → *sseryanyi*

'strength' 'strong person'

sse+ li+ lume → *sseddume*

'male' 'male animal'

nna + lu+ lungi → *nnalulungi*

'beautiful' 'beautiful girl'

nna+ lu+ biri → *nnalubiri*

attenuated 'body' slim person'

nna+ ka+ ato → *nnakaato*

diminutive 'boat' 'canoe-shaped'

nna+ ka+ were → *nnakawere*

'baby' 'mother of baby'

nna+ li+ luvu → *nnadduvu*

'greedy' 'greedy woman'

ss e+ lu+ ganda → *sseruganda*

'relationship 'brother'

sse+ ka+ lootera → *ssekalootera*

'dream for' 'head'

ka+ tonda → *katonda*

'create' 'creator'

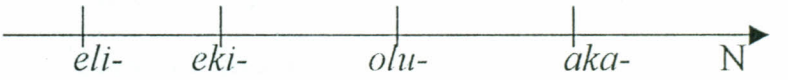
wa + ngo → *wango*

'leopard' 'Mr. Leopard'

The rest of the superimpositions are not attested; nevertheless they do not sound very counterintuitive.

In Present-day Luganda the gradation for number as such (not quantity associated with number) is the very inverse of the gradation for quantity, that is

(17)



Natural numbers are articulated as follows:

(18)

-mu	1
-biri	2
-satu	3
-na	4
-taano	5
mukaaga, 3	6
musanvu, 3	7
munaana, 3	8
mwenda, 3	9
kkumi, 5/6	10
kkumi na	(…+ SN *(mu, biri, satu, na, taano)*)
	11 12 13 14 15
kkumi na	*((mu)* + SN *(kaaga, sanvu, naana, enda))*
	16 17 18 19
amakumi abiri	20
amakumi asatu	30
amakumi ana	40
amakumi ataano	50
nkaaga, 10	60
nsanvu, 10	70
kinaana, 7	80
kyenda, 7	90
kikumi, 7/8	100
bikumi bibiri	200
bikumi bisatu	300

bikumi bina	400
bikumi bitaano	500
lukaaga, 11	600
lusanvu, 11	700
lunaana, 11	800
lwenda, 11	900
lukumi, 11/10	1000
enkumi bbiri	2000
enkumi ssatu	3000
enkumi nnya	4000
enkumi ttaano	5000
kakaaga, 12	6000
kasanvu, 12	7000
kanaana, 12	8000
kenda, 12	9000
kakumi, 12/14	10000
bukumi butaano	50000
bukumi mukaaga	60000
bukumi mwenda	90000
kasiriivu, 12/14	100000
kakadde, 12/14	1000000
kawumbi, 12/14	10000000
kase, 12/14	100000000
katabalika, 12/14	1000000000

Ignoring inconsistencies in the articulation of cardinal number the following fuller gradation for cardinal number emerges:

(19)	10^1	ten	10^1	(e)kkumi
	10^2	one hundred	10^2	(e)kikumi

10^3	one thousand
10^6	one million
10^9	one billion
10^{12}	one trillion
10^{15}	one quadrillion
10^{18}	one quintillion

10^3	(o)lukumi
10^6	(a)kakadde
10^9	wakkadde
10^{12}	wakikadde
10^{15}	walukadde
10^{18}	wakakadde
10^{21}	nnakkadde
10^{24}	nnakikadde
10^{27}	nnalukadde
10^{30}	nnakakadde
10^{33}	ssekkadde
10^{36}	ssekikadde
10^{39}	sserukadde
10^{42}	ssekakadde
10^{45}	(a)kawumbu
10^{48}	waggumbu
10^{51}	wakiwumbu
10^{54}	waluwumbu
10^{57}	wakawumbu
10^{60}	nnaggumbu
10^{63}	nnakiwumbu
10^{66}	nnakawumbu
10^{69}	sseggumbu
10^{72}	ssekiwumbu
10^{75}	sseruwumbu
10^{78}	ssekawumbu
10^{81}	(a)katiiriitu
10^{84}	wattiiriitu

10^{87}	wakitiiriitu
10^{90}	walutiiriitu
10^{93}	wakatiiriitu
10^{96}	nnattiiriitu
10^{99}	nnakitiiriitu
10^{102}	nnalutiiriitu
10^{105}	nnakatiiriitu
10^{108}	ssettiiriitu
10^{111}	ssekitiiriitu
10^{114}	sserutiiriitu
10^{117}	ssekatiiriitu

sse- intensifies more than *nna-* which, in turn, intensifies more than *wa-* (cf. Fig. 2). The nominal stems *–kadde*, *-wumbu*, *-tiiritu* belong to the nouns *akakadde*, 12 'million', *empumbu*, 9 'sawdust' and *akatiiririitu*, 12 'something very small'; *akatiiriitu* would be smaller than *akawumbu* which, in turn would be smaller than *akakadde* (a diminutive form of *omukadde* 'old person').

In scientific Luganda articulation of extremely large and infinitesimal numbers would be occasioned by statements like:

(a) The earth contains about 10^{51} atoms.

(b) The sun is composed of about 10^{57} atoms.

(c) The solar system contains about 10^{70} atoms.

(d) The universe contains about 10^{80} atoms.

(e) The age of the universe is about $4x10^{17}$ years.

Applying the daringly extrapolative move in (19), I render the numbers into Luganda as follows:

(a) atomu wakiwumbu

(b) atomu wakawumbu

(c) atomu nnakawumbu kkumi

(d) atomu sseruwumbu kikumi

(e) emyaka walukadde ebikumi bina

Even somewhat queer combinations of SI (sub) multiples with extremely large numbers are conceivable.

For example 10^{20} Tm can be read in the extrapolated Luganda as :

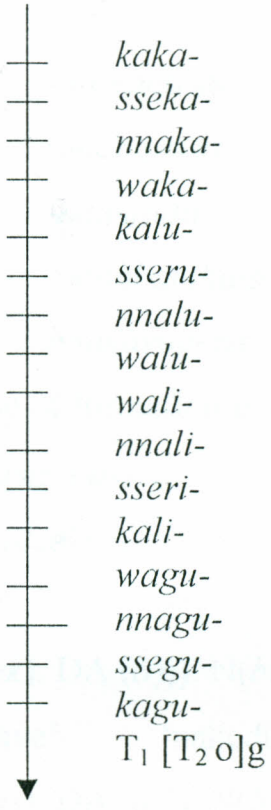
nnagumita wakakadde kikumi

For the gradation of length of time, I consider the geological hierarchy in (20).

(20)	Era of...	Obukulu	(o)bwa...
	Period of...	Omugigi	(o)gwa...
	Epoch of...	Ekiseera	(e)kya...

Then I invert the gradation in (15) to obtain (21) (i.e. going back on the time line).

(21)



The gradation in (21) will later be used to render the Geological Time Scale.

I now conclude the task of extrapolating Luganda expression formation with a substantial injection of expression formation morphemes into scientific Luganda. The main patterns of expression formation I shall use are:

(a) SA (*nna.* N)

(b) SA ((*li.* (SV. DA(*a*))). N)

(c) SA (X. (SV DA (a))), where X is *nnali,*

nnamu, or *nnaka*

exemplified by *-nnakampala* 'Kampalan'

-nnamateeka	'legal'
-ddekabusa	'devastating'
-zzisabyalo	'devastating'
-ttabamiruka	'ecumenical, general'
-nnamuzisa	'destructive'
-nnamutta	'deadly'
-nnabbambula	'scorching'
-nnakayogeza	'verbal'

Their explicit mode of formation is as follows:

(a) 'SA (*nna*. N(*kampala*))

SA (*nna*. N(*mateeka*))

'laws'

(b) `SA ((*li*. (SV*(lek*). DA (*a*))). N(*busa*))

'to leave' 'nakedness'

SA ((*li*. (SV (*zis*). DA (*a*))). N(*byalo*))

'to destroy' 'villages'

SA ((*li*. (SV (*tab*). DA (*a*))). N(*miruka*))

'to join' 'parishes'

(c) 'SA ((n*namu*. (SV (*zis*). DA (*a*)))

'to destroy'

SA ((*nnamu*. (SV (*tt*). DA (*a*)))

'to kill'

SA ((*nnali*. (SV (*bambul*). DA (*a*)))

'to scorch'

SA ((*nnaka*. (SV *yogez*). DA (*a*)))

'to cause to speak'

Phrases like *omunnamateeka* 'lawyer'
musisi ddekabusa 'devastating earthquake'
entalo zizzisabyalo 'devastating wars'
olukiiko luttabamiruka 'ecumenical council'
ebyokulwanyisa binnamuzisa 'weapons of mass destruction'
obulwadde bunnamutta 'deadly disease'
omusana gunnabbambula 'burning sunlight'
ekigambo kinnakayogeza 'verbal word'
are acceptable in Present-day Luganda.

SA (*nna.* N) is a denominal adjective, while SA(X. (SV. DA (*a*))) is deverbal. I wish to stipulate that if SA (X. (SV. DA (*a*))) is also possible and acceptable, then SA ((*li.* (SV. DA *(a)*)).N) is also possible and acceptable provided that the choice of N is conceptually feasible. In SA (X. (SV. DA (*a*))), the order of preference is to be : *nnali, nnamu,* and *nnaka* for X; that is, *nnamu* is taken if *nnali* would be counterintuitive, and *nnaka* is adopted if *nnamu* would also be counterintuitive. Essentially, with the Table 3 below, I endeavour to generate a myriad of denominal adjectives which are economical systemic and consistent.

TABLE 3

Rendition of Scientific English Morphemes into Luganda

English morpheme	Luganda correspondence	Expression Formation base	Gloss
a-, an-	-nnattaliza -nnattalina -nnabbulwa	-taliz- -talina -bulw-	to spare to be without to lack
a-, ab-, abs-	-nnamwesuula	-esuul-	to be at a distance from
ad-, ac-, af-, ag-, al-, an-, ap-, ar-	-nnassemberera	-semberer-	to approach
all-	-nnazzinga, -nnabbuna	-zing- -bun-	to encircle, fold up to spread over
ambi-, amphi (s)-	-nnanjuyi- -nnankulu-	enjuyi amakulu	sides meanings
an(a)-	-nnabuggya	obuggya	again
anchi-	-nnakumpi -nnassegera	okumpi -seger-	vicinity to be near to
ant (i)-	-nnakkonta	-kont-	to counteract
ante-, antero-	-nnassaala	-saal-	to spearhead
ap (o)-	-nnamwesuula	-esuul-	to be detached
arch-	sse- -nnabyadda	ebyedda	past affairs
auto-	e- -nnamwekyusa	- -kyus-	to change itself
by (e)- = anchi-			
circum-	-nnabbugira	-bugir-	to surround

cis-	-nnamulaaliirira	-laaliirir-	to lie on this side of
contra-, counter- = anti (i)-			
cross-	-nnassomoka -nnakkiika	-somok- -kiik-	to cross over to put across
crypto-	-nnakkisa	-kis-	to hide
demi-	-nnakyakubiri	ekyokubiri	half
dextro-	-nnakuddyo	ddyo	right-hand side
dia-	-nnassala	-sal-	to cut
diplo-, dupl-	-nnazzaala	-zaal-	to produce
dis-, dif-	-nnamwawulo	-yawul-	to differentiate
dys-	-nnansobi	ensobi	defect, fault
en-, em-, endo-, ento-	-nnamunda	munda	inside
ep (i)-	-nnakungulu	kungulu	on the surface
equ-	-nnamwenkanya	-enkany-	to make equal
eu-	-nnabuwoomu	obuwoomu	pleasure
ex-,e- ec-, ef- exo-	-nnabweru	ebweru	outside
extra-	-nnassukka	-sukk-	to exceed
final	-nnakkomya	-komy-	to make final

fore-	-nnabusaale	obusaale	being first
future	-nnamaaso	amaaso	eyes
-graphy	kalojja-	-lojj-	to narrate
hemi- = demi-			
hetero-	-nnabwawufu	obwawufu	difference
holo-	-nnakiramba-	ekiramba	a whole
homo-, homeo-	-nnabumu	obumu	sameness
-ic (s)	kanna-		
-iform	-wavu	DV(wal). DA (u)	
in-$_1$, il-$_1$, im-$_1$ =a(n)-			
in-$_2$, il-$_2$, im-$_2$ = (en)-			
inter-	-nnattaba	-tab-	to join
intra- = en-			
intro-	-nnamuyingira	-yingir-	to enter
iso- = equ-			
juxta- = anchi-			
-logy	kanna-, kayiga-	-yig-	to learn

longi-	-nnakkwebera	-kweber-	to crawl through
mal-	-nnabubi	obubi	bad state
mes (o)-	-nnawakati	wakati	middle part
met (a)-	-nnamuwondera	-wonder-	to follow later
-metry -metrics	kapima-	-pim-	to measure
multi-	-(y)ingi -nnamwala	-(y)al-	to be in plenty
neo- =an(a)-	-nnamulembe	omulembe	up-to-date
-nomy =-ic(s)			
non- =a(n)			
ob-, oc-, of-, op- = ant (i)-			
-oid = iform			
omni- = all-			
ortho-	-nnattuusa	-tuus-	to do perfetly
out-	-nnassinga	-sing-	to excel
over- = extra-	sse- -nnassukka	-sukk-	exceed
pan-= all-			
par (a)- =anchi-	-nnamwereega	-ereeg-	to become taut
partial	-nnakitundu	ekitundu	a part
past	-nnakyayita	ekyayita	that which past
per-, pel-=dia-			
peri-= circum-			
poly-= multi-			
post-= met(a)-			
pre-= fore-			
primary	-nnakasooka	-sook-	to be first
pro-	-nnakasigirwa	-sigirw-	to be made deputy
Proto-	-nnakazadde	nnakazadde	mother

Pseudo-	-nnaddyeka	-dyek-	to deceive
quasi-	-nnaddinga	-linga	to seem
retro-	-nnaddadda	-ddadda	to go backwards
se- = a (n)-			
secondary	-nnakabirye	ebbiri	two
semi-= demi-			
sinistro	-nnakukkono	kukkono	left-hand side
tele-	-nnabweya	ebweya	far
tertiary	-nnakasatwe	essatu	three
trans- = cross-			
tripl-	-nnasatuwaza	-satuwaz-	to triple
ultra-	-nnassukkirira	-sukkirir-	to be beyond
vice- = pro-			
macromacro-	nnasukka(-)	-sukk-	to exceed
ultramacro-	wassukka (-)		
macro-	sukka(-)		
maxi-	musukka (-)		
hyper-	kisukka (-)		
super-	lusukka (-)		
sub-, hypo-	lukka (-)	-kk-	to go down
infra-	kikka (-)		
mini-	mukka (-)		
micro-	likka (-)		
ultramicro-	wakka (-)		
micromicro-	nnakka (-)		

IV.2 Terminological Systems in Luganda

Chemical nomenclature is regulated by the International Union of Pure and Applied Chemistry (IUPAC). Economy, generativity, internationality and systematicity are essential features of chemical nomenclature.

Compliance with internationality and systematicity has to be reconciled with language-specific acceptability. Consider, for instance, (22) which exhibits differences in graphemic, morphemic and syntactical rendition.

(22a) Ger. *Kalziumchlorid,* F. *chlorure de calcium,* E.*calcium chloride*

(22b) Ger. *Sulphat, Sulphate;* E. *sulfate, sulfates*

Chemical elements are set out in (23).

(23)

Ac	actinium	aktinio
Al	aluminium	aluminio
Am	americium	amerisio
Sb	antimony	antimonio
Ar	argon	argoni
As	arsenic	arseno
At	astatine	astato
Ba	barium	bario
Bk	berkelium	berikelio
Be	beryllium	beryulio
Bi	bismuth	bismuthi
B	boron	boroni
Br	bromine	bromu
Cd	cadmium	kadimio
Ca	calcium	kalsio
Cf	californium	kalifornio
C	carbon	karboni
Ce	cerium	serio
Cs	cesium	sezio
Cl	chlorine	klori
Cr	chromium	kromu
Co	cobalt	kobalti
Cb	columbium	kolumbio
Cu	copper	kupro

Cm	curium	kurio
Dy	dysprosium	dyusprozio
Es	einsteinium	einsteinio
Er	erbium	erbio
Eu	europium	europio
Fm	fermium	fermio
F	fluorine	fluori
Fr	francium	fransio
Gd	gadolinium	gadolinio
Ga	gallium	galio
Ge	germanium	germanio
Au	gold	zzaabu
Hf	hafnium	hafnio
He	helium	helio
Ho	holmium	holmio
H	hydrogen	hyudrogenio
In	indium	indio
I	iodine	iodi
Ir	iridium	iridio
Fe	iron	fero
Kr	krypton	kryuptoni
La	lanthanum	lanthano
Lr	lawrencium	laurensio
Pb	lead	essasi
Li	lithium	lithio
Lu	lutetium	lutetio
Mg	magnesium	magnesio
Mn	manganese	mangani

Md	mendelevium	mendelevio
Hg	mercury	zzebaki
Mo	molybdenum	molyubdeno
Nd	neodymium	neodyumio
Ne	neon	neoni
Np	neptunium	neptunio
Ni	nickel	nikelo
Nb	niobium	niobio
N	nitrogen	nitrogenio
No	nobelium	nobelio
Os	osmium	osmio
O	oxygen	oksigenio
Pd	palladium	paladio
P	phosphorus	fosfori
Pt	platinum	platino
Pu	plutonium	plutonio
Po	polonium	polonio
K	potassium	potasio
Pr	praseodymium	praseodyumio
Pm	promethium	promethio
Pa	protactinium	protaktinio
Ra	radium	radio
Rn	radon	radoni
Re	rhenium	renio
Rh	rhodium	rodio
Rb	rubidium	rubidio
Ru	ruthenium	ruthenio
Sm	samarium	samario

Sc	scandium	skandio
Se	selenium	selenio
Si	silicon	silikoni
Ag	silver	effeeza
Na	sodium	sodio
Sr	strontium	stronsio
S	sulfur	sulfa
Ta	tantalum	tantalo
Tc	technetium	teknesio
Te	tellurium	telurio
Tb	terbium	terbio
TI	thallium	thalio
Th	thorium	thorio
Tm	thulium	thulio
Sn	tin	stano
Ti	titanium	titanio
W	tungsten,wofram	wolframu
U	uranium	uranio
V	vanadium	vanadio
Xe	xenon	ksenoni
Yb	ytterbium	uterbio
Zn	zinc	zinka
Zr	zirconium	zirkonio

I propose that IUPAC chemical suffixes be shared in lugandised form as shown in (24)

(24a)	*-ane*		*-aano*
	methane	CH_4	methaano

	ethane	C_2H_6	ethaano
	propane	C_3H_8	propaano
	butane	C_4H_{10}	butaano
	pentane	C_5H_{12}	pentaano
	hexane	C_6H_{14}	heksaano
	heptane	C_7H_{16}	heptaano
	octane	C_8H_{18}	oktaano
	nonane	C_9H_{20}	nonaano
	decane	$C_{10}H_{22}$	dekaano

(24b)	*-ene*	*-eeno*
	methene	metheeno
	nonene	noneeno
(24c)	*-yne*	*-yuuno*
	ethyne	ethyuuno
	propyne	propyuuno
(24d)	*-ate*	*-(w)aato*
	chlorate	kloraato
	carbonate	karbonaato
	nitrate	nitraato
	bromate	bromaato
	sulphate	sulfaato
	chromate	kromaato
	zincate	zinkaato
	aluminate	aluminaato
(24e)	*-ase*	*-aaso*
	sucrase	sukraaso
	lactase	laktaaso
(24f)	*-ose*	*-ooso*

	sucrose	sukrooso
	lactose	laktooso
	glucose	glukooso
	hexose	heksooso
	pentose	pentooso
	frustose	fruktooso
	aldose	aldooso
(24g)	*-al*	*-alo*
	methanal	methanalo
	ethanal	ethanalo
	propanal	propanalo
(24h)	*-ol*	*-olo*
	methanol	methanolo
	ethanol	ethanolo
	propanol	propanolo
(24i)	*-yl*	*-yulo*
	methyl	methyulo
	ethyl	ethyulo
	propyl	propyulo
(24j)	*-ile*	*-iilo*
	nitrile	nitriilo
(24k)	*-ide*	*-iido*
	bromide	bromiido
	iodine	iodiido
	oxide	oksiido
	dioxide	dioksiido
	monoxide	monoksiido
	tetroxide	tetroksiido

	chloride		kloriido
	pentachloride		pentakloriido
	peroxide		peroksiido
	sulphide		sulfiido
(24l)	*-ic*		*-nna-*
	nitric		-nnanitro
	chloric		-nnakloro
	ethanoic		-nnethaano
	butanoic		-nnabutaano
(24m)	*ammine*		*yamiino*
	hydrocarbon		hyudrokarboni
	alkane	$C_n H_{2n+2}$	alkaano
	alkene	$C_n H_{2n}$	alkeeno
	alkyne	$C_n H_{2n-2}$	alkyuuno
	alcohol	$C_n H_{2n+1}OH$	alkoholo
	aldehyde	$C_n H_{2n+1} CHO$	aldehyuudo
	ketone	$ROOR_1$	ketoono
	carboxylic acid	COOH	asidi omunnakarboksyulo
	ether	ROR_1	ethero
	alkyl halide	$C_n H_{n+1}H$	haliido alkyulo
	haloform	CHX_3	ekihalo
	nitrile		nitriilo
	amine		amiino
	amide		amiido
	amino acid		asidi omwamiino
	ester		estero
	fat		amasavu
	oil		amafuta

alkyl	alkyulo
carbohydrate	karbohyudraato
sugar	ssukaali
polysaccharide	polyusakariido

It will be recalled that the conceptual calculus is meant to promote conceptual focussing prior to expression formation. Let me take the formalisation of chemical reaction types as an example of conceptual clarification. Consider the conceptual unions in (25).

(25a) $[M_1 \text{ j } M_2] \text{ v } [M_3 \text{ j } M_4]$

(25b) π c [M v [M_1 j M_2]], where $\pi \vdash$A, W, B

(25c) $[M_1 \text{ j } M_2] \text{ v } M$

(25d) $[M_1 \text{ j } M_2] \text{ v } [[M \text{ j } W] \text{ d}[M \text{ j}^{-}W]]$

With (25) we capture virtually all chemical reaction types. Chemical reactions are categorisable according to the active chemical agent (25a), the physical agent (25b), the product (25c) or thermodynamic considerations (25d). We note in the margin that materialisation according to Einstein's law relating energy to mass

(26) B v M

is a case of (25c). Concepts such as halogenation, hydrolysis, hydrogenation and ozonolysis (25a), pyrolysis, electrolysis, photolysis, fumigation (25b), polymerisation, alkylation (25c) become readily amenable to expressional articulation in Luganda. For instance, if the chemical reaction in (27).

(27) $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$

is identified as a case of (25a), then by interpreting M_2 as chlorine, we could easily arrive at an appropriate Luganda expression in (28).

(28) *obu + klori +wal + I* → *obukloriwazi*
"chlorination"

Turning to biological nomenclature, we observe that it is systematic and, according to international convention, in neo-Latin. Thus, a Luganda-speaking biologist would have to use *Canis familiaris* instead of *embwa* 'dog', *Musca domestica* instead of *ensowera* 'housefly', *Homo sapiens* instead of *omuntu* 'human' and so on whenever systematic names are compelling. Similarly, he would use such taxonomic expressions like *Canidae*, *Annelida, Cephalopoda, Rhodophyseae*, *Eugelenophyta, Psilophtales* and *Mammalia* whenever he refers to systematic groups (taxa).

Biological nomenclature is regulated by two codes:

> The International Code of Zoological Nomenclature (ICZN) developed by International Zoological Congresses;

and

> The International Code of Botanical Nomenclature (ICBN) developed and adopted by International Botanical Congresses.

For teaching purposes, especially at pre-university levels of education, the nomenclature can be articulated in Luganda in order to attain transparency. This is the task I accomplish

below. The Kiganda clan system exhibits the following hierarchy:

Ssaabataka	"head of clan heads"
Akasolya	"clan head"
Ekika	"clan"
Essiga	"clan division"
Omutuba	"clan sub-division"
Olunyiriri	"lineage"
Enda	"womb, family"

Let the Kiganda clan system correspond to the nomenclatural systems so that

Kingdom	*Obwassaabataka*, $1^0/2^0$
Phylum	*Akasolya*, 12/14
Class	*Ekika*, 7/8
Order	*Essiga*, 5/6
Family	*Omutuba*, 3/4
Genus	*Olunyiriri*, 11/10
Species	*Enda*, 9/10

Synthesising the Kiganda clan nomenclature and the gradation for size (quantity), all the biological nomenclature can be rendered into Luganda. *Without* loss of conceptual precision, I am replacing *Obwassaabataka* with *Obwakabaka* 'Kingdom' because the King (Kabaka) is the *Ssaabataka.*

<u>The Categories of Taxonomic Hierarchy (Zoological Code).</u>

neo-Latin	Luganda	
REGNUM	OBWAKABAKA	OBWA-
Subregnum	Walubwakabaka	Walubwa-
Infraregnum	Nnalubwakabaka	Nnalubwa-
Superphylum	Wassolya	Wakka-
PHYLUM	AKASOLYA	AKA-
Subphylum	Walusolya	Waluka-
Superclassis	Wakka	Wakkya-
CLASSIS	EKIKA	EKYA-
Subclassis	Waluka	Walukya-
Infraclassis	Nnaluka	Nnalukya-
Supercohortus	Sseruka	Sserukya-
Cohortus	Kaluka	Kalukya-
Subcohortus	Wakaka	Wakakya-
Infracohortus	Nnakaka	Nnakakya-
Superordo	Wassiga	Waddya-
ORDO	ESSIGA	ERYA-
Subordo	Walusiga	Walulya-
Infraordo	Nnalusiga	Nnalulya-
Superfamilia (-oidea)	Wattuba	Waggwa-
FAMILIA (-idea)	OMUTUBA	OGWA-
Subfamilia (-inae)	Walutuba	Walugwa-
Infrafamilia	Nnalutuba	Nnalugwa-
Supertribus	Sserutuba	Sserugwa-
Tribus(-ini)	Kalutuba	Kalugwa-
Subtribus(-ae, -i)	Wakatuba	Wakagwa-

Infratribus	Nnakatuba	Nnakagwa-
Supergenus	Walinyiriri	
GENUS	OLUNYIRIRI	
Subgenus	Walunyiriri	
Infragenus	Nnalunyiriri	
Superspecies	Walinda	
SPECIES	ENDA	
Subspecies	Walunda	

The Categories of Taxonomic Hierarchy (Botanical Code)

neo-Latin	Luganda	
REGNUM	OBWAKABAKA	OBWA-
Subregnum (-bionta)	Walubwakabaka	Walubwa-
DIVISIO (-phyta/-mycota)	KASOLYA	AKA-
Subdivisio (-phytina/-mycotina/-icae)	Walusolya	Waluka-
CLASSIS (-phyceae -mycetes/ opsida, -ideae)	EKIKA	EKYA-
Subclassis (-phycidae / -Mycetidae, -idae, -ideae	Waluka	Walukya
Superordo (-anae)	Wassiga	Waddya-
ORDO (-ales)	ESSIGA	ERYA-
Subordo (-ineae)	Walusiga	Walulya-
FAMILIA (-aceae)	OMUTUBA	OGWA-
Subfamilia (-oideae)	Walutuba	Walugwa-
Tribus (-eae)	Kalutuba	Kalugwa-
Subtribus (-inae)	Wakatuba	Wakagwa-
GENUS	OLUNYIRIRI	
Subgenus	Walunyiriri	

Sectio	Nnalunyiriri
Subsectio	Sserunyiriri
Series	Kalunyiriri
Subseries	Wakanyiriri
SPECIES	ENDA
Subspecies	Walunda
Varietas	Nnalunda
Subvarietas	Sserunda
Forma	Kalunda
Subforma	Wakanda

In order to formulate the rule of expression formation in biological nomenclature, consider the class of Mammals i.e. *Classis Mammalia*

(29) *Ekika ekya Eziyonka*
'class of those which suck'
Ekika Ekyeziyonka
'Classis Mammalia'

Further, consider the *Infraclassis Eutheria*

(30) Nnaluka *Nnalu + kya + ssenjizzi*
"true hunters"

Nnalu- is the gradational prefix. The principal taxonomic category is marked by *ki* so that *ki + a→kya*

The rule therefore, is:

(31) PN + PPrn + *a* + N

In this case, we have

(32) PN (*nnalu*) + PPrn *(ki)* + *a* + N (*ssenjizzi)*

I now dispose of the point mooted earlier namely, the rendition of the Geological Time Scale into Luganda. Geologically speaking, time is graded according to Table 4

TABLE 4

Geological Time Scale

Eras and Years of Duration	**Major Divisions**	**Periods and number of years from the present**	**Epochs**
Cenozoic (60,000,000)	Quaternary	2,000,000)	Holocene
			Pleistocene
	Tertiary	Late Tertiary	Pliocene
			Miocene
		Early Tertiary (60,000,000)	Oligocene
			Eocene
			Palaeocene
Mesozoic (125,000,000)	Late Mesozoic	Upper Cretaceous	
		Middle Cretaceous	
		Lower Cretaceous (125,000,000)	
	Early Mesozoic	Jurassic (157,000,000) Triassic (185,000,000)	
Paleozoic (368,000,000)	Late Paleozoic	Permian (223,000,000)	
		Pennsylvanian (Upper Carbon-iferous) (271,000,000)	

	Middle Paleozoic	Mississipian (Lower Carboniferous) (309,000,000) Devonian (354,000,000) Silurian (381,000,000)	
	Early Paleozoic	Ordovician (448,000,000)	
		Cambrian) (553,000,000)	
Proterozoic (900,000,000)		(1,500,000,000)	
Archeozoic (550,000,000+)		(2,000,000,000)	

(adapted from Fuller and Tippo (1961: 852))

Although the prefixes *holo-*, *pleisto-*, *plio-*, *mio-*, *oligo-*, *eo-*, and *paleo-* are not systematic , the geological epochs could be named systematically in Luganda . With *-cene* as *jjuuzi* "recent time" and applying the prefixes for the gradation of length of time , I arrive at (33).

(33)

Kakajjuuzi	"Holocene"
Ssekajjuuzi	"Pleistocene"
Nnakajjuuzi	"Pliocene"
Wakajjuuzi	"Miocene"
Kalujjuuzi	"Oligocene"
Sserujjuzi	"Ecocene"
Nnalujjuuzi	"Paleocene"

Even eras lend themselves to systematic rendition into Luganda as (34) indicates.

(34a)	*Obukulu*	"Era"
(34b)	*Obwensolo Bunnajjuuzi*	"Cenozoic"
	Obwensolo Bunnawakati	"Mesozoic"
	Nnalubwensolo	"Paleozoic"
	Obwensolo Bunnakazadde	"Proterozoic
	Obwensolo Bunnabyadda	"Archeozoic"

It should be noted that I have resorted to Table 3 to deal with the prefixes *meso-* , *protero-* and *archeo-*.

Coining medical terminology in Luganda is not an insurmountable problem; it is a matter of systematically extending the already existing terminology of medical Luganda. A medical Luganda terminologist could easily resort to the extensive glossary of Greco-Latin combining forms in Appendix B and apply those methods of terminological elaboration of Luganda I have argued for so as to coin the myriads of requisite terms. However, in (35) I present affixes with high currency together with the basis of expression formation for their rendition into Luganda.

(35)	-aemia	omusaayi 3/4
	-aesthesia	-ewulir-
	-agogue	-viis-
	-algia	- lum-, obulumi 14
	-asthenia	-nafuw-, -nafu
	-biosis	-lamir-, obulamu 14
	-blast	-omutunsi 3/4

-cele	-zimb-, ekizimba 7/8
-cephaly	omutwe 3/4
-clasis	-zikiririr-
-clysis	-yingir-
-coccus	-sig-, ensigo 9/10
-cyst	ensunduba 9/10
-cyte	akasenge 12/14
-derm	olususu 11/10, eddiba 5/6
-desis	-nywer-
-dynia	-lum-, obulumi 14
-ectasia	-gaziw-, -gazi
-ectasis	-gaziw- -gazi
-ectomy	-sal-
-facient	-kol-
-form	-wavu
-gen, -genic, -genesis	-tond-,-kol-
-genous	-leet-
-gram	-lag-
-graph, -graphy	-lojj-
-(i) -asis	-lwal-, kalwala-
-iatrics	-jjanjab-
-icide	-tt-
-id	-wavu
-iparous	-zaal-
-ism	ka-12^{0}, bu-14
-itis	kaakiriza-
-ivorous	-ly-
-kinesis	-ejjulul-

-lysis	-megulul-, -wul
-malacia	-gond-
-mania	-laluk-
-megaly	-gaziw-, -gazi
-morphous	-wavu
-oid	-wavu
-oma	-zimb-, ekizimba 7/8
-opia, -opsy	-lab-
-osis	-lwal-, kalwala-
-ostomy	-ggul-
-otomy	-sal-
-pathy	-lwal-, -ewulir-
-penia	-bul- ebbula 5
-petal	-noony-
-pexy	-wang-
-phage, -phagia, -phagous, -phagy	-ly-
-phasia	-yoger-
-phily, -philous, -phile	-ettanir-
-phobia, -phobe	-kyaw-
-phore, -phoresis	-etikk-, -kongojj-
-phylaxis	-ziyir-
-plasia, -plasty	-tond-, -kol-
-poiesis	-kol-, tond-
-ptosis	-suul-
-rhagia	-yabik-, -kulukut-
-rhaphy	-tung-

-rhoea	-kulukut-
-rhexis	-yabik-
-schist(o)	-yatik-
-stasis, -stasy	-yimirir-, -laal-
-taxis, -taxy	-tegek-
-tom, -tome, -tomy	-sal-
-trophy	-liis-, emmere 9
-tropism, -tropic	-kyukiririr-
-ura	enkali 9

IV.3 Concluding Remarks

Werner (1972) identifies *Eindeutigkeit* (precision), *grosse Anzahl* (huge number) and *internationale Verwendbarkeit* (international usability) as the three criteria for terminologicality in the biosciences. These are the criteria of precision , systematicity and internationality. Since systematicity entails bound-morphemic generativity which, in turn, entails economy, biological nomenclature must be precise, economical, generative, international and systematic. For the sake of expressional transparency in Luganda, the Luganda expression formation processes must undergo considerable extrapolation. This extrapolation I have conducted in the Sections IV.1 and IV.2. Five issues emerge from the extrapolation.

Firstly, many Luganda speakers will certainly remonstrate against the artificiality of many of the morphemes I have proposed. I very much doubt whether a Luganda lexicon of

science with Luganda as its base will ever fail to evoke negative emotions at least at the time of its inception. Emotional hostility against the expressional artificiality is only likely to be muted if the scientific lexicon of Luganda is left to evolve. But I take heart at the fact English experienced pangs of artificiality in its development to expressional maturity, for Flood (1961 : xi-xiv) reports:

> "The largest group of scientific words are those which have been invented. The advance of science during the last few centuries has been so rapid and so extensive that no language has been capable of providing, ready-made, all the words which were required. Further, the classical languages do not contain words appropriate to modern discoveries, inventions and concepts. (There is no Latin word, for example, for photography!) Hence the scientist has had to invent new words for his own purpose.
>
> "It is very rare for a scientist to make up a word 'out of his head'; the term *ester* for a compound formed by the interaction of an alcohol and an organic acid was perhaps such an invention. A small but interesting group of terms comprises those based on proper names. In the naming of the chemical elements recourse has been made to the names of places (as in *polonium*, *ytterbium*), of gods and goddesses (as in *thorium*, vanadium), of planets and asteroids (as in *uranium, cerium*), and of scientists themselves (as in *cerium, gadolinium*). Scientists' names have also been used to provide the names of units (e.g.*watt, volt, gauss, joule*) and hence the names of measuring instruments (e.g.*voltmeter*). Among the other terms based on the names of scientists are *daltonism, nicotine, bakelite and mendelism*. A number of plants, e.g. *fuchsa* , *dahlia* are named after botanists.
>
> "In his task of inventing new terms, however, the scientist has usually turned to the classical languages for

his raw material. He has taken 'bits and pieces' -roots, prefixes, suffixes - from these languages and joined them together to form the terms he needed. Thus, when he needed a general name for animals such as snails and slugs which apparently walk on their stomachs, he took the Greek roots *gast (e)ro-* (stomach) and *pod* (foot) and formed the new word *gastropod.* When he wanted a word to describe a speed greater than that of sound he took the Latin prefix *super-* (above, beyond) and the Latin root *son-*(sound) and coined the adjectives *supersonic.* Thousands of scientific words have been built up from classical word-elements in this way.

"It may be asked why the scientist should have turned to the classical languages for the words and word-elements which he needed. By turning to a language other than his own he is certainly able to find words and elements which were distinct from those of ordinary speech but he turned to the classical languages for an important historical reason. The fifteen and sixteeth centuries witnessed that great revival of classical learning which is commonly called the Renaissance. Latin was regarded as the universal language of scholarship; it was the 'perfect' language of philosophy, theology and science. This classical tradition persisted into the seventeenth century - both Harvey and Newton wrote their great works in Latin - and it was not until towards the end of that century that English was fully accepted as an adequate and suitable language for a scholarly exposition of science.

"During this period many words were taken into the scientific vocabulary and many new words were constructed (chiefly in the form of Latin words) from classical elements. The tradition of using the classical languages as a source of scientific words remains.

Greek was not used in the same way as a medium of expression but it was held in respect as the language of the people who at one time led the world in art, science and philosophy. Morever, it provided a particularly suitable basis for scientific language. It had been

developed by a long line of philosophers as a medium for accurate expression and its elements were such that derivatives and compounds were readily formed. The scientists therefore mainly went to the Greek for the new terms which they needed (though, as has been pointed out, the terms were at one time often framed in Latin form). Greek is still the source of most of the new terms of science and more than half of the words of the great vocabulary of science are ultimately of Greek origin.

"Sometimes both Greek and Latin elements are combined in the same word. *Television* is a well known example; the prefix *tele-* (from afar) is Greek and the root *vis-* (seeing) is Latin. (The "all-Greek" word *teleorama* would have been more satisfying to the purists but it is unlikely to be adopted). The formation of "hybrid" words of this kind may be considered objectionable if "pure" alternatives are readily available and equally convenient. Thus the term *odoriphore* is a needless hybrid; the "all-Greek" term *osmophore* would serve just as well. There appears to be no justification for the invention of the hybrid word *pluviometer* (rain gauge) when two all-Greek terms, *hyetometer* and *ombrometer,* are available. And chemists still seem not to have made up their minds whether to use Latin or Greek prefixes of number before the Latin root-*valent.*

"Undoubtedly some hydrids have been formed because of thoughtlessness or ignorance, but many have been formed because certain prefixes and suffixes have become well known and have been found to be convenient. Thus the familiar Greek root-*meter* (measurer) has been added to all sorts of stems, e.g to a Latin stem in *audiometer* and to an English stem in *weatherometer.* (Note the insertion of the *o* before-*meter*; in all -Greek terms an *o* normally arises as the ending of the stem.) The Greek element-*logy* (often regarded as -*ology*) is now freely added to stems of various kinds and origins; the three common medical elements – itis (inflammation), -*oma* (growth, tumour) and -*osis* (morbid state) are not infrequently added to

> Latin stems (e.g. as in *gingivitis*, *fibroma*, and *silicosis).* Certain prefixes of classical origin, e.g.*re-*, *pre-*, *micro-*, *sub-*, *tele-*, are still 'living' and are freely used in combination with words of any origin, e.g.in *re-oxidise*, *pre-Cambrian*, *microfilm*, *substandard* and *telecommunication.*
>
> "The process of word-building has certanity resulted in some peculiar-looking words. e.g. *heterochlamydeous*, *otorhinolaryngology* and *postzygapophysis* (in which one prefix of Latin origin and two of Greek have been added to the Greek word *physis*), but many of them readily break down into their components parts and reveal their meanings. Some of the ugliest words, perhaps, are found in the field of medicine but the longest words are the names given to certain chemical compounds. *Tetrahydronaphthylamine*, with twenty-three letters, is a very humble example; some names contain over sixty letters. These long names, however, are easily understood by a chemist, for they are logically constructed and provide detailed descriptions of the compounds to which they are given."

Even to the present-day chemical morphemes being invented.

> *So many endings are already in such use that IUPAC felt it desirable to propose the noncommital but strange and unaesthetic suffixes '-un' 'une', and 'ur' (urgh!) for new trivial names. Whether these will be accepted instead of the long –used '-in' (insulin, penicillin, inulin, etc.) remains to be seen.*
>
> (Cahn and Dermer(1979: 151)

Secondly, related to artificiality is the overloading of some alredy-existing morphemes. For instance, I have proposed more load for *ka-*, *-li-* and especially *–nna-*. Not only English had its morphemes from proto-Germanic and Greco-Latin assigned

more expression formation tasks but also a non-Indoeuropean languages like Indonessian. Alisjabana (1976: 90) writes:

> "It is clear that in the social and cultural change which goes together with a change in the structure of thought, a shift occurs in the frequency of the use of the various affixes. Some affixes become less used since the thought expressed by it (sic) decreases in the context of the new culture, while other affixes are used more frequently....(The) use of the affixes *pe-an* and *ke-an* increases through the abundance of abstract concepts which poured into the Indonesian language through its modernization "
>
> Alisjabana (1976 : 90)

Thirdly, many Luganda speakers will raise their eyebrows at my adoption of unusual vowel and consonant clusters, and graphemes like *h* and *th* in chemical terminology. I have not opted for radical lugandisation for the sake of discernibility of the alien origin of the term concerned. Economy has also been an additional objective; *Kristo* is more economical than *Kulisito* "Christ" *Eriyo* for "helium"would be advocated by the Bible Society of Uganda (1979). But *helio* is more traceable to "helium". Furthermore, I have treated chemical names like proper names which are to be recast into Luganda graphic shape. Consider F. *Pierre*, Ger.*Peter*, Lgd. *Petero*, Ksw. *Petro* for E. "Peter". The case of Lgd. *Petero* deserves further comment. I am objectively aware that Luganda is in contact with English. The question, therefore, why E. "Peter" does not or did not become Lgd. *Pita.*

The answer is found in the systematic lugandisation of Biblical names. For the purpose of translating the Bible the Bible Society of Uganda defines Classical Hebrew and Classical Greek as the source languages of the Old and New Testaments respectively. The version of the New Testments, prepared jointly by Protestants and Roman Catholics, contains examples in (36).

(36)

Transliterated Greek	Luganda
Christos	Kristo
Phrygia	Furugiya
Phortunatos	Forutunaato
Titos	Tito
Tiberias	Tiberiya
Timotheos	Timoteewo
Syria	Siriya
Saulos	Sawulo
Petros	Petero
Pamphylia	Panfuliya
Lysias	Lusiya
Johannes	Yowanne
Kypros	Kipuro
Iesous	Yesu
Herod	Erode
Thessalonike	Tessalonika
Hermes	Erume
Agabos	Agabo
Alphaios	Alufaayo

Amphipolis	Anfipoli
Knidos	Kuniido
Ioel	Yoweeli
Markos	Mariko
Stephanos	Steefano
Phanuel	Fanuweli
Tychikos	Tukiiko
Tyros	Tiiro
Euboulos	Ewubulo
Dekapolis	Dekapoli
Gallion	Galiyo
Hesron	Ezirooni
Zaboulon	Zabulooni
Zeus	Zeewo

On the basis of the data in (36), let me compare the transliteration of classical Greek into Latin with the transliteration of the same Classical Greek into Luganda. I do this for two reasons. Firstly, in the biological nomenclature, Classical Greek is latinised. Secondly, English, the language which immediately influences Luganda, drew and still draws heavily on the Classical Greek and Latin.

(37)

Transliterated Greek	Latin Equivalent	Luganda Equivalent
-os	-us	-o
-e	-a	-a
-on	-um	-o, -ooni

a	-a	-a
o	o	o
i	i	i
e	e	e
ai	ae	ayi
ei	i	
oi	oe	oyi
eu	eu	ewu
au	au	awu
y	y	u, i
ou	u	u
ph	ph	f
ch	ch	k
th	th	t
ps	ps	pus
k	k, c	k
	h	Ø
x	x	kis
	j	y
oe	oe	owe

My adaption of graphemes in (38)

(38) ai, oi, au, eu, uo, oe, -o, -oni,
bs, h, th, x, ks

may well be rejected by some Luganda speakers. They may resist the adoptions in (39)

(39) *aktinio* *galio*
helio *fluori*

bromu	*oksigenio*
klori	*ksenoni*
iodi	*thorio*
ruthenio	

citing probably anglophilia or even anglophobia. I am trying to optimise traceability and economy. Pronunciation need not pose any significant problem, for the actual phonetic realisation will depend on the scientist's familiarity with English. As a matter of fact, it does not matter whether an English physicist pronounces "weber" (the unit of magnetic flux) as (40)

(40a) /veibɐ/

(40b) /webɐ/

(40c) /ve : bɐ/ (Ger. pronunciation of the German physicist's name

/ve : bɐ/ Weber honoured)

The suffix *–ine* is superfluous as (41) shows.

(41)	Ger.	*Brom*	"bromine"
		Chlor	"chlorine"
		Jod	"iodine"
		Fluor	"fluorine"

I go along with Alisjabana on the question whether English should or should not phonologically influence those languages which are spoken in its spheres of influence. He writes:

> [A] problem faced in the Malaysian language is that the English spelling deviates considerably from the spoken word. There is a tendency in the Malaysian language to prefer the spoken language above the written word, so

> that, for example, in Malaysian is written : *steshen* for station, while in Indonesian is used *stasion* or *setasion.* The English ton (1000kg) becomes in Malaysian *tan,* (in Indonesian *ton*), the English card becomes *kad* (in Indonesian *kartu*), television becomes *talivishen* (in Indonesian *televisi*), the English police becomes *polis* (in Indonesian *polisi*), the English agent is *ejen* (in Indonesian agen). I am of the opinion that it is preferable to take the written word in the European language as basis of the modern vocabulary, since there is greater similarity in the written international vocabulary than in the spoken language as is specially exemplified by the English spelling.
>
> Alisjabana (1976: 81)

Fourthly, although for the biological nomenclature neo-Latin is stipulated, English derivatives as in (42)

(42)	chordates	(from the phylum Chordata)
	hominids	(from the family Hominidae)
	felines	(from the subfamily Felinae)
	carnivores	(from the order Carnivora)
	felids	(from the family Felidae)

can easily and even more systematically be rendered into Luganda by applying the nomenclatural system I have enunciated.

Fifthly, neo-Latin is not mandatory in nosological nomenclature.

ANNOTATED TRANSLATIONS

V.I Introduction

During my quest for suitable Luganda terms for scientific concepts, it is imperative that I strive for a differentiated appreciation of the Pegitosca Criterion. By this I mean that the Pegitosca factors are given differentiated weighting depending on the subject field in question. Within the purview of this study I wish to show how the results secured in the previous Chapter can be used to translate scientific English and German materials into Luganda. The materials are to be taken from the fields of logic, mathematics, physics, chemistry and biology.

For the sake of ease of mental processing, elegance and economy, symbols are widely used in logic, mathematics, physics and chemistry. All the internationally sanctioned systems of symbolism should be adopted into and, where possible, adapted to Luganda. For instance, it would be rather irrational not to adopt 'Xe' as a symbol for xenon just because the Luganda alphabet does not include 'X'.

Expressional transparency in Luganda is impossible if the international convention of naming living organisms in neo-Latin is to be accepted. However, as I showed in the previous Chapter, a Luganda-based parallel nomenclatural system is possible and justifiable. In order to achieve generativity and transparency, new affixes and affixoids have to be invented on the basis of the already existing ones. Without such affixal

innovation biological nomenclature and medical terminology are next to impossible in Luganda.

There are cases where hitherto established conceptual classifications are at variance with those acceptable in the international scientific community. For instance, (1) shows that conceptual reclassification is warranted if German and Luganda speakers are informed that the whale is a mammal and not a fish.

(1) Lgd. *Lukwata* 'sea monster' Ger. *Walfisch, Wal* 'whale'

The principle of concept marking in Sec. II.3 harmonises extremely well with Luganda conceptual bond marking in Sec. III.2. For the purpose of annotating translations in the next Section, I now re-present thirteen concept transformation rules

(CTR 1-13) corresponding to the bonds marked in Luganda.

CTR 1.1 $\dfrac{\pi\ \Omega\ \pi_1 \vdash Q}{\pi\ h\ Q\ \vdash\ \pi\ [Qo]h}$

CTR 1.2 $\pi_1\ h\ \pi_2 \vdash \pi_2\ [\pi_1\ h]o$

CTR 1.3 $H\ h\ Q\ \vdash H\ [Qo]h$

CTR 2 $[\ldots[[\pi_1\ j\ \pi_2]\ j\ \pi_3]\ j \ldots j\pi_n] \vdash \pi$

CTR 3.1 $[\pi\ h\ Q']\ v\ [\pi\ h\ Q] \vdash \pi\ [Q'o]h$

CTR 3.2 $[\pi\ h\ Q]\ v\ [\pi\ h\ Q'] \vdash \pi\ (Q'o)h$

CTR 3.3 $\pi_1\ v\ \pi_2 \vdash \pi_1\ [\pi_2\ r]\ v$

CTR 4.1 $\pi_1\ g\ \pi_2 \vdash \pi_1\ [\pi_2\ o]g$

CTR 4.2 $\pi_1\ g'\ \pi_2 \vdash \pi_1\ [\pi_2\ o']g'$

CTR 5 π_1 s π_2 $\vdash \pi_1$ [π_2 o]s

CTR 6 π_1 m π_2 $\vdash \pi_2$ [π_1 m]o

CTR 7 π_1 y π_2 $\vdash \pi_1$ [π_2 o]y

CTR 8 π i C $\vdash \pi_1$ [Cr]i

CTR 9 π q C $\vdash \pi$ [Cr]q

CTR 10 π a π $\vdash \pi$ [π b] a

CTR 11.1 π_1 c π_2 $\vdash \pi_1$[π_2r]c

CTR 11.2 π_1 c π_2 $\vdash \pi_2$ [π_1c]r

CTR 11.3 H c [π c C] $\vdash \pi$ [H c. Cr^2]cr

CTR 11.4 $\underline{\text{R c [[} R_1 \text{ h Q'] v [} R_1 \text{ h Q]]} \vdash \text{R c C}}$

R c C $\vdash$ R [Cr]c

CTR 11.5 $\underline{\pi \text{ c C} \vdash \text{Q}}$

π h Q $\vdash \pi$ [Qo]h

CTR 12 π f C $\vdash \pi$ [Cr]f

CTR 13 π_1 p $\pi_2 \vdash \pi_1$[π_2 r]p

If Present–day Luganda attests the rule for forming verbs from adjectives, i.e.

V(A.DV*(wal)*),

then let the rule be extended to

V (A.DV(*wUk, wUl, wIl, wan*))

Translations

A complete annotation would ideally consist of

(a) an English or German term

(b) a concept transformation rule CTR

(c) an expression formation base for a Luganda term.

(d) The Luganda term,

Examples follow in (2)

(2a) "thyroid"; CTR 5; *engabo*, 9 "shield";
-nnangabowavu, -nnakigabo

(2b) "proof"; CTR 12.2; *-kakas-* "to prove"; *ekikakaso*, 7

(2c) "logic"; CTR 2; *ensonga*, 9/10 "reason(s)"
kannansonga, 1^{o}

(2d) "logician" ; CTR 4.3; *kannansonga; kannansonga*, 1^{o}

(2e) "science", "scientist"; CTR 2, CTR 4.1;
okumanya "knowledge"; *kannakumanya*, 1^{o}

(2f) "library", CTR 6; *ebitabo* "books"; *wabitabo*

(2g) "desalination plant"; CTR 12.4, CTR 6.1;
omunnyo "salt"; *ekinnamunnyowoliro*

(2h) "certainty" ; CTR1.1; *-kakat-* "to be certain" *obukakafu*

(2I) "privatise" ; CTR 12.4; *nnyini* "owner"; *-nnannyiniwaz-*

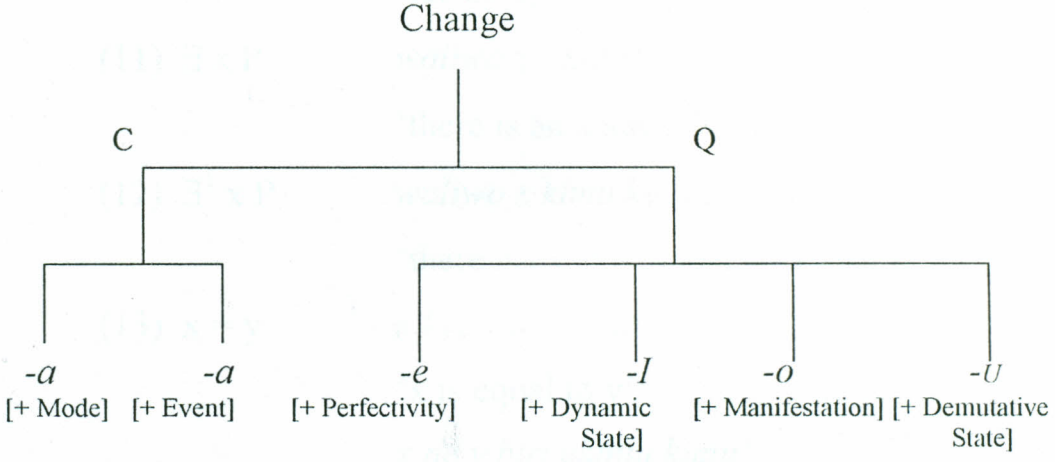
(2j) "socialise" ; CTR 12.4; *abantu* "people" *-nabantuwaz-*

(2k) "modernise" ; CTR 12.4 ; *omulembe* "era";
-nnamulembewaz-

I intend to omit the citation of the relevant concept transformation rule because this can easily be inferred from the Luganda expression formation base in conjunction with the adjectival suffix. It will be particularly important to bear in mind the suffixal marking of the conceptual periods C and Q which is shown in FIGURE 3.

FIGURE 3

Suffixal Marking of C and Q



V.2 Translated Materials

V.2.1 Logical Materials

(3) Let P, Q and R be sentences in propositional logic.

Ka P, Q, ne R zibe sentensi mu kannansonga w'ebitegeezo.

(4) ¬ P *Ssi P* or *tekiri nti P*

'not P' 'it is not the case that P'

(5) P ∧ Q *P ne Q, byombiriri*

'both P and Q'

(6) P ∨ Q *P oba Q, oba byombiriri*

'P or Q, or both'

(7) P→Q *Ssinga P, olwo Q*

'if P, then Q'

(8) P↔Q *P ssinga era kyokka ssinga Q*

'P if and only if Q'

(9) 'Let x, y and z be individual variables in the first order predicate calculus'.

Ka x, y ne z bibe ebikyukakyuka ebisonjofu mu mbala

y'ebirango ey'eddaala erisooka.

(10) $\forall$ x P *olwa (kulwa) buli x, P*

'for all x, P'

(11) $\exists$ x P *waliwo x, nga P*

'there is an x such that P'

(12) $\exists^1$ x P *waliwo x kimu kyokka, nga P*

'there is exactly one x such that P'

(13) x = y *x kyenkanankana y*

'x is equal to y'

x ne y biri ekintu kimu

'x is identical to y'

(14) $\Box$ p *kiteekwa okuba nga* P or P *kikaka*

'it is necessary that P' or 'necessarily P'

(15) $\Diamond$ P *kisoboka okuba nti* P or P *kisoboka*

'it is possible that P' or 'possibly P'

(16) $\alpha_1, \alpha_n \vdash \alpha$ *α kikakasika okuva mu) $\alpha_1, \ldots \alpha_n$*

'α is provable from $\alpha_1, \ldots \alpha_n$

(17) $\alpha_1, \ldots \alpha_n \vdash \alpha$ *α kigoberezo kituufu ekya $\alpha_1, \ldots \alpha_n$*

'α is a valid consequence of $\alpha_1, \ldots \alpha_n$'

(18) 'A tautology has the truth-value T; an antitautology has the truth-value F,'

Kimaddiŋŋano kirina omuwendo gw'amazima T; kimaddiŋŋano kinnakkonta kirina omuwendo gw'amazima F.

(19) 'The valid rule of inference called *modus ponendo ponens* can be symbolised as follows:

Ekifuzi ky'okugobereza ekituufu ekiyitibwa 'modus ponendo ponens' kisobola okunnabubonerowazibwa bwe kiti:

$\triangle \vdash \alpha$

$\underline{\Gamma \vdash \alpha \rightarrow \beta}$

$\triangle u \Gamma \vdash \alpha \rightarrow \beta$

P >——< Q

'Either P or Q (but not both)'

P oba Q (naye ssi byombi)

Or

P ne Q byefeebyagana

(21) P↓ Q *P ne Q bigaanagana*

'Neither P nor Q'

(22) ι x F(x) *x ekyo nga kirina ekyawuzi F*

'that x such that it has the property F'

(23) $\wedge$ x F (x) *x ebyo nga birina ekyawuzi F*

'those x such that they have the property F'

(Notes on V.2.1 (3)–(23))

"proposition"; *-tegeez-;* "to state"; *ekitegeezo*

"individual"; *-sonjok-;* "to individualise"; *sonjofu*

"calculus"; *-bal-;* "to count"; *embala*

"predicate"; *-lang-;* "to proclaim"; *ekirango*

"tautology"; *-ddiŋŋan-* "to repeat" ; *ekiddiŋŋano*

"antitautology"; *ekiddiŋŋano kinnakkonta*

"consequence"; *-goberer-;* "to follow"; *ekigoberero*

"mutually devalue"; *omuwendo,* "value"; *-wendowolagan-*

"property"; *-(y)awul-* "to differentiate"; *ekyawuzi*

(24a) Text 1:

SUMMARY OF RULES OF DERIVATION

1 Rule of Assumptions (A)

Any proposition may be introduced at any state of a proof. We write to the left the number of the line itself.

2 Modus Ponendo Ponens (MPP)

Given A and A →B, we may derive B as conclusion. B depends on any assumptions on which either A or A→B. depends

3 Modus Tollendo Tollens (MTT)

Given ¬ B and A→B we may derive ¬ A as conclusion. ¬ A depends on any assumptions on which either ¬ B or A→B depends.

4 Double Negation (DN)

Given A, we derive ¬ ¬ A as conclusion, and vice versa. In either case, the conclusion depends on the same assumptions as the premiss.

5 Conditional Proof (CP)

Given a proof of B from A as assumption, we may derive A→B as conclusion on the remaining assumptions (if any)

6 &-Introduction (&I)

Given A and B, we may derive A & B as conclusion. A & B depends on any assumptions on which either A or B depends.

7 &-Elimination (&E)

Given A & B, we may derive either A or B separately. In either case, the conclusion depends on the same assumptions as the premiss.

8 v-Introduction (vI)

Given either A or B separately, we may derive A v B as conclusion. In either case, the conclusion depends on the same assumptions as the premiss.

9 v-Elimination (vE)

Given A v B, together, with a proof of C from A as asssumption, we may derive C as conclusion. C depends on any assumptions on which A v B depends or on which C depends in its derivation from A (apart from A) or on which C depends in its derivation B (apart from B).

10 Reductio ad Absurdum (RAA)

Given a proof of B &¬B from A as assumption, we may derive ¬ A as conclusion on the remaining assumptions (if any).

(Notes on V.2.1 (24)]

"rule"; *omufuzi;* "ruler"; *ekifuzi*

"assumption"; *-twal-;* "to take";*ekitwale*

"proof"; *-kakas-;* "to prove"; *ekikakaso*

"conclusion"; *-fundikir-;* "to conclude"; *ekifundikiro*

"negation"; *-gaan-;* "to negate"; *ekigaano, eŋŋaana*

"premiss"; *omutume;* "messenger"; *ekitume*

(24b) Translation of Text 1

AMATEEKA G'OKUVIISAMU MU BUFUNZE

1 Ekifuzi ky 'Ebitwale (Kifu)

Ekitegeezo kyonna kisobola okuyingirizibwa wonna ekikakaso we kiba kituusibbwa. Ku kkono tuwandiika ennamba y'omusittale gwe nnyini.

2 Modus Ponendo Ponens (MPP)

Nga A ne A→B biweereddwa, tusobola okuviisamu B nga ekifundikiro. B kyesigama ku bitwale byonna A oba A→B kwe kyesigama.

3 Modus Tollendo Tollens (MTT)

Nga ¬ B ne A→B biweereddwa, tusobola okuviisamu ¬ A nga ekifundikiro. ¬ A kyesigama ku bitwale byonna ¬ B oba A →B kwe kyesigama.

4 Eppaana Mirundi-ebiri (Gaana-2)

Nga A kiweereddwa, tusobola okuviisamu ¬ ¬ A , n'akaddannyuma. Mu ngeri zombi, ekifundikiro kyesigama ku bitwale bye bimu nga ekitume.

5 Ekikakaso Kinnakakalu (Kikaka)

Nga ekikakaso kya B okuva mu A nga ekitwale kiweereddwa, tusobola okuviisamu A →B nga ekifundikiro ekyesigama ku bitwale ebisigaddewo (bwe bibaawo).

6 Okuyingizaamu (Kuyi -&)

Nga A kiweereddwa, tusobola okuviisamu A & B nga ekifundikiro. A & B kyesigama ku bitwale byonna A oba B kwe kyesigama.

7 Okuggyamu & (Kuggya-&)

Nga A kiweereddwa, tusobola okuviisamu A oba B ku bwakyo. Mu ngeri zombi, ekifundikiro kyesigama ku bitwale bye bimu nga ekitume.

8 Okuyingizaamu v (Kuyi –v)

Nga A oba B ku bwakyo kiweereddwa, tusobola okuviisamu A v B nga ekifundikiro. Mu ngeri zombi, ekifundikiro kyesigama ku bitwale bye bimu nga ekitume.

9 Okuggyamu v (Kuggya – v)

Nga A v B kiweereddwa, gattako na ekikakaso kya C okuva mu A nga ekitwale era n'ekikakaso kya C okuva mu B nga ekitwale, tusobola okuviisamu C nga ekifundikiro. C kyesigama ku bitwale byonna A v B kwe kyesigama oba C kwe kyesigama mu kuviisibwa kwakyo okuva mu B (nga B kitalizibbwa).

10 Reductio ad Absurdum (RAA)

Nga ekikakaso kya B & ¬ B okuva mu A nga ekitwale, kiweereddwa, tusobola okuviisamu ¬ A nga ekifundikiro ekyesigama ku bitwale ebisigaddewo (bwe bibaawo).

Translated from Lemmon (1965: 39-40)

(25a) Text 2:

A Counterexample

Some philosophers have suggested that the conditions which are individually necessary for knowledge as formulated in (iT), (iB), and (iJ) are jointly sufficient for knowledge as well [17]. This would amount to affirming the following equivalance as an analysis of knowledge:

S knows that p if and only if it is true that p, S believes that p, and S is completely justified in believing that p.

In short, knowledge is completely justified true belief. Nevertheless, this analysis has been disputed by Gettier and requires amendment[18].

Gettier argues that a man might be completely justified in believing that F by his evidence, where F is some false statement, and deduce T from F, where T is some true statement. Having deduced T from F, which he was completely justified in believing, the man would then be completely justified in believing that T. Assuming that he believes that T, it would follow from the analysis considered that the man knows that T. He might, however, not know this at all, especially if T is a disjunction of two statements, the statement F and a true statement Q, and the man in question has no reason whatever for thinking that Q is true. In such a case, the belief that T will be true but the only reason the man has for believing T to be true is the inference of T from F. Since F is false, it is a matter of luck that the man is correct in his belief that T [19].

17 Ayer and Chisholm defend similar analyses in works cited above.

18 Edmund Gettier, Jr, "Is Justified True Belief Knowledge?' Analysis, xxiii (1963), 121-3. Bertrand Russell made a similar observation in *The Problems of Philosophy,* 132.

19 Gettier, op. cit.

Notes on V.2.1 (25)

"philosophy, philosopher", *amagezi;* "wisdom"; *kannamagezi* "become justified for"; e*nsonga;* "reason"; *-songawalirw-* "disjunction"; *-(y)awukanir- ;* "to separate from one another" *ekyawukaniro*

"defend"; *-taas-*

(25b) Translation of Text 2

Ekyokulabirako Ekikontanyi

Bakannamagezi abamu baaleeta ekirowoozo ekigamba nti obukalu obwetaagisibwa kannakamu kulwa okumanya nga bwe bwasanguzibbwa mu (iT), (iB), ne (iJ) era bwetagisibwa awamu olwa okumanya [17]. Kino kyandikkirizisa ekyenkanonkano ekiddirira nga ekiyungululo kya okumanya:

> *S amanya p ssinga era kyokka ssinga kya mazima, S alowooza nti p, era S annansongawalirwa bukomerevu mu kulowooza nti p.*

Mu bufunze, okumanya kwe kulowoza okw'amazima okunnansonga- wazibwa obukomerevu. Naye ekiyungululo kino kyanenеŋŋanyizibwa Gettier era kyetaaga okulongoosebwamu [18]. Gettier awakana nti omuntu ayinza okunnansongawalirwa obukomerevu mu kukkiriza nti F okusinziira ku bujulizi, nga F ekitegeezo gundi ekitali kya mazima, olwo naviisa T mu F, nga T kitegeezo gundi eky'amazima. Nga amaze okuviisa T mu F, kye yali annansongawaliddwa obukomerevu okulowooza, omuntu yandinnansongawalirwa obukomerevu okulowooza nti T. Bwe kitwalibwa nti alowooza nti T, kyandigoberedde okuva ku kiyungululo ekyekkalirizibbwa nti omuntu, amanyi nti T.

Kyokka ayinza obutakimanya n'akamu naddala ssinga T kiba ekyawukaniro ky'ebitegeezo ebibiri, ekitegeezo F n'ekitegeezo Q eky'amazima, era nga omuntu ayogerwako talina nsonga n'emu emulowoozesa nti Q kya mazima. Bwe guba bwe gutyo, ekirowoozo nti T kijja kuba kya mazima, naye ensonga yokka gy'alina okumulowoozesa nti T kya mazima kye kigoberezo kya T okuva mu F. Olwa okuba nti F ssi kya mazima, kya mukisa bukisa nti omuntu mutuufu mu kulowooza nti T[19].

17 Ayer ne Chisholm bataasa ebiyungululo ebifaananako mu mirimu egijuliriddwa waggulu.

18 Edmund Gettier, Omuto, "Is Justified True Belief. Knowledge", Analysis, xxiii (1963: 121-3) Bertrand Russell yakenga kye kimu mungeri efaananako mu *The Problems of Philosophy*, 132.

19 Gettier, omulimu ogujulizibwa.

Translated from Lehrer (1974: 18)

V.2.2 Mathematical Materials

(26) $M = \{x \mid x \varepsilon \mathbf{N}\}$

M kye kibinja ky'ennamba x zonna zinnabutonde

'M is the set of all natural numbers x'

(27) $x \varepsilon \mathbf{N}$ *x nnakibinja mu* **N**

'x is a member of **N**

(28) $A \subset B$ *A kibinja kito ddala ddala mu B*

'A is a proper subset of B'

A ddala ddala kizingirwa mu B

'A is properly included in B'

(29) A ∩ B *ekisalaganiro kya A ne B*

'the intersection of A and B'

(30) A ∪ B *ekimuwazo kya A ne B*

'the union of A and B'

(31) A\B *A nga kitooleddwako* B

'A minus B'

(32) A\A = ∅ *A nga kitooleddwako A kyenkana ekibinja ekyereere*

'A minus A equals the empty set'

(33) < x, y > *omugogo gwa x ne y omutegeke*

'the ordered pair of x and y

(34) A x B *ekizaazise okuva mu A ne B*

'the set product of A and B'

(35) ℙ (A) *kinnabuyinza kya A*

'power set of A'

(36a) 'f maps out of A into B'

(36b) 'f maps from A into B'

(36c) 'f maps out of A onto B'

(36d) 'f maps from A onto B'

(36e) 'f uniquely maps out of A into B'

(36f) 'f uniquely maps from A onto B'

(36a) *f kimaapuwaza okuva mu A nga kizza mu B*

(36b) *f kimaapuwaza okuva mu A nga kizza mu B*

(36c) *f kimaapuwaza okuva mu A nga kizza ku B*

(36d) *f kimaapuwaza okuva mu A nga kizza ku B*

(36e) *f kimaapuwaza bemmummululu okuva mu A nga kizza mu B*

(36f) *f kimaapuwaza bemmummululu okuva ku A nga kizza ku B*

or f kimaapuwaza kimu-eri-kimu okuva ku A nga kizza ku B

(37) *'B is the complement of the set A'*

B kye kimalayo ky'ekibinja A

(38) 'U is the universal set'.

U kye kibinja kinnabyonnawazo

(39) f(x) 'f of x' *f gwa x*

(40) 'f (x) is the image of x under the function f'

f (x) kye kifaananyi kya x wansi w'omukolo f.

(41) 'f^1 is the inverse relation of the function f'

f^1 kye kigandawazo nnagalika eky'omukolo f

Numbers are classified in (42)

(42) $\mathbf{C} = \mathbf{R} \cup \mathbf{I}$

$\mathbf{Q} = \mathbf{Z} \cup \mathbf{F}$

$\mathbf{N} = \mathbf{P}` \cup \mathbf{P}$

$\mathbf{R} = \mathbf{Q} \cup \mathbf{Q}`$

$\mathbf{Z} = \mathbf{Z}` \cup \{o\} \cup \mathbf{N}$

(43) $\mathbf{C} = \{a + bi \mid a, b \varepsilon \mathbf{R} \wedge i^2 - 1\}$

'complex number' *ennamba zinnabuzibu*

(44) $\mathrm{II} = \{bi \mid b\varepsilon \mathbf{R} \setminus \{o\} \wedge i^2 = -1\}$

'imaginary numbers' *ennamba enfumiitirize*

(45) **R** 'real numbers' *ennamba wawu*

(46) $\mathbf{Q} = \left\{ a/b \,/\, a, \ b \varepsilon \mathbf{Z} \setminus \{o\} \right\}$ 'rational numbers'

ennamba emmenyefu kinnakkomo

(47) 'irrational numbers' *ennamba emmenyefu kinnabutakoma*

(48) $\mathbf{Z} = \{o, \pm 1, \pm 2, \ldots\}$ 'integers' *ennambirira*

(49) $\mathbf{F} = \{a/b \mid a, b \in \mathbf{Z} \setminus \{o, 1\}\}$ 'fractions' *emmenyefu*

(50) $\mathbf{Z}^{-}$ {-1, -2, -3,.....} 'negative integers' *ennambirira*
eŋŋaanyi

(51) 0 'zero' *ezzeero*

(52) $\mathbf{N} = \{1, 2, 3, \ldots\}$ 'natural numbers'
ennambirira zinnabutonde
'positive integers' *ennambirira enzikirizi*

(53) $\mathbf{P} = \{2, 3, 5, 7, 11, 15, 17, 19, \ldots\}$
'prime numbers' *ennamba enkulu*

(54) 'nonprime numbers' *ennamba zikkontankulu*

(55) 'The conjugate of a + bi is a – bi'
Ennywanyi ya a + bi a - bi

(56) a + b 'a plus b' a *ngatteko b*

(57) a – b 'a minus b ' a *ntooleko b*

(58) a x b 'a times b' a *emirundi b*

(59) a ÷ b 'a divided by b a *egabiddwamu b*

(60) a > b 'a greater than b' *a kusinga b*

(61) a < b 'a less than b' *a ntono ku b*

(62) a ≈ b 'a approximately equal to b'*a kumpi kwenkana b*

(63) a >> b 'a much greater than b' *a kusingira ddala b*

(64) $x \to \infty$ 'x approaches infinity' *x esemberera (o) butakoma*

(65) 4! = 24 'Factorial 4 equals 24! *4 kinnafakta 24*

(66) x^n 'x (raised) to the nth power.'
'x (nga eyimusibbwa okutuuka) ku buyinza bwa n

(67) $\sqrt[n]{x}$ 'the nth root of x' *ekikolo kya x ekya n*

(68) $y \propto x$ 'y varies directly as x'

y ekyukakyuka butereevu nga x

(69) $\lim f(x)$ 'the limit of f (x) as x approaches a'

$x \rightarrow a$ *enkomerero ya f (x) nga x esemberera a*

(70) $(A^{-1}$ 'the inverse of the non-singular matrix A'

enfuulannenge y'endoko A etali ya bwannamunigina

(71) A^{T} 'the transpose of the matrix A

(endoko) enseetulule y'endoko A

(72) det A 'the determinant of the square matrix A

emmiimulula y'endoko A ey'omulabba

(73) $\sum_{r=1}^{n} f(r)$ 'the sum of f (r) to n terms'

omugatte gwa f (r) okutuuka ku bimiimo n

(74) $\prod_{r=1}^{n} f(r)$ 'the product of f (r) to n terms'

omuzaalise gwa f(r) okutuuka ku bimiimo n

(75) $\log_a x$ 'the logarithm of x to base a'

enyanda ganyo ya x ku musingi a

(76) ln x 'the natural logarithm of x

enyandaganyo nnabutonde eya x

(77) dy/dx 'the differential coefficient of y with respect to x'

omumuwendoganyo gwa y gunnamwawulo nga gufa ku x

(78) f'(x) 'f prime of x' *f kasale gwa x*

(79) $\int_a^b f(x)dx$ 'the integral of f (x) with respect to x from a to b'

omulambirizo gwa f (x) nga gufa ku x okuva ku a okutuuka ku b

(80) P (A) 'the probability of the event A'

obwandiba bw'ekituukiriro A

(81) P (A/B 'the probability of the event A conditional on the event B`

obwandiba bw'ekituukiriro A ku kakalu k'ekituukiriro B

(Notes on 2.2.2 (26)-(81)]

"natural"; *obutonde;* "nature"; *-nnabuton*de

"member"; *ekibinja;* "set"; *-nnakibinja*

"intersection"; *-salaganir-;* "to intersect at" *ekisalaganiro*

"union"; *-mu;* "one"; *ekimuwazo*

"pair"; *omugogo*

"to map uniquely"; *-maapuwaz- bemmummululu*

"universal"; *byonna;* "all"; *-nnabyonnawaz-*

"inverse"; *-galik-;* "to invert"; *-nnaggalika*

"complex";*obuzibu;* "difficulty"; *-nnabuzibu*

"imaginary"; *-fumiitirize*

"real"; *wawu*

"rational"; *-menyefu;* "broken finitely" *kinnakkomo*

"irrational"; *-menyefu;* "broken infinitely" *kinnabutakoma*

"fraction"; *-menyek-;* "to break"; *emmenyefu*

"prime"; *-kulu*

"nonprime"; *-kkontankulu*

"determinant"; *-miimulul-;* "to tie very tightly"

"logarithm"; *-gabir-;* "to give to"; *olugabiro*

"coefficient"; *omuwendo:* "value"; *omumuwendoganyo*

"integral"; *-lambirira;* "whole" ; *omulambirirawazo*

"probability"; *obwandiba*

Let the Greek alphabet from which symbols are widely adopted in logic, mathematics, physics and chemistry be assimilated to Luganda as in (82)

(82)

A	α	alpha	alfa
B	β	beta	beta
Γ	ϬϬ	gamma	gamma
Δ	δ	delta	delta
E	∈	epsilon	epsiloni
Z	ζ	zeta	zeta
H	η	eta	eta
Θ	θ	theta	theta
I	ι	iota	iota
K	κ	kappa	kappa
Λ	⋋	lambda	lambuda
M	μ	mu	myu
N	ν	nu	nyu
Ξ	ξ	xi	ksi
O	o	omicron	omikroni
Π	π	pi	pi
P	ρ	rho	ro
Σ	σ ς	sigma	sigma
Y	υ	upsilon	yupsiloni
Φ	ϕ φ	phi	fi
X	χ	chi	hyi
Ψ	ψ	psi	psi

Ω ω omega omega

I render some mathematical texts into Luganda.

(83a) Text 3: Differential Equations

Introduction

A differential equation is an equation which involves at least one derivative of an unknown function. The following are some examples of differential equations:

$$dy/dx = \sin x$$

$$x\, dy/dx = y^2 + 1$$

$$dy/dt + y\, d^2/dt^2 = \cos t - e^y$$

$$x\, 2d^2y/dx^2 - 2x\, dy/dx + 2y = (x^2 - 2x + 2)\, e^x$$

Many problems in physics, chemistry, engineering etc can be formulated in the form of differential equations. Thus differential equations play an important role in the application of mathematics to scientific problems.

Example 1

It is known that the rate of decay of a radioactive substance is proportional to the amount present. Express this in the form of a differential equation.

Solution

Let y be the amount of the radioactive substance present at time t. Then dy/dt is the rate of change. By assumption, d y/dt is proportional to y. Thus dy/dt = ky for some constant k.

Example 2

Newton's law of cooling states that the rate of change of temperature in a cooling body is proportional to the difference

in temperature between the body and its surroundings. Using t for time in minutes , x for temperature of the cooling body in ^{o}C and x_0 for the temperature of the surroundings (assumed to be constant), express the law in the form of a differential equation.

Solution

The rate of change of temperature is expressed as dx/dt. The difference in temperature between the body and its surroundings is given by $x - x_0$. Since dx/dt is proportional to $x - x_0$, we have $dx/dt = k (x - x_0)$ for some constant k.

Example 3

Newton's law of gravitation states that the acceleration of a particle is inversely proportional to the square of the distance between the particle and the centre of the earth. Using x for that variable distance and t for time, express the law in the form of a differential equation relating to x and t.

Solution

Let v and a be respectively the velocity and acceleration of the particle at time t. Then

$$v = dx/dt, \quad a = dv/dt$$

and hence

$$a = dv/dt = d/dt\ (dx/dt) = d^2x/dt^2$$

Since a is inversely proportional to x^2, we have

$$a = k/x^2$$

for some constant k. Thus, the required differential equation is

$$d^2x/dt^2 = k/\ x^2$$

"engineering, technology";*obukodyo;* "techniques" *kannabukodyo*

"science"; *okumanya;* "knowledge" *kannakumanya*

"decay"; *-seebengerer-*

"rate of decay"; *omuseebengerero*

"derivative"; *-viis-;* "to extract" *omuviisemu*

"matter"; *omutole;* "lump" *nnamutole*

"radioactive"; *akagulu;* "ray" *-kaguluwazi*

"rate of change"; *-kyuk-;* "to change" *omukyuko*

'gravitation"; *-sikiriz-;* "attract" *omusikirizo*

"gravitation"; *obuzito;* "weight" *nnabuzito*

"Earth"; *ettaka;* "earth" *Nnattaka*

"mathematics"; *okubala;* "(to) count(ing)" *kannakubala*

"distance"; *-esuul-;* "to be at a distance from *obwesuulo*

"to vary directly, to be proportional to"; *-kyuk- butereevu* "to vary inversely, to be inversely proportional to "; *-kyuk- kinnaggalika*

"particle"; *akasirikitu*

"surroundings; *-etoolool-; obwetooloole*

"temperature" *-bugumy-;* "to be warmed" *obubugumye*

(83b) Translation of Text 3:

Ekyenkano kinnamwawulo kye kyenkano ekirimu waakiri omuviisemu ogumu ogw'omukolo ogutamanyiddwa. Ebiddirira

bye bimu ku byokulabirako by 'ebyenkano binnamwawulo'

$dx/dx = \sin y$

$x\ dy/dx = y^2 + 1$

$dy/dt + y\ d^2y/dt^2 = \cos t - e^y$

$x\ 2d^2y/dx^2 - 2x\ dy/dx + 2y = (x^2 - 2x + 2)\ e^x$

Ebizibu bingi mu fizika, kemiya, kannabukodyo n'ebirala bisobola okwasanguzibwa mu kikula ky'ebyenkano binnamwawulo. Ebyenkano binnamwawulo bikulu mu nkozesa ya kannakubala ku bizibu bya kannakumanya.

Ekyokulabirako 1

Kimanyiddwa nti omuseebengerero gw'omutole ogukaguluwazi gukyuka butereevu nga obungi obuliwo. Yasanguza kino mu kikula ky'ekyenkano kinnamwawulo.

Ekimerengulo

Leka y bube obungi bw'omutole ogukaguluwazi oguliwo ku kiseera t. Olwo dy/dx gwe mukyuko. Kitwalibwa nti dy/dx gukyuka butereevu nga y. Nolwekyo $dy/dx = ky$ kulwa ekitakyuka gundi k.

Ekyokulabirako 2

Etteeka ly'okuwola erya Newton ligamba nti omukyuko gw'obubugumye mu mubiri oguwola gukyuka butereevu nga enjawulo eriwo wakati w'obubugumye bw'omubiri n'obwetoole. Nga okozesa t okuyumiririra ekiseera mu ddakiika, x okuyimiririra obubugumye bw'omubiri oguwola mu ^oC ne x_o okuyimiririra obubugumye bw'obwetooloole (obutwalibwa nga tebukyuka), yasanguza etteeka mu kikula ky'ekyenkano kinnamwawulo.

Ekimerengulo

Omukyuko gw'obubugumye gwasanguzibwa nga dx/dt. Enjawulo mu bubugumye wakati w'omubiri n'obwetooloole bwagwo eweebwa na $x - x_o$, tufuna $dx/dt = k_o (x - x_{o,})$ olw'ekitakyuka gundi k.

Ekyokulabirako 3

Etteeka lya nnabuzito erya Newton ligamba nti omwanguyo gw'akasirikitu gukyuka kinnagalika nga omulabba gw'obwesuulo wakati w'akasirikitu n'amassekati ga Nnattaka. Nga okozesa x okuyimiririra obwesuulo obwo obukyuka ne t okuyimiririra ekiseera, yasanguza etteeka mu kikula ky'ekyenkano kinnamwawulo ekigandawaza x ne t.

Ekimerengulo

Leka v ne a mu buddiri*ηη*ane obwo bibe embiro n'omwanguyo gw'akasirikitu ku kiseera t. Olwo $v = dx/dt$, $a = dv/dt$ era okuva awo $a = dv/dt = d/dt\ dx/dt = d^2x/dt^2$

Okuva a lwe kikyuka kinnagalika nga x^2, tufuna $a = k/x^2$ kulwa ekitakyuka k gundi. Nolwekyo, ekyenkano ky'omwawulo ekyetaagibwa kiri $d^2x/dt^2 = k/x^2$

Translated from Chow et al (1981: 232-232)

(84a) Text 4

Lagrangian equations

In the absence of constraints Lagrange's equations of motion (Eq..17.66) were found to be

$$d/dt[\partial \mathbf{L}/[\partial q_i/\partial t]] - \partial L/\partial q_I = 0,$$

with t (time) the one independent variable and $q_i(t)$ (particle position) a set of dependent variables. Usually the generalized coordinates q_i are chosen to eliminate the forces of constraint,

but this is not necessary and not always desirable. In the presence of constraints φ_k Hamilton's principle is

$$\delta\int [L(q_i \,.\, dq_i/dt \,.\, t) + \Sigma\, \lambda_k(t)\, \varphi_k(q_i \,.\, t)]\, dt = 0 \qquad (17.116)$$

and the constrained lagrangian equations of motion are

$$d/dt\, [\partial \mathbf{L}/[\partial q_i/\partial t]] - \partial L/\partial q_i = \Sigma\, a_{ik}\lambda_k. \qquad (17.117)$$

Usually $\varphi k = \varphi k(qi \,.\, t)$, independent of the generalized velocities $d\mathbf{q}_i/dt$. In this case the coefficient a_{ik} is given by

$$a_{ik} = \partial\varphi_k/\partial q_i. \qquad (17.118)$$

If q_i is a length, then $a_{ik}\lambda k$ (no summation) represents the force of the kth constraint in the q_i direction, appearing in Eq.17.117 in exactly the same way as $-\partial V/\partial q_i$.

[Notes on V.2.2 (84)]

"constraint"; *-kugir-;* "to constrain" *ekikugiro*

"position"; *-esangir-;* "to find itself at" *akeesangiro*

"principle"; *omusingi;* "basis" *ekinnamusingi*

"coordinate"; *-tegekagany-* "to coordinate" *ekitegekaganyo*

(84b) <u>Translation of Text 4:</u>

Ebyenkano by'Ekilagrange.

Nga tewali bikugiro ebyenkano by'obwejjuluzi bya Lagrange (Kyenka. (17.66) byazuulibbwa okuba nga

$d/dt\, [\partial \mathbf{L}/[\partial qi/\partial t]] - \partial L/\partial qi = 0$, ne t (ekiseera) ekikyuka ekyetwala ne $q_i(t)$ (akeesangiro k'akasirikitu) ekibinja ky'ebikyuka ebiteetwala. Ebitegekaganyo ttwalirawamu bitera okulondebwa amaanyi g'obukugire gasaanyizibwewo, naye

kino tekiteekwa era ssi bulijjo lwe kyetaagibwa. Nga ebikugiro φ_k we biri kinnamusingi wa Hamilton kiri

$$\delta\int[L(q_i .dq_i/dt . t) + \Sigma\lambda k(t)\varphi k(qi . t)] dt = 0, \qquad (17.116)$$

era ebyenkano by'obwejjuluzi eby'Ekilagrange ebikugire biri

$$d/dt[\partial \mathbf{L}/ [\partial q_i/\partial t]] - \partial L/\partial q_i = \Sigma a_{ik}\lambda_k. \qquad (17.117)$$

Kitera okuba nga $\varphi_k = \varphi_k(q_i , t)$, tebyesigama ku mbiro $d\mathbf{q}_i/dt$. Mu ngeri eno omuwendowaganyo a_{ik} guweebwa na

$$a_{ik} = \partial\varphi_k/\partial q_I \qquad (17.118)$$

Ssinga q_i buwanvu, olwo a_{ik} (tewali kugattirira) eyimiririra eryanyi ly'ekikugiro kya –k mu bwolekero bwa q_i erabika mu Kyenka.17.117 mu ngeri ye nnyini nga $-\partial V/\partial q_i$.

Translated from Arfken (1970: 795)

2.3 Physics Materials

I turn to physics materials by first dealing with Base SI (85), Supplementary SI (86) and Derived SI (87) Units; the Derived Units have special names which have to be adopted intact because most of them were originally proper (personal) ones.

(85)

length	*obuwanvu*	
mass	*obutole*	
time	*ekiseera*	
electric current	*omukulukuto omumeeme*	
thermodynamic temperature	*obubugumye bunnajjululwabbugumu*	
amount of substance	*obungi bw'omutole*	
luminous intensity	*obunyiinyiitivu bw'ekitangaala*	
metre	*mmita*	m

	kilogramme	*sseggramu*	kg
	second	*ssikonda*	s
	ampere	*ampere*	A
	kelvin	*kelvin*	K
	mole	*mmolo*	mol
	candela	*kasubbaawa*	cd
(86)	plane angle	*ensonda enseeteevu*	
	radian	*ssekagulu rad*	
	solid angle	*ensonda empulubavu*	
	steradian	*ssempulubavu*	
(87)	frequency	*omuddiŋano*	
	energy	*ekimulimuwazi*	
	force	*eryanyi*	
	power	*obuyinza*	
	pressure	*omunyigirizo*	
	electric charge	*obuwange obumeeme*	
	electric potential difference	*enjawulo y'obwekusike obumeeme*	
	electric resistance	*obugugubi obumeeme*	
	electric conductance	*obuyisaamu obumeeme*	
	electric capacitance	*obusobola obumeeme*	
	magnetic flux	*omuwanguko omunnamagineti*	
	inductance	*obufukuutirira*	
	magnetic flux density (magnetic induction)	*omufukuutiriro omunnamagneti*	
	luminous flux		
	illumination	*omutangaazo*	
	hertz	hertz	Hz

joule	joule	J
newton	newton	N
watt	watt	W
pascal	pascal	Pa
coulomb	coulomb	C
volt	volt	V
ohm	ohm	Ω
siemens	siemens	S
farad	farad	F
weber	weber	Wb
henry	henry	H
tesla	tesla	T
lumen	lumeni	lm
lux	luksi	lx

(88a) Text 5:

1.1 Mechanics of a particle

The essential physics involved in the mechanics of a particle is contained in *Newton's Second Law of Motion*, which may be considered equivalently as a fundamental postulate or as a definition of force and mass. For a single particle, the correct form of the law is:

$$\mathbf{F} = d\mathbf{p}/dt, \qquad (1\text{-}1)$$

where **F** is the total force acting on the particle and **p** is the *linear momentum* of the particle defined as follows:

Let s be the curve traced by the particle in its motion, and **r** the radius vector from the origin to the particle. The vector can then be defined formally by the equation:

$$\mathbf{v} = d\mathbf{r}/dt, \qquad (1\text{-}2)$$

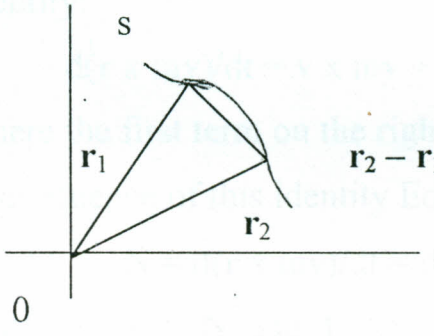
where the derivative is evaluated by the usual limiting process (cf. Fig. 1-1):

$$d\mathbf{r}/dt = \lim_{\Delta t \to 0} [(\mathbf{r}_2 - \mathbf{r}_1)/\Delta t] = \lim_{\Delta t \to 0} [\Delta s/\Delta t] = ds/dt$$

(This last form for the derivative explicitly indicates that $\mathbf{v}$ is tangent to the curve). Then the linear momentum $\mathbf{p}$ is defined in terms of the velocity as

$$\mathbf{p} = m\mathbf{v}, \qquad (1\text{-}3)$$

so that (1-1) can be written $\mathbf{F} = d(m\mathbf{v})/dt$.



(1-4)

In most cases the mass of the particle is constant and Eq. (1.1) reduces to:

$$\mathbf{F} = m(d\mathbf{v}/dt) = m\mathbf{a} \qquad (1.5)$$

where $\mathbf{a}$ is called the acceleration of the particle as defined by

$$\mathbf{a} = d^2\mathbf{r}/dt^2 \qquad (1\text{-}6)$$

Many of the important conclusions of mechanics can be expressed in the form of conservation theorems, which indicate under what conditions various mechanical quantities are constant in time. Eq. (1-1) directly furnishes the first of these, the *Conservation Theorem of the Linear Momentum of a Particle: If the total force,* $\mathbf{F}$, *is zero, then* $d\mathbf{p}/dt = 0$ *and the linear momentum,* $\mathbf{p}$, *is conserved.* The angular momentum of the

particle about point O, denoted by **L** is defined as

$$\mathbf{L} = \mathbf{r} \times \mathbf{p} \tag{1-7}$$

where **r** is the radius vector form 0 to the particle. Notice that the order of the factors is important. We now define the *moment of force* or *torque* about O as

$$\mathbf{N} = \mathbf{r} \times \mathbf{F} \tag{1-8}$$

The equation analogous to (1-1) for **N** is obtained by forming the cross product of **r** with Eq. (1-4):

$$\mathbf{r} \times \mathbf{F} = \mathbf{N} = \mathbf{r} \times d(m\mathbf{v})/dt \tag{1-9}$$

Eq. (1-9) can be written in a different form by using the vector identity:

$$d(\mathbf{r} \times m\mathbf{v})/dt = \mathbf{v} \times m\mathbf{v} + \mathbf{r} \times d(m\mathbf{v})/dt$$

where the first term on the right obviously vanishes. In consequence of this identity Eq. (1-9) takes the form

$$\mathbf{N} = d(\mathbf{r} \times m\mathbf{v})/dt = d\mathbf{L}/dt. \tag{1-10}$$

Note that both **N** and **L** depend upon the point O, about which the moments are taken.

As was the case for Eq. (1-1), the torque equation, (1-10), also yields an immediate conservation theorem, this time the *Conservation Theorem for the Angular Momentum of a Particle: If the total torque,* $\mathbf{N}$*, is zero, then* $d\mathbf{L}/dt = 0$*, and the angular momentum* $\mathbf{L}$ *is conserved.*

Next consider the work done by the external force . **F** upon the particle in going from point 1 to point 2. By definition this work is

$$W_{12} = \int_1^2 \mathbf{F} \cdot d\mathbf{s} \tag{1-11}$$

For constant mass (as will be assumed from now on unless otherwise specified), the integral in Eg. (1-11) reduces to

$$\int \mathbf{F} \cdot d\mathbf{s} = m \int (dv/dt) \cdot v \, dt = m/2 \int (d(v^2)/dt) \, dt$$

and therefore

$$W_{12} = m(v_2^2 - v_1^2)/2 \qquad (1\text{-}12)$$

The scalar quantity $mv^2/2$ is called the kinetic energy of the particle and is denoted by T, so that the work done is equal to the change in the kinetic energy:

$$W_{12} = T_2 - T_1 \qquad (1\text{-}13)$$

If the force field is such that the work W done around a closed orbit is zero, i.e.

$$\oint \mathbf{F} \cdot d\mathbf{s} = 0, \qquad (1\text{-}14)$$

then the force (and the system) is said to be conservative. Physically it is clear that a system cannot be conservative if friction or other dissipation forces are present, for $\mathbf{F}.d\mathbf{s}$ due to friction is always positive and the integral cannot vanish. By Stokes'' Theorem, the condition for conservative forces, Eq.(1-14), can be written:

$$\nabla \times \mathbf{F} = 0,$$

and since the curl of a gradient always vanishes **F** must therefore be the gradient of some scalar:

$$\mathbf{F} = - \triangle V, \qquad (1\text{-}15)$$

where V is called the *potential, or potential energy.* The existence of V can be established without the use of theorems of vector calculus. If Eq. (1-14) holds, the work W_{12} must be independent of the path of integration between end points 1 and 2. It follows then that it must be possible to express W_{12} as the change in a quantity which depends only upon the position of

the end points. This quantity may be designated by –V, so that for a differential path length we have the relation:

$$\mathbf{F} \cdot ds = -dv$$

or

$$\mathbf{F} = -\partial v/ds,$$

which is equivalent to Eq. (1-15). Note that in Eq. (1-15) we can add to V any quantity constant in space, without affecting the results. Hence, *the zero level of V is arbitrary.*

For a conservative system the work done by the forces is

$$W_{12} - V_1 - V_2 \qquad (1\text{-}16)$$

Combining Eq. (1-16) with Eq. (1-13) we have the result

$$T_1 + V_1 = T_2 + V_2. \qquad (1\text{-}17)$$

which states in symbols the *Energy Conservation Theorem for a particle: If the forces acting on a particle are conservative, then the total energy of the particle, T + V, is conserved.*

Goldstein (1950: 1-4)

[Notes on V.2.3.(88)]

"mechanics"; *mekanika*

"mechanic"; *makanika*

"postulate"; *-sab-;* "to request"; *ekisabo*

"define"; *ensalo;* "border"; *-salowaz-*

"linear"; *-nnamusittale*

"momentum"; *–vuumuul-;* "to move forward at full speed"; *envuumuulo*

"curve"; *-got; olugote*

"vectorial"; *-kongojj-; -kongozzi*

"radius vector"; *ekikongozz ky'akagulu*

"evaluate"; *-wendowolol*

"moment"; *-nyool-;* "to twist"; *akanyoolo*

"conservation"; *-kuumirir-;* "to conserve"; *obukuumirizi*

"theorem"; *-kakas-;* "to prove"; *ekikakase*

"theory"; *-tetenkanyiriz-;* "to try hard to figure out"; *omutetenkanyilizo*

"torque"; *obunyoole*

"scalar"; *olupimo;* "scale"; *-nnalupimo*

"orbit, path"; *akakubo;* "path"; *olukubo*

"system"; *-yung-;* "to join"; *omuyungo*

"field"; *ekisaawe;* "field"; *omusaawe*

(88b) Translation of Text 5:

1-1 Mekanika w'akasirikitu. Omulamwa gwa fizika ali mu mekanika w'akasirikitu guli mu *Tteeka ly'Obwejjuluzi Ery'okubiri erya Newton*, erisobola okulowoozebwako nga ssemusingi oba ekisalowazo ky'eryanyi n'obutole. Kulwa akasirikitu ak'eddembe, ekikula ky'etteeka ekituufu kiri:

$$\mathbf{F} = d\mathbf{p}/dt, \qquad (1\text{-}1)$$

nga **F** lye lyanyi lyonna erikola ku kasirikitu era nga **p** ye envuumuulo nnamusittale y'akasirikitu esalowazibwa bweti: Leka s lube olukubo lw'akasirikitu akejjulula, era leka **r** kibe ekikongozzi ky'akagulu okuva ku nsibuko okutuuka ku kasirikitu. Embiro z'ekikongozzi zisalowazikira kikula mu kyenkano:

$$\mathbf{v} = d\mathbf{r}/dt, \qquad (1\text{-}2)$$

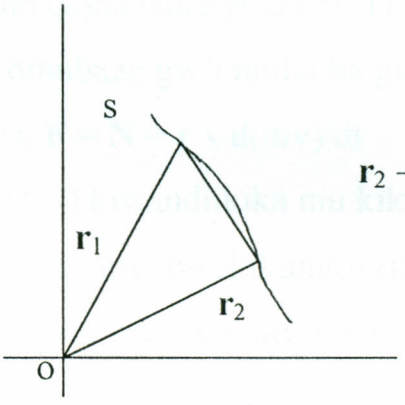
nga omuviisemu gumuwendowololwa mu masembereza aga bulijjo (cf. Fig. 1-1):

$$\mathbf{dr}/dt = \lim_{\Delta t \to 0} [(\mathbf{r}_2 - \mathbf{r}_1)/\Delta t] = \lim_{\Delta t \to 0} [\Delta \mathbf{s}/\Delta t] = d\mathbf{s}/dt$$

(Ekikula kino ekisembyeyo kulwa omuviisemu kyoleka lwatu nti **v** zikwata ku lugote). Olwo envuumuulo nnamusittale **p** esalowalizibwa mu mbiro nga

$$\mathbf{p} = m\mathbf{v}, \qquad (1\text{-}3)$$

olwo (1-1)okuwandiikibwa $\mathbf{F} = d(m\mathbf{v})/dt$.



$$\mathbf{r}_2 - \mathbf{r}_1 = \Delta \mathbf{s} \qquad (1\text{-}4)$$

Emirundi egisiga obutole bw'akasirikitu tebukyuka era Kyenka.(1-1) kizzika ku:

$$\mathbf{F} = m(d\mathbf{v}/dt) = m\mathbf{a} \qquad (1\text{-}5)$$

a wekiyitirwa omwanguyo gw'akasirikitu era ogusalowazibwa

$$a = d^2/dt^2 \qquad (1\text{-}6)$$

bifundikiro bya mekanika bingi ebikulu ebyasanguzikira mu kikula ky'ebikakase by'obukuumirizi ebiraga mbeera ki obungi bw'ekimekanika obutali bumu mwe butakyukira mu kiseera Kyenka.(1-1) kiwa butereevu emu zo, *Ekikakase ky'obukumirizi kulwa Envuumuulo Nnamusittale y'Akasirikitu: Sssinga eryanyi lyonna,* **F,** *liba zzeero, olwo* d**p**/dt = *o era Envuumuulo*

nnamusittaleβ ekuumirirwa.

Envuumuulo nnansonda ey'akasirikitu ku poyinti 0, erambibwa ne **L** esalowazibwa nga

$$\mathbf{L} = \mathbf{r} \times \mathbf{p} \qquad (1\text{-}7)$$

r we kabeerera ekikongozzi ky'akagulu okuva ku 0 okutuuka ku kasirikitu. Labukira obutegeke bwa ffakita (emibazibwa). Kati tusalowaza obunyoole ku 0 nga

$$\mathbf{N} = \mathbf{r} \times \mathbf{F} \qquad (1\text{-}8)$$

Ekyenkano ekyefaananyiriza (1-1) kulwa **N** kifunikira mu kuzimba omubaze gw'omulabba gwa **r** ne Kyenka (1-4):

$$\mathbf{r} \times \mathbf{F} = \mathbf{N} = \mathbf{r} \times d(m\mathbf{v})/dt \qquad (1\text{-}9)$$

Kyenka. (1-9) kiwandiikika mu kikula ekirala nga tukozesa obwenkanyinkanyi bwekikongozzi:

$$d(\mathbf{r} \times m\mathbf{v})/dt = \mathbf{v} \times m\mathbf{v} + \mathbf{r} \times d(m\mathbf{v})/dt$$

ekimiimo ekisooka ku ddyo we kibulira. Nga ekigoberezo ky'obwenkanyinkanyi buno Kyenka. (1-9) kitwala ekikula

$$\mathbf{N} = d(\mathbf{r} \times m\mathbf{v})/dt = d\mathbf{L}/dt. \qquad (1\text{-}10)$$

Kenga nti **N** ne **L** zeesigama ku poyinti 0, obunyolo kwe butwalibwa. Nga bwe gwabadde kulwa Kyenka. (1-1), ekyenkano ky'obunyoole, (1-10), nakyo kivaamu mangu ekikakase ky'obukuumirizi, ku mulundi guno *Ekikakase ky'Obukuumirizi kulwa Envuumuulo Nnansonda ey'Akasirikitu: Ssinga obunyoole bwonna,* ***N****, buba zzeero, olwo* $d\mathbf{L}/dt = 0$*, era mmomento nnansonda ekuumirirwa.*

Kati lowooza ku mulimu ogukolebwa **F** ey'ebweru ku kasirikitu mu kugenda okuva ku poyinti 1 okutuuka ku poyinti 2. Mu busalowaze omulimu guno guli

$$W_{12} = \int_1^2 F \, . \, ds \qquad (1\text{-}11)$$

Olwa obutole obutakyuka (nga bwe kijja okutwalibwa okuva kati okujjaako nga kyatuukirizibwa bulala) omulambirizo mu Kyenka. (1-11) guzzibwa ku

$$\int \mathbf{F} \, . \, ds = m \int (d\mathbf{v}/dt) . \, \mathbf{v} \, dt = m/2 \int (d(\mathbf{v}^2)/dt) \, dt$$

era nolwekyo

$$W_{12} = m(v_2^2 - v_1^2)/2 \qquad (1\text{-}12)$$

Obungi bunnalupimo $mv^2/2$ buyitibwa ekimulimuwazi ky'obwejjuluzi bw'akasirikitu era bulambibwa na T, olwo omulimu ogukolebwa n'egwenkana enkyuka mu kimulimuwazi ky'obwejjuluzi

$$W_{12} = T_2 - T_1 \qquad (1\text{-}13)$$

Ssinga omusaawe gw'eryanyi guba nga omulimu W ogukolebwa ku lukubo oluggalewo guli zzeero, kwe kugamba,

$$\oint \mathbf{F} \, . \, ds = 0, \qquad (1\text{-}14)$$

olwo eryanyi (era n'omuyungo) ligambibwa okuba *ekkuumirizi.* Mu kifizika kitangaavu nti omuyugo tegusobola kuba mukuumirizi ssinga amanyi g'obukuubi oba amapunguuzi gabaawo, kubanga **F**.d s oguva ku bukuubi bulijjo mukkirizi era omulambirizo tegusobola kubula. Bwe tweyambisa Ekikakase kya Stokes, akakalu k'amaanyi amakuumirizi, Kyenka. (1-14), kasobola okuwandiikibwa:

$$\nabla \times \mathbf{F} = 0$$

era olw'okuba nga amasadde g'omusuliko bulijjo gabula

F kiteekwa okuba omusuliko gunnalupimo gundi:

$$\mathbf{F} = -\nabla V. \qquad (1\text{-}15)$$

V w'eyitirwa *amakusike*, oba *ekimulimuwazi ekikusike.* Okubeerawo kwa V kusobola okutebenkezebwa nga ebikakase by'embala y'ebikongozzi tebikozesebwa. Ssinga Kyenka.(1-14) kituufu omulimu guteekwa obuteesigama ku lukubo lw'okulambiriza wakkati w'enkomerero 1 ne 2. Olwo kigoberera nti kiteekwa okusoboka okwasanguza W_{12} nga enkyuka y'obungi obwesigama ku keesangiro k'enkomerero kwokka. Obungi buno tusobola okubulambisa –V ,olwo obuwanvu bw'olukubo lw'omwawulo bufunirwe oluganda:

$$\mathbf{F} \cdot ds = -dv$$

oba

$$F_s = -\partial v/ds,$$

ekyenkanankana Kyenka. (1-15). Kenga nti mu Kyenka.(1-15) ku V tusobola okuggatako obungi bwonna obutakyuka mu bbanga nga tewali kikyuka. Nolwenkyo, *eddaala zzeero erya V lya kyeyagalire.* Olwa omuyungo omukuumirizi omulimu ogukolebwa amaanyi guli.

$$W_{12} - V_1 - V_2 \qquad (1\text{-}16)$$

Bwe tugatta Kyenka. (1-16) ne Kyenka (1-13) tufunamu

$$T_1 + V_1 = T_2 + V_2 \qquad (1\text{-}17)$$

ekigamba mu bubonero

> *Ekikakase ky'obukuumirizi bw'Ekimulimuwazi olw'Akasirikitu: Ssinga amaanyi agakola ku kasirikitu gaba amakuumirizi, olwo ekimulimuwazi kyonna eky'akasirikitu, T + V, kikuumirirwa.*
>
> Translated from Goldstein (1950: (1-4)

(89) Text 6:

The de Broglie Relation

In the previous chapter we have seen that electrons and other subatomic particles sometimes exhibit properties similar to those commonly associated with classical waves so that, for example, electrons of the appropriate energy are diffracted by crystals in a manner similar to that originally observed in the case of x-rays. Morever, the energy and momentum of a free particle can be expressed in terms of the angular frequency and wave vector of the associated plane wave by the de Broglie relations (1.10). In this chapter we shall consider one-dimensional examples only and extend our treatment to three-dimensional systems in the next chapter. In one dimension the wave vector and momentum of a particle can be treated as scalars so that the de Broglie relations can be written as

$$E = \hbar\omega \qquad p = \hbar k \qquad (2\text{-}1)$$

We shall use these and the properties of classical waves to set up a wave equation, known as the *Schrödinger wave equation*, appropriate to these matter waves, and when we solve this equation for the case of particles that are not free but move in a potential well, we shall find that solutions are only possible for particular discrete values of the total energy. We shall apply this theory to a number of examples and compare the resulting energy levels with experimental results.

[Notes on V .2.3(89)]

"electron"; *elektroni*

"atom"; *atomu*

"classical"; *ennono; -nnannono*

"diffract"; *-wugul-*

"crystal"; *kristo*

"x-ray"; *akagulu-x*

"frequency"; *omuddiriŋŋano*

"plane"; *-seeteevu;* "flat"; *"oluseeteevu*

"pontential well"; *oluzzi; olukusike*

"discrete"; *-ekusifu*

"dimension"; *olupimiro*

(89b) Translation:

Wansi w'omutwe oguwedde tulabye nti elektroni n'obusirikitu bunnaatomu lukka oluusi bwolesa emize egifaanana n'egyo egitera okunywanyizibwa n'mayengo gannannono nga, okugeza, elektroni z'ekimulimuwazi ekisaanira ziwugulibwa kristo mu ngeri efaanana kwe eyo eyakengebwa mu kusooka ku bugulu-x. Ate eraekimulimuwazi ne envuumuulo ey'akasirikitu ak'eddembe bisobola okwasangulizibwa mu muddiriŋŋano gunnansonda n'ekikongozzie ky'ejjengo ly'oluseeteevu erigwanira nga tukozesa ebigandawazo bya de Broglie (1.10).

Wansi w'omutwe guno tujja kuleeta ebyokulabirako binnalupimiro -lumu byokka era tujja kweyongera tutuuke ku miyungo ginnampimiro -ssatu wansi w'omutwe oguddirira. Mu lupimiro olumu ekikongozzi ky'ejjengo n'envuumuulo y'akasirikitu bisobola okutwalibwa nga obungi bunnalupimo: n'olwekyo ebigandawazo bya de Broglie bisobola okuwandiikibwa nga

$$E = \hbar\omega \qquad p = \hbar k \qquad (2.1)$$

Tujja kukozesa bino n'emize gy'amayengo gannannono tuteekewo ekyenkano ky'ejjengo ekimanyiddwa nga *ekyenkano ky'ejjengo kya Schrödinger* ekikwatagana "n'amayengo ga nnamutole," era bwe tumerengula ekyenkano kino nga obusirikitu si bwa ddembe wabula nga bwejjulula mu luzzi olukusike, tujja kuzuula nga ebimerengulo bisobokera kulwa miwendo g'ekimulimuwazi kyonna emyekusifu. Tujja kukozesa omutetenkanyirizo guno ku byokulabirako ebiwera era tugeraageranye amadaala g'ekimulimuwazi agavaamu n'ebiva mu kugezesa.

Translated from Rae (1986: 15)

V.2.4 Chemical Materials

I propose that in chemical nomenclature the IUPAC affixes are assimilated graphologically, and phonologically to Luganda.

(90)

-ane	-aano
-ene	-eeno
-yne	-yuuno
-ate	-aato
-ase	-aaso
-ose	-ooso
-al	-alo
-ol	-olo
-yl	-yulo
-ile	-iilo
-ide	-iido

	-ic	-nna
(91)	aqua-	akwa-
	aza-	aza-
	azido-	azid(o)-
	bromo-	brom(o)-
	sec-	sec-
	tert-	tert-
	catena-	catena-
	chloro-	klor(o)-
	cis-	cis-
	closo-	kloso-
	cyano-	syuan(o)-
	cyclo-	syuklo-
	cycloalk-	syulkloalk-
	de-	de-
	dehydro-	dehyudr(o)-
	deoxy-	deoksyu-
	des-	des-
	deuterio-	deuterio-
	diazo-	diazo-
	disulfido-	disulfiid(o)-
	dithio-	dithio-
	endo-	endo-
	epi-	epi-
	exo-	ekso-
	fac-	fac-
	fluoro-	fluor(o)-
	formyl-	formyul(o)-

friedo-	fried(o)-
halocarbonyl-	halokarbonyul-
homo-	homo-
hydro-	hyudro-
hydrido-	hyudrid(o)-
hypo-	hyupo-
hydroxy-	hyudroksy-
iso-	iso-
meta-	meta-
methoxo-	methoks(o)
methylene-	methyuleen(o)-
neo-	neo-
nido-	nido-
nitro-	nitro-
nitroso-	nitroso-
nitrosyl-	nitrosyul-
nitryl-	nitryul-
nor-	nor-
ortho-	ortho-
oxa-	oksa-
oxy-	oksy-
para-	para-
per-	per-
peroxo-	perokso-
pyro-	pyuro-
rac-	rac-
rel-	rel-
seco-	seko-

sulfo-	sulfo-
syn-	syun-
thioxo-	thiokso-
trans-	trans-
tritio-	tritio-
uranyl-	uranyul-
vinyl-	vinyul-
-co-	ko-
-io-	io-
meth-	meth-
eth-	eth-
prop-	prop-
but-	but-
pent-	pent-
hex-	heks-
hept-	hept-
oct-	okt-
non-	non-
dec-	dek-

In (92) I pronounce in Luganda the reactions of the Solvay Process I first introduced in Sec. I.1.

(92a) $NH_3 + CO_2 + H_2O \rightarrow (NH_4)HCO_3$

Omukka ammonia gwegatta n'omukka karboni dioksiido n'amazzi ne muvaamu ammonio hyudrogenio karbonaato.

(92b) $NaCl + (NH_4)HCO_3 \rightleftharpoons NaHCO_3\downarrow + NH_4Cl$

Sodio kloriido yeegatta ne ammonio hyudrogenio karbonaato ne muvaamu sodio hyudrogenio karbonaato ne ammonio kloriido (ekyegatto kya kaddannyuma(⇌): kyokka $NaHCO_3$ awandukamu(↓))

(92c) $2NaHCO_3 \rightarrow Na_2CO_3 + HO_2 + CO_2\uparrow$

Obumole bubiri obwa sodio hyudrogenio carbonaato bubumbukira mu sodio karbonaato.

V.2.5 .Biological Materials

It will be recalled that in Sec. IV.2 I advocated transparency of biological nomenclature especially at the pre-University levels of education. In contradistinction to chemical nomenclature, biological nomenclature is easily amenable to articulation in Luganda. Indeed this is what was accomplished in Sec. IV.2. The major task to be tackled in this Subsection is to translate the biological taxonomy from neo-Latin into Luganda.

(93) The Plant Kingdom *Obwebimera*

(94) Subkingdom Thallophyta (cf App B 1460)
Walubwabututunusi

(95) Phylum Cyanophyta (App B 316) *Akabunnabbululu*

(96) Phylum Euglenophyta *Akabunnankompewawu*

(97) Phylum Chlorophyta *Akabukiragala*

(98) Phylum Chrysophyta (App B 345) *Akoobuzaabu*

(99) Phylum Pyrophyta (App. B 1128) *Akoobuliro*

(100) Phylum Phaeophyta *Akoobwakirivu*

(101) Phylum Rhodophyta *Akoobumyufu*

(102) Phylum Schizomycophyta (App. B 1228)
Akabutikobwatifu

(103) Phylum Myxomycophyta (App. B 826, 819)
Akabutikominyira

(104) Phylum Eumycophyta (App. B 819) *Akabutikowawu*

(105) Class Phycomycetes *Ekyobulungu*

(106) Class Ascomycetes (App. B 98) *Ekyobusawo*

(107) Class Basidiomycetes (App. B 129) *Ekyobusingi*

(108) Class Fungi Imperfecti (App. B 494)
Ekyobutikomatankane

(109) Subkingdom Embryophyta (App. B 164)
Walubwabinnankonge

(110) Phylum Bryophyta (App B 164) *Akeebitinsi*

(111) Class Musci (App B 814) *Ekyenkonge)*

(112) Class Hepaticae (App B.587) *Ekyebinnakibumba*

(113) Class Anthocerotae (App B. 69, 223) *Ekyabimulijjembe*

(114) Phylum Tracheophyta (App. B 1419) *Akabinnamussiro*

(115) Subphylum Psilopsida (App B.1094) *Walukabikunama*

(116) Class Psilophytinea (App.B 1094) *Ekyebikunama*

(117) Order Psilophytales (App B.1094) *Eryebissekunama*

(118) Order Psilotales (App. B 1094) *Eryebikunama*

(119) Subphylum Lycopsidia (App. B 716) *Walukabisege*

(120) Class Lycopodineae (App. B 716) *Ekyabikigeremuse*

(121) Order Lycopodiales (App.B 716) *Eryabikigeremusege*

(122) Order Lepidodendrales (App. B 674) *ryagannamagamba*

(123) Order Selaginellales *Eryabuserago*

(124) Order Pleuromeiales (App. B 1035) *Eryabikalubiriizi*

(125) Order Isotales *Eryebyenkanya*

(126) Subphylum Sphenopsida (App. B 1308)
Walukabiwanowavu

(127) Class Equisetineae (App. B 426) *Ekyebibaaasi*

(128) Order Hyeniales *Eryebiyisi*

(129) Subphylum Pteropsida (App. B 1100)
Walukabiwawawavu

(130) Class Filicinae *Ekyobuyongo*

(131) Order Coenopteridales (App. B 1100) *Eryebiwawawavu*

(132) Order Ophioglossales *Eryebisota*

(133) Order Marattiales *Eryabinnamaratti*

(134) Order Filicales *Eryobuyongo*

(135) Class Gymnospermae (App. B 561, 1306)
Ekyabinnansigobukunya

(136) Subclass Cycadophytae *Walukyabikindu*

(137) Order Cycadofilicales *Eryabikindubuyongo*

(138) Order Bennettitales *Eryabinnabennetti*

(139) Order Cycadales *Eryenkindu*

(140) Subclass Coniferorophyta *Walukyabikonowazi*

(141) Order Cordaitales (App. B 270) *Eryebitima*

(142) Order Ginkgoales *Eryabigingo*

(143) Order Coniferales *Eryebikonowazi*

(144) Order Gnetales *Eryabigineta*

(145) Class Angiospermae(App. B 60) *Ekyabinnansigo*

(146) Subclass Dicotyledoneae *Walukyabinnantibabbiri*

(147) Subclass Monocotyledoneae *Walukyabinnalutibalumu*

(148) The Animal Kingdom *Obwensolo*

(149) Phylum Protozoa (App. B 1088) *Akazinnakasooka*

(150) Class Flagellata (App. B 451) *Ekyazinnambooko*

(151) Class Sarcodina *Ekyensembeesi*

(152) Class Sporozoa (App. B 1321) *Ekyazinnansigo*

(153) Class Ciliata (App. B 233) *Ekyazinnankowe*

(154) Class Suctoria *Ekyennuunyi*

(155) Phylum Porifera (App. B 1060) *Akazinnabyangwe*

(156) Class Calcarea *Ekyazinnamayindu*

(157) Class Hexactinellida *Ekyazinnabugulumukaaga*

(158) Class Demospongiae (App. B 1319)
Ekyazinnabyangwebiweweevu

(159) Phylum Coelenterata *Akempowongole*

(160) Class Hydrozoa *Ekyazinnamumazzi*

(161) Class Scyphozoa (App. B 1241) *Ekyazinnampaawo*

(162) Class Anthozoa(App. B 69) *Ekyazinnakimuli*

(163) Phylum Ctenophora (App. B 301) *Akensanirizi*

(164) Phylum Platyhelminthes (App. B 584)
Akensiriηηanyimbeebeetavu

(165) Class Turbellaria (App. B 1451) *Ekyemmonzi*

(166) Class Trematoda(App. B 1427) *Ekyazinnabituli*

(167) Class Cestoda (App. B 230) *Ekyazinnankoba*

(168) Phylum Nemertea *Akeezanemerita*

(169) Phylum Nematoda (App. B 848) *Akeezinnawuzi*

(170) Phylum Acanthocephala (App. B.3, 221)
Akazinnamutwensoomi

(171) Phylum Chaetognatha (App. B 325, 544)
Akazinnajjobakuluba

(172) Phylum Nematomorpha (App. B 848) *Akeezikiwuzi*

(173) Phylum Rotifera (App. B 1192) *Akazinnamuziga*

(174) Phylum Gastrotricha (App. B 509, 1432)
Akazinnajjobakulubuto

(175) Phylum Entoprocta (App. B 1082) *Akazinnakinyomunda*

(176) Phylum Ectoprocta (App. B 1082) *Akazinnakinyokungulu*

(177) Phylum Brachiopoda (App. B 1045) *Akazinnabitambula*

(178) Phylum Phoronida (App. B 1148, 859) *Akezinnakisu*

(179) Phylum Aṇnelida (App. B 66) *Akezinnampeta*

(180) Phylum Onychophora (App B 1148) *Akezinnabinuulo*

(181) Phylum Arthropoda (App B 10494) App B 1045, 94)
Akazimagulunnyingo

(182) Phylum Mollusca (App. B 795) *Akeηηonvu*

(183) Phylum Echinodermata (App. B 403)
Akazinnamununngu

(184) Phylum Hemichordata(App. B 340)
Akazinnazluguwakitundu

(185) Phylum Chordata (App. B 340) *Akazinnaluguwa*

(186) Subphylum Urochordata(App. B 1488, 340)
Walukazinnaluguwamukira

(187) Subphlum Cephalochordata (App. B 221, 340)
Walukazinnaluguwamutwe

(188) Subphlum Vertebrata (App B 1515) *Walukazinnalugongo*

(189) Superclass Pisces (App. B 1018) *Wakkyabyannyanja*

(190) Class Agnatha (App. B 544) *Ekyazinnabbulwaluba*

(191) Class Placodermi (App. B 360) *Ekyazimbikkwalususu*

(192) Class Chrondrichthyes *Ekyazinnakibebenu*

(193) Class Osteichthyes (App. B 926) *Ekyazinnamagumba*

(194) Superclass Tetrapoda (App. B 1045)
Wakkyazinnamagulwana

(195) Class Amphibia *Ekyabiramirawabirye*

(196) Class Reptilia (App. B 1182) *Ekyazeewalula*

(197) Class Aves (App B 119) *Ekyennyonyi*

(198) Class Mammalia (App. B 729) *Ekyazinnamabeere*

(199) Subclass Prototheria (App. B 1088, 1468)
Walukyazinnakusookakuyigga

(200) Subclass Metatheria/Marsupalia (App. B 737)
Walukyazinnakasawo

(201) Subclass Eutheria (App. B 1470) *Walukyanjizziwawu*

(202) Order Insectivora (App. B 605, 1540) *Eryendyabiwuka*

(203) Order Chiroptera *Eryebinyira*

(204) Order Carnivora (App. B 206, 1540) *Eryendyannyama*

(205) Order Rodentia (App. B 1190) *Eryenkekesi*

(206) Order Lagomorpha (App. B 651) *Eryobumyu*

(207) Order Primates (App. B 1075) *Eryazissenkulu*

(208) Order Artiodactyla (App. B 349)
Eryazinnabugerebutereevu

(209) Order Perissodactyla (App. B 997, 349)
Eryazinnabugerensuunsuuba

(210) Order Edentata (App. B 358) *Eryazinnabbulwamannyo*

(211) Order Proboscidea (App. B 1081) *Eryazinnakigalabi*

(212) Order Cetacea (App. B 231) *Eryazirukwata*

(213) Order Sirenia *Eryensirena*

The taxonomy of the housefly is as follows:

(214) Kingdom Animalia *Obwensolo*

Phylum	Chordata	*Akazinnaluguwa*
Class	Hexapoda	*Ekyazinnamagulumukaaga*
Order	(Insecta)	*(Eryebiwuka)*
Order	Diptera	*Eryazinnabiwawabibiri*
Family	Muscidae	*Ogwensowera*
Genus	Musca	*Ensowera*
Species	domestica	*nnawaka*

Hence, *Musca domestica "Ensowera nnawaka"*

The following is the classification of the human:

(215)	Kingdom	Animalia	*Obwensolo*
	Phylum	Chordata	*Akazinnaluguwa*
	Superclass	Tetrapoda	*Wakkyazinnamagulwana*
	Class	Mammalia	*Ekyazinnamabeere*
	Subclass	Placentalia	*Walukyazinnakisungwa*
	Order	Primates	*Eryazissenkulu*
	Superfamily	Hominoidea	*Waggwennyintu*
	Family	Hominidea	*Ogwennyintu*
	Genus	Homo	*Omuntu*
	Species	sapiens	*omugezi*

Hence, *Homo sapiens "Omuntu omugezi"*

Now I turn to the classification of the dog.

(216)	Kingdom	Animalia	*Obwensolo*
	Subkingdom	Metazoa	*Walubwazinnanvannyuma*
	Phylum	Chordata	*Akazinnaluguwa*
	Subphylum	Vertebrata	*Walukazinnalugongo*
	Superclass	Tetrapoda	*Wakkyazinnamagulwana*

Class	Mammalia	*Ekyazinnamabeere*
Subclass	Theria	*Walukyanjizzi*
Infraclass	Eutheria	*Nnalukyanjizziwawu*
Cohort	Ferungulat	*Kalukyazinnabinuulonkambwe*
Superorder	Ferae	*Waddyankambwe*
Order	Carnivora	*Eryendyannyama*
Suborder	Fissipeda	*Walulyazinnabigerebyaseemu*
Superfamily	Canoidea	*Waggwambwa*
Family	Canidae	*Ogwembwa*
Subfamily	Caniae	*Walugwambwa*
Genus	Canis	*Embwa*
Species	familiaris	*nnabulijjo*

The taxonomy of maize follows:

(217)	Kingdom	Plantae	*Obwebimera*
	Division	Magnoliophyta	*Akabinnamaginoli*
	Class	Liliopsida	*Ekyamalanga*
	Order	Cyperales	*Eryabikyupero*
	Family	Gramineae	*Ogwebisagazi*
	Subfamily	Panicoideae	*Walugwamiwemba*
	Genus	Zea	*Empeke*
	Species	mays	*kasooli*

I look at one more taxonomy (that of the rose) before translating a German text in (219).

(218)	Kingdom	Plantae	*Obwebimera*
	Subkingdom	Embryobionta	*Walubwabinnankonge*
	Division	Tracheophyta	*Akabinnamussiro*

Subdivision	Spermatophytina	*Walukabinnansigo*
Class	Angiospermopsida	*Ekyabinnansigo*
Subclass	Dicotyledonidae	*Walukyabinnantibabbiri*
Superorder	Rosanae	*Waddyabirosa*
Order	Rosales	*Eryabirosa*
Suborder	Rosineae	*Walulyabirosa*
Family	Rosaceae	*Ogwabirosa*
Subfamily	Rosoideae	*Walugwabirosa*
Tribe	Roseae	*Walugwabirosa*
Genus	Rosa	*Ekirosa*
Subgenus	Rosa	*Walurosa*
Section	Caninae	*Nnalurosa*
Subsection	Caninae	*Sselurosa*
Species	canina	*nnambwa*

The following text is taken from a university textbook on biological taxonomy.

(219a) Text:

Grundlagen und Ziele der biologischen Systematik. Stammbaeume der Pflanzen und Tiere

Ein vollstaendiges Bild von der Mannigfaltigkeit der pflanzlichen und tierischen Organismen ist nur zu gewinnen, wenn man verschiedene Daten ueber Form, Funktionen, Lebensweise, Verbreitung, Veraenderlichkeit, und alle anderen Eigenschaften dieser Lebewesen zu gewinnen sucht. Dazu ist

1. eine eindeutige Kennzeichnung und Abgrenzung der als

gleichartig oder ungleichartig angesehenen Organismen und 2. die Gliederung der Formenfuelle in einem uebersichtlichen System notwendig. Tragen nun einerseits alle biologischen Disziplinen mit ihren Befunden zur genaueren Kenntnis der Organismen und damit ihrer systematischen Zuordnung bei, so ist es andererseits die biologische Systematik, welche die Grenzen zwischen den zu einem bestimmten Zeitpunkt unterscheidbaren Organismen gestuft angibt. Das von der Systematik erstellte System vermag weitaus mehr zu leisten als ein blosses Ordnungssystem.

Die soeben kurz umrissenen Aufgaben des Charkterisierens und Abgrenzens und des "Einordnens" werden innerhalb der Systematik von zwei einander ergaenzenden Arbeitsrichtungen wahrgenommen, naemlich der analytisch –deskriptiv arbeitenden Phyto- bzw. Zoographie und der vergleichend-synthetisch orientierten Systematik im engeren Sinne.

Aufgabe der Phyto - und Zoographie is es, von allen systematischen Einheiten eine so vollstaendige Beschreibung zu geben, dass man die beschriebenen Arten und Gruppen jederzeit wiedererkennen und von anderen, eventuell sehr aehnlichen unterscheiden kann (z.B. *Primula*-Arten oder *Liliaceae* und *Amaryllidaceae*) Die beschriebenen und voneinander unterschiedenen sowie ihrer Kategorie nach bestimmten Arten (Taxa, Einzahl: Taxon) muessen eindeutige Namen erhalten, deren Aufstellung und Gebrauch durch internationale Nomenklaturregeln festgelegt sind. Es ist keineswegs

selbstverstaendlich, dass wir ueberhaupt Sippen erkennen und gegeneinander abgrenzen koennen. Es waere durchaus denkbar, dass die mannigfaltigen Formen der Organismen kontinuierlich durch Uebergaenge untereinander verbunden waeren. Man beobachtet jedoch im Gegenteil eine diskontinuierliche Verteilung vieler Eigenschaften: einerseits beobachten wir bei einer Gruppe von Individuen etwa Angehoerigen ein und derselben Art-trotz einer gewissen Variabilitaet doch eine auffaellige Gleichfoermigkeit, andererseits finden wir eine Ungleichfoermigkeit zwischen Angehoerigen verschiedener Arten vor, die nicht durch Zwischenformen ueberbrueckt wird. Diese *diskontinuierliche Variabilitaet* ist es, welche uns die Unterscheidung natürlicher Gruppen ermoeglicht, wobei gewoehnlich (nur) einzelne besonders hervorstechende und konstante Eigenschaften als Merkmale dienen. Zur Zeit der Entwicklung der *Ichthyostegalia* oder des *Archaeopteryx*

(S. 777) war eine Trennung von Amphibien und Fischen bzw. Reptilien und Voegeln nicht moeglich. Durch Aussterben von Formen, die Verbindungsglieder zwischen Arten und hoeheren systematischen Einheiten gebildet hatten, koennen die Grenzen zwischen solchen systematischen Gruppen eines bestimmten Zeitpunktes in der Erdgeschichte vertieft werden (vgl. aber auch S. 817).

Czihak et al (1976: 813)

[Notes on (219)

System	*omuyungo*
Systematik	*kannamiyungo*

Stammbaum	*olulyo*
Daten	*ebiwe, kalonda*
Biologie	*kannabiramu*
Disziplin	*ettabi (ly'okuyiga)*
Befund	*-zuul-*"to find" *ekizuulo*
Ordnungssystem	*omuyungo gw'obusengeke*
Analytisch -deskriptiv	*-yunguluzi; -lozzi*
Vergleichend –synthetisch	*-geraageranyi-gattirizi*
Phytographie	*kalojjabimera*
Art	*enda*
Kategorie	*ekkowe*
Nomenklatur	*-tuum* "to name"*entuuma*
Sippe	*ekika*
diskontinuierliche Variabilitaet	*obukyusisi bunnalumaggamagga*

(219b) Translation:

EMISINGI N'EBIGENDERERWA BYA KANNAMIYUNGO OMUNNABIRAMU. ENDYO Z'EBIMERA N'ENSOLO

Tetuyinza kufuna kifaananyi kijjuvu ku lufulubenje lw'ebimera n'ensolo okujjako nga tufuba okunoonya kalonda yenna ku kikula, emikolo, ensula, obubunyi, obukyusisi n'emize emirala gyonna egy'ebiramu ebyo. Olw'ekyo tuteekwa (1) okulamba n'okwawula ebiramu ebigambibwa nti " bifaanagana" oba nti "tebifaanagana"; (2) okukibinjawaza akesedde k'ebikula mu muyungo omutangaavu. Newakubadde nga ku ludda olumu amatabi gannabiramu gonna olw'ebizuulo byago gasonda bingi ebisingako nga bifa ku biramu n'okubinnakibinjawaza ekinnamiyungo, kyokka ku ludda olulala kannamiyungo

omunnabiramu ye asobola okulaga enjawulo eziri wakkati w'ebiramu gundi ku kiseera gundi. Omuyungo oguva mu kannamiyungo gulina enkizo y'amaanyi ddala okusinga omutegekaganye obuyungo omusengeke.

Emirimu gy'okulamba n'okwawula era"n'okusengeka" egikooneddwako waggulu gituukiririzibwa kinnamiyungo mu ngeri bbiri: (1) ennyunguluzinnombozzi ; kalojjabimera oba kalojjansolo, (2) engeraageranyi-ngattirizi mu makulu agasingako okumiima. Omulimu gwa kalojjabimera ne-nsolo kwe kulojjera ddala buli kibinja ekinnamiyungo olwo omuntu asobole okwawula enda n'ebibinja buli kaseera, wadde ezo oba ebyo ebifaanagana ennyo (okug. enda za *Primula*, oba *Liliaceae* na *Amaryllidaceae*). Emitegeko egirojjebbwa era egyawuddwamu nga giteekeddwa mu makowe gaagyo giteekwa okufuna amannya amekusifu agagoberera ebifuzi by'entuuma ttabamawanga. Tekitegeerekekerawo okusobola okumanya n'okwawula ebika. Tewandibaddewo kugaana kulowooza nti ebikula by'ebiramu biseebengerera mu binaabyọ awatali kwesikkatiramu. Kyokka tukenga nga emize mingi gigabanyizibwa mu ngeri eyeesikkatiramu: ku ludda olumu tukenga nga ebiri mu nda emu wewaawo byawukanamu kyokka ate bifaananamu, ate nga ku ludda olulala tuzuula obutafaananamu, wakkati w'ebiri mu nda ez'enjawulo nga obutafaanagana buno tewali bikula bya wakkati byandikunnalutindowaziza . Obukyusisi obuteesikkatiramu buno bwe butosobozesa okwawula "ebibinja binnabutonde" nga emize emisonjofu era emitebenkevu giri nga *ebirambis*i. Mu

kiseera ky'okulaakulana kwa *Ichthyostegalia* oba *Archaeopteryx* (lup. 777) okwawula ebiramirawabirye n'ebyennyanja oba ebyewalula n'ebinyonyi kwali tekusoboka. Nga ebikula ebinnalujegerewaza enda n'emitegeko egya waggulu bizikkiridde, enjawulo wakkati w'ebibinja nga ebyo esobola okweyongera mu kiseera ky'ebyafaayo bya Nnataka (ger. era ne lup.187)

Translated from: Czihak et al (1976: 813)

Additional annotations are required in those cases in (93)-(213) where no reference has been made to Appendix B.

(220)	*enkompe*	"eye spot" (96)
	kiragala	"chlor" (97)
	-yakirivu	"phaeo-" (100)
	-myufu	"rhodo-" (101)
	akalungu	"phyco-" (105)
	buserago	"selaginella" (123)
	-enkanya	"iso" (125)
	empisi	"hyen-" (128)
	akayongo	"filic-" (130)
	omusota	"ophio-" (132)
	maratti	"maratti" (133)
	olukindu	"cycad-" (136, 137, 139)
	bennetti	"benetti" (138)
	kono	"con(us)" (140)
	-gineti	"gnet-" (144)
	olutiba	"cotyled-" (146,147)

okusembeesa	"carry(flesh)" (151)
okunuuna	"suct-" (154)
ejjindu	"calcar-" (156)
akagulu	'actin-" (157)
mukaaga	"hexa" (157)
-wowongole	"coel-"159)
-beebeetavu	"platy-" (164)
nemerita	"nemert-" (168)
ekinuulo	"onych-" (180)
okuzimbako	"plac-" (191)
ekibebenu	"chondri-"(192)
okulamira wabirye	'to survive on both sides'
ekinyira	'bat-'(203)
obugere obutereevu	'straight legs' (208)
sirena	"sirenia"

VI. COLLABORATION WITH A GROUP OF TEACHERS

VI.1 Introduction

The system of hypothetical terminological elaboration of Luganda I propounded in Chapters IV and V was presented to a group of teachers in collaboration with Research and Development Network (REDENET) at three workshops conducted on the 2nd, 9th and 16th December 1995 at the Faculty of Education, Makerere University.

REDENET was founded in 1990 by a group of eight grassroot-based researchers, animators and trainers in Uganda. The main objective of the founders was to contribute to the survival and affirmation strategies of Ugandan communities by stimulating a spirit of commitment to, and start or strengthen processes of (re)valuation, (re)validation and building upon the indigenous knowledge base which nourishes farming, pastoral, healthcare, language, community, education and value systems.

Using various animative techniques, mostly those rooted in the Ugandan cultural heritage, REDENET promotes the collective investigation, analysis and action on problems and issues of importance in people's daily lives such as food, security, health, the identity crisis moral and emotional socialisation, intercultural learning, content, functions and goals of modern knowledge.

Since 1993 REDENET has worked under the aegis of a registered Non-Governmental Organisation YIGA NG'OKOLA RESOURCE CENTRE for the purpose of executing a

collaborative programme of participatory research and formation of animators.

Seeking collaboration, I asked two questions.
First, would the participants in the workshops appreciate

(a) the PEGITOSCA Criterion
(b) the Periodic System of Conceptual Elements
(c) the Conceptual Calculus
(d) the Principle of Concept Marking
(e) concept marking in English and Luganda
(f) the extrapolation of Luganda expression formation rules
(g) the systems of terminological elaboration of Luganda in physics, chemistry, biology and mathematics?

Second, would the participants apply (a)-(g) above to exercises at the Primary, Secondary and Tertiary levels of formal education?

I hypothesised that the participants would accommodate the system of articulating scientific concepts in Luganda provided that they would have understood the system and its methodological implications.
I pursued, therefore, three objectives:

(a) to administer a pre-workshop attitudinal questionnaire on the role of Luganda in the scientific and technological development of Uganda (see Appendix C)
(b) to familiarise the participants with the system of terminological elaboration as set out in this study

(c) to invite the participants to criticise, improve on and possibly use the system.

The participants were to be drawn from current or former teachers of Mathematics, Physics, Chemistry, Biology, Luganda and Linguistics at Primary, Secondary and Tertiary levels of education. Three workshops were planned to be spread over three consecutive Saturdays and to involve about 20 participants per workshop.

Following discussions between the Project Co-odinator (Mr Edward Mukasa) and the Project Director (K. B. Kiingi) it was decided to hold all three workshops in one venue, namely the Faculty of Education premises at Makerere University. This was intended to cut down on costs, time wastage and afford easy access to facilities for processing and reproducing working documents and learning materials. Another advantage would be to make the Project Director easily accessible for consultation by participants in between workshops as he would stay at a Guest House nearby.

The selection of participants took into account the following considerations: geographical coverage (five districts out of the nine found in the Buganda region), location (rural/urban), subject, special gender balance, level of education (primary/secondary/tertiary), nature of schools (government aided/private), denominational-based/independent, boarding/day and mixed/single gender). Resource persons were

selected for their academic interest and practical efforts as *linguists* in the field of terminological elaboration. They were Dr. Kasalina Matovu (Institute of Languages) and Fred Masagazi (Department of Language Education) both from Makerere University. Lists of the particiants are to be found in Appendix C.

Once funds for the project were secured the Project Co-ordinator decided not to rely on just sending out written invitations (see Appendix C) but to visit in person all the institutions concerned and talk *individually* to the invited particpants. The choice of who to invite was facilitated by all sorts of formal and informal channels: from clan solidarities to religious fraternities, from old boy/girl net works to Parent-Teacher Associations. There was also the snowball effect whereby one participant approached another suggested who could be equally interested and committed to the process.

There were several reasons for going out in person to meet and speak to the participants. First, December is not a particularly ideal month for workshops because attendance can be seriously affected by the examination/marking season, end-of-school year festivities, or the sheer rush of weddings before Christmas, etc.

Second, some institutions observe a strict staff hierarchy which means that before any invitations are responded to, the inviting organisation has to explain in greater detail to the authorities concerned, the scope, value and relevance of the workshop.

Then a decision is taken who to release/nominate or whether to attend at all. Fortunately, there was only one institution which declined our invitation.

Third, but perhaps most important of all, a personal visit to the participants was necessary to establish a pre-workshop rapport for explaining and negotiating the workshop agenda, get them to appreciate their role as people starting out on a process of becoming potential miltipliers, and secure their understanding and agreement to fill in the questionnaire (see Appendix C) which was attached to the invitation.

On the basis of the pre-workshop feedback we changed slightly the workshops design including the agenda because it was too ambitious and would impose a heavy load on the participants. It was decided to divide the participants into two groups. One attended the first workshop on December 2nd (see Appendix C) and the other a second workshop on December 9th (see Appendix C). The groups then came together in a combined and final workshop on December 16th (see Appendix C). The agenda was also divided into a theoretical and a practical phase - the former being covered in the first and second workshops and the latter in the final workshop. Throughout both phases the working language was Luganda. There was no time to present and discuss the findings of the attitudinal questionnaire.

VI.2 Teaching Workshops

The theoretical phase used a lecture format and was conducted in plenary session. The contents of the lecture were outlined in advance, in note form, on newsprint and affixed on the walls of the lecture hall. The following topics formed the agenda:

-PEGITOSCA Criterion

-Periodic System of Conceptual Elements; Conceptual Calculus

-Concept Transformation Rules.

-Marking of Scientific Concepts in European (i.e. mainly Greco-Latin) and in Luganda.

-Extrapolation of Expression Formation Rules in Luganda.

Some time (evidently not enough) was set aside at the end of each topic for comments, questions and discussion with the tone being set by the resource persons, notably Dr. Kasalina Matovu.

On PEGITOSCA Kiingi explained that terminologists differentiate between a term, a concept and an expression. A term is made up of an expression plus the concept.

PEGITOSCA was embraced very well judging by comments in the discussion. Some examples given to demonstrate how it has been applied in practice when coining certain terms; drew criticism from some specalists in Luganda/Linguistics particularly on grounds of transparency and acceptability. But the criticism did not carry the weight of participants' opinions because, it was pointed out, it was founded on an inadequate appreciation of a scientist's *logical* quest either to balance all the elements in the Criterion or to emphasize one at the expense

of all the others if his or her hands were tied, for example, by international conventions.

The Periodic System of Conceptual Elements and the *Conceptual Calculus* as developed by Kiingi were explained with regard to their theoretical roots which were given as logic, metaphysics, philosophy of science, participant role theory and the theory of translation and systematic nomenclature. The purpose is to enable a terminological elaborator to formalise concepts or to look deeper inside them by developing a conceptual taxonomy.

It was explained in response to questions from participants that the determination of which role is more complex than the other is arrived at by looking at the Concept Transformation Rules and working out Conceptual Equations. In the equations letters and symbols are used to stand for conceptual predicates.

Although the participants understood and appreciated the value of Conceptual Calculus as a method or tool for looking further into the structure of concepts and defining roles, it was agreed that it is still a matter of some debate as to how many groups there actually are.

Questions as to why some slots in the table or system are empty led to some heated discussion between the linguists and the scientists whether the Table was not faulty and inadequate because it did not cater for idiomatic and poetic expressions.

In such expressions, many objects or entities to which a scientist would not logically ascribe Will, Desire or Perception are assigned precisely such groups as for example in the case of the sun or plants. Eventually it was agreed that there are valid conceptual reasons to leave such slots empty.

There were two other interesting points that emerged. First some linguists contested the claim that we can at all speak of *forming* concepts in Luganda when these are already in existence as *universal* entities which recognise no language borders. Our task according to these linguists would seem to be one of translation rather than terminological elaboration. The position taken by the overwhelming majority was that it is the *conceptual elements* rather than the concept as such which are universal. Our task therefore is to use the elements to form concepts in Luganda.

The second point was whether in our quest for terminological elaborateness through the use of conceptual calculus we do not run the risk of overlooking the fact that there are limits to how far a language can be formalised. Again here agreement was reached that useful as the *calculus* is, *it is simply a tool to show the elaborator's mind where to look for help in coining words:* it is not intended to replace the natural speaker's intuition.

In order to demonstrate to the participants that they need not be overawed by the sheer number of Greco-Latin affixes and affixoids in the scientific lexicons of European languages, the

contents of Sec.II. 3 were displayed with extensive anglicised exemplification and each participant obtained a copy of the list of 1550 Greco-Latin affixoids (Appendix B). I argued that if some extrapolation of Luganda expression formation rules were to be accepted, then Luganda would not have to regard any language as a dependable mine of specialised expressions to a degree comparable to that of European with respect to Greco-Latin or Kiswahili with respect to Arabic.

Furthemore, and most important, copies of Chapter IV and V were made available to each participant. This measure was meant to facilitate the work in group sessions.

In the practical phase, a learning-by-doing format was used in working groups. Participants were given texts (see Appendix C) – mainly past examination questions at primary, secondary and tertiary level - and asked to translate them, solve the problems and demonstrate in a simulated classroom how they had arrived at the answers. Four groups were formed by the participants. All primary level science and Luganda teachers came together in one Group (A). Mathematicians, physicists, computer scientists and statisticians came together in a combined Group (B and C).

Chemists, Biologists, Geologists and Zoologists came together in yet another Group (D). Linguists and Luganda lecturers also formed a separate Group (E) which mostly critiqued the system

of terminological elaboration and evaluated the three workshops.

Using what they had picked up from the theoretical phase plus their experience as teachers and their intuition as native speakers of Luganda, the participants approached their task in a very systematic way. The exercises were not too hard. What was being tested was their capacity to articulate scientific concepts in Luganda, whether and how far they had accommodated the system of terminological elaboration introduced to them, and whether they felt confident in articulating science in Luganda. On all these accounts the outcome was very impressive.

The task of critiquing the system of terminological elaboration and evaluating the workshops was also carried out by the three Science Groups. All the groups through their chosen spokespersons reported back to the general session.

Before presenting the elicited data from the questionnaire, the answers to the exercises and the group reports, it should be pointed out that of the 43 possible respondents eight (8) of them did not submit or complete the questionnaire. It is also interesting to note that 19, 15 and 9 respondents are employed at the tertiary, secondary and primary levels of education respectively (cf. Lists of Participants in Appendix C).

The following were the responses to the pre-workshop questionnaire. Only responses to Questions 3-21 (Q3-21) are recorded, for the name of the participant and the date of completion of the questionnaire are not relevant to the issue of the questionnaire. The number of responses is in brackets..

Q.3	21-30 years	(10)
	31-40 years	(16)
	41-50 years	(7)
	51-60 years	(1)
	61-70 years	(1)
Q.4	Male	(24)
	Female	(11)
Q.5	Teachers	(31)
	Computer specialist	(2)
	Statistician	(1)
	Geologist	(1)
Q.6	Urban	(22)
	Rural	(12)
Q.7	Secondary	(9)
	Tertiary	(24)
Q.8	Study outside home region: "yes"	(15)
	"no"	(20)
Q.9	Work outside home region: "yes"	(12)
	"no"	(23)
Q.10	Luganda	(33)
	English	(26)
	Others	(8)

Q 11	Was taught science in Luganda	(11)
	Up to primary Two	(2)
	Primary Three	(1)
	Primary Four	(5)
	Primary Six	(1)
	Primary Seven	(1)
Was taught science but not in Luganda		(23)
Q.12	Studied Luganda as a subject:	
	"No"	(10)
	"yes"	(24)
	Primary Leaving	
	Primary Leaving Examination	(12)
	Senior Two	(1)
	Senior Three	(1)
	Uganda Certificate of Education	(6)
	Uganda Advanced Certificate of Education	(4)
	Master of Arts	(1)
Q.13	Luganda	(23)
	English	(13)
	Others	(4)
Q.14	"Yes"	(29)
	Because of communication	(21)
	Because it is the vehicle (medium) of thought	(15)
	"No"	(2)
	Terms are the same everywhere	(1)
Q.15	"Yes"	(24)
	"No"	(11)
Q.16	Primary level	(35)

	Secondary level	(22)
	Tertiary level	(11)
Q.17	"Yes"	(28)
	Historical neglect of local languages	(13)
	Lack of interest	(13)
	Lack of competence	(6)
	"No"	(1)
Q.18	"Yes"	(11)
	"No"	(28)
	Ethnolinguistic conflict in Uganda	(22)
	Only English can be a medium for science and technology	(5)
	English is an international language	(1)
	Luganda is difficult	(3)
Q.19	"Yes"	(31)
	Advantage	
	Better understanding of science and technology	(26)
	Disadvantages	
	A lot of preparatory work	(1)
	Monolingual school intakes in a multilingual society	(7)
	Bad translation into Luganda	(1)
	No Luganda books in science and technology	(2)
	Switching to English as a medium of instruction (after Primary Four)	(1)
	"No"	(7)
Q.20	"Yes"	(27)
	"No"	(1)
	"Perhaps"	(5)

Q.21	"No"	(35)
	English is the official language in Uganda	(3)
	English is international	(19)
	English nourishes Luganda	(7)
	English has a lot of scientific literature	(6)

The answers to the problems and the group reports (see Appendix C) were produced within a period of less than 1 1/2 hours; consequently, they were submitted to us before they could be rendered into a neater form.

If the responses to Q. 16 and Q. 20 of the questionnaire are considered in conjunction with the answer to the problems and the group reports, a very interesting attitudinal change comes into focus. This is borne out by translated and edited extracts from the group reports. Let us consider the extracts below.

Ground A (Primary level Science/Mathematics
Rapporteur-Mohammed Kaboggoza

> *The workshops have demonstrated that it is possible to teach science and mathematics effectively and creatively in Luganda.*
>
> *The workshop has enabled us to overcome the lack of confidence in our language as a medium with a capacity comparable to that of foreign (European) languages in conveying scientific knowledge.*
>
> *The time has been too short to cover everything we wanted.*

The level, pace and examples used in the theoretical work were rather too high for primary level teachers.

Group B (Mathematics and Physics Secondary/Tertiary)
Rapporteur: Pauline Ndwadde

The invitation to the workshop did not give us sufficient time to prepare ourselves for effective participation. The choice of venue, transport arrangement and our reception and welfare have all been excellently catered for.

We have learnt a lot in the workshops but the time was not enough. The course (project) Director was good and displayed a remarkable mastery of his subject.

Most of the content taught in the workshop was new but very attractive to us. The working documents given to us are invaluable and much appreciated.

We suggest that similar workshops in the future be of a longer duration and more time be allocated for discussion and practical work. We need more examples of translated texts.

The way forward should be to organise more intensive workshops for us, the first participants as a core group. We would then become the multipliers to diffuse this knowledge into not only our institutions but also to others within our reach. But if we are to be effective multipliers, the issue of providing some initial financial support needs to be addressed.

D (Group Chemistry and Biology: Secondary and Tertiary)
Rapporteur: Petronella Nakitolo

Time pressure did not allow for comprehensive coverage of the agenda. The course Director was very good but due to lack of time he tended to skip some points.

Nevertheless, the workshops have been good and whatever we have learnt here is useful and necessary.

We would welcome the opportunity to learn and do more of the same.

Future workshops should cover the same contents more intensively but also provide for more grounding in the Luganda language.

Group E: (Luganda/Linguistics – Makerere University)
Rapporteur: Zinunula Vincent

We came into these workshops with the expectation of learning about the system of terminological elaboration and the marking of scientific concepts in Luganda. We knew very little about PEGITOSCA and so we wanted to gain more knowledge about it, its application and its present status. We also wanted to satisfy ourselves whether it is really possible for science to be taught in Luganda from primary to tertiary levels.

On the whole we have gained the following from these workshops:

(1) We now understand PEGITOSCA very well.

(2) Its usefulness extends beyond concept formation to translation, interpretation and word borrowing.

(3) The system of terminological elaboration make possible the teaching of science and technological education in Luganda.

(4) Utilising the criterion of generativity, Kiingi has made a positive contribution to the development of

Luganda by showing that concepts can be built on nouns instead of verbs only.

On the critical side we feel that though Kiingi has made his presentations very effectively, he has tended to be rather intolerant of our criticism. We commend Mukasa's moderating role which has facilitated the exchanges between us and Kiingi to be productive. We wish to reiterate the point that some of the terms coined by Kiingi are not transparent enough, while there are some indigenous terms which he has inexplicaby left out although in our opinion they fulfill the PEGITOSCA criterion.

Some of the terms which have been coined seem better suited for conceptualisation of science at a higher level than at the primary level. That leaves a gap which needs to be addressed with regard to simplification and transparency.

The thinking that scientists should take the lead in terminological elaboration and linguists should only give advice and be consulted is problematic because quite often the two do not talk the same language. Nevertheless the workshops here have shown it is possible and we are grateful for the opportunity to have been invited.

We would like to conclude by recommending the following:

(1) Kiingi's work deserves the highest academic honours.

(2) There is a need to create simplified scientific terminology suitable for use in primary level science.

(3) Future workshops should be more intensive but not rushed.

(4) Dr. Kiingi should collaborate more closely with the Institute of Languages at Makerere.

Since there was no time to discuss the findings of the questionnaire I cannot exactly characterise (with documentary evidence) the attitudinal change which certainly occurred in the course of the workshops. However, during my informal discussions after the third workshop, it transpired that all the participants held the view that Luganda would or could be a medium of scientific and technological discourse even at the tertiary level of formal education.

Groups A, B/C and D complained about insufficient time in view of the agenda of the workshops. That I considered all levels of education entailed a relatively heavy load on the primary school teachers. Unlike Group D, Group B/C advanced more translated texts probably because nomenclatural systems in mathematics and physics are not as pronouncedly systematic as those in chemistry and biology. Consequently, they would need more extensive and intensive exemplification before gaining considerable confidence in the articulation of mathematics and physics in Luganda. In the light of my massive application of extrapolated, expression formation rules to biological nomenclature, Group D felt that grounding in the Luganda language was in fact imperative. This sentiment strengthens my contention that the task of elaborating the scientific lexicon of any language should ideally be in the province of the scientists themselves. Once they have been adequately exposed to the linguistic structure of their language

and to that of prompting languages such as English, German, French, Russian, Japanese, Greek and Latin, they hardly need any assistance of professional linguists or language specialists. Group E echoes the same problem of bringing scientists and linguists together with a view of term planning and generation.

Group E explicity approves of the extrapolation to generate verbs from nominal stems. Generation of verbs from nouns is becoming a commonplace particularly in scientific Kiswahili. Here are some examples taken from TUKI 1990.

(1) *ku + sumaku +ish+a → kusumakisha*
'magnet' 'magnetise'

ku + sumaku + u + a → kusumakua
'demagnetise'

ku + oksidi +ish +a → kuoksidisha
'oxide' 'oxidise'

u + oksidi + ish + aji → uoksidishaji
'oxidation'

u + rutuba + ish + aji → urutubishaji
'fertility' 'fertilisation'

i + li + yo + kwanta + ish + w + a→ iliyokwantishwa
'quantised'

During the workshops I proposed that not only *–wal* (already in Present-day Luganda) but also *–wIr, -(a) GAn, -wUk, -wUl* and their acceptable compounds be used in order to generate verbs

from nominal stems. The participants received my coinage for *desalination plant*. Ger. *Entsalzungsanlage* with keen interest. The concept was fairly alien to them probably because Lake Victoria (Lgd. *Nnalubaale*) has fresh water! The scientists did not meet with any difficulty in the informal explication of the concept.

The process of coining a Luganda equivalent of desalination plant afforded me the best opportunity of demonstrating how powerful my theory of scientific terminology is. For the sake of exposition, I took steps shown in (2)–(6).

(2a) The water is salty.

M h Q

(3a) The salty water becomes fresh.

(M h Q) v (M h Q′)

(4a) The plant desalinates the water.

R c ((M H Q) v (M h Q′))

(5a) A human agent uses the plant to desalinate the water.

Hc (R c ((M h Q) v (M h Q′)))

(6a) H c (R c ((M h Q) v(M h Q′))) $\vdash$ Q_oR h Q_o $\vdash$ R(Q_oo) h

Proceeding to conceptual marking , I obtain

(2b) *-nnamunnyo*

(3b) *-nnamunyowok-*

(4b) *-nnamunnyowos-*

(5b) *-nnamunnyowoses-*

(6b) *ekinnamunnyowoseso*

I note that the prompting effect in (7) is a welcome side-issue

(7)

English	German	Luganda
salt	Salz	omunnyo
salty, saline	salzig	nnamunnyo
to desalinate itself)	sich entsalzen	-nnamunnyowok-
to desalinate something	entsalzen	-nnamunnyowos-
to desalinate with	entsalzen mit	nnamunnyowoses-
plant	anlage	eki-…-o
desalination plant	entsalzungsanlage	ekinnamunnyowoseso

If, on the other hand , I were to conceptually focus on the place of the desalination process, I would arrive at mutatis mutandis

(4c) A human agent desalinates the water.

Hc((M h Q) v (M h Q))

(5c) The human agent desalinates the water at a place.

(Hc((MhQ) v (Mh Q)))m L

(6c) $\underline{[Hc[[\ M\ h\ Q]\ v\ [M\ h\ Q']]]\ mL \vdash\ Q_O}$

$L\ h\ Q_O \vdash L\ [Q_o\ o]h$

Again proceeding to conceptual marking, I obtain

(5d) *-nnamunnyowoser-*

(6d) *ekinnamunnyowosero*

Four objections were voiced against my coinage. The first objection related to the infracriterion of antecedence (cf. the PEGETOSCA Criterion). "Don't or didn't we have something similar to this in our language?" asked one participant.

I pleaded ignorance stressing notwithstanding that the concepts which go into "desalination plant" or *Entsalzungsanlage* were already familiar to them. Secondly, they objected to the "unbearable" length of the coinage. I rejoined that my coinage was optimally long, and that I was eschewing a circumlocutory rendition. Thirdly, "Is deslination not international?" was implicitly urging me to lugandise the putatively international English term. I explained the historical fact that German scientists were not necessarily compelled to germanise English terms (at least not on as large a scale as the participants thought). However, German, French and English drew and still draw on a common lexical mine Greco-Latin for their terminologies. For example, the terms F. *chlorure de calcium* and Ger. *Kalziumchlorid* can hardly be assumed to be adoptions from English.

At any rate, as the German shows, even Eurocentric internationalily was not binding. The most vehement objection was lodged against the artificiality (Lgd. *obugingirire* (E. "concoction")) of my coinage. Granted, the scientific Luganda I am developing entails somewhat contrived expressions as those in (8)

(8)	*eminzaani wakka*	"ultramicrobalance"
	kannajjululwabbugumu	"thermodynamics"
	Ekyazinnabugulumukaaga	"Hexactinellida"
	embiro ssukkaddoboozi	"supersonic speed"

But I invent expressions if and only if internationality is not mandatory, I find no suitably economical and precise expression in Present-day Luganda, and I am not inclined to lugandise the English expression. I did not plead with the participants to accept my coinage but, rather, to accommodate it for at least a while. Furthermore, on realising that they did not deem the English and neo-Latin terms in (8) to be artificial or concocted (Lgd. *bigingirire*), I digressed into the articulation of extremely large cardinal numbers.

(9)	English (USA)	German	(Proposed) Luganda
	10^{1} ten	*zehn*	*(e)kkumi*
	10^{2} hundred	*hundert*	*(e)kikumi*
	10^{3} thousand	*tausend*	*(o)lukumi*
	10^{6} million	*Million*	*(a)kakadde*
	10^{9} billion	*Milliarde*	*wakkadde*
	10^{12} trillion	*Billion*	*wakikadde*
	10^{15}quadrillion	*Billiarde*	*walukadde*
	10^{18} quintillion	*Trillion*	*wakakadde*
	10^{21}		*nnakkadde*
	10^{24}	*Quadrillion*	*nnakikadde*
	10^{27}		*nnalukadde*
	10^{30}	*Quinquillion*	*nnakakadde*
	10^{33}		*ssekkadde*
	10^{36}	*Sextillion*	*ssekikadde*
	10^{39}		*sserukadde*
	10^{42}	*Septillion*	*ssekakadde*
	10^{45}		*(a)kawumbu*

10^{48}	*Oktillion*	*waggumbu*
10^{51}		*wakiwumbu*
10^{54}	*Nonillion*	*waluwumbu*
10^{57}		*wakawumbu*
10^{60}	*Dezillion*	*nnaggumbu*
10^{63}		*nnakiwumbu*
10^{66}		*nnakawumbu*
10^{69}		*sseggumbu*
10^{72}		*ssekiwumbu*
10^{75}		*sseruwumbu*
10^{78}		*ssekawumbu*
10^{81}		*(a)katiiriitu*
10^{84}		*wattiiriitu*
10^{87}		*wakitiiriitu*
10^{90}		*walutiiriitu*
10^{93}		*wakatiiriitu*
10^{96}		*nnattiriitu*
10^{99}		*nnakitiiriitu*
10^{100}	*Googol*	
10^{102}		*nnalutiiriitu*
10^{105}		*nnakatiiriitu*
10^{108}		*ssettiiriitu*
10^{111}		*ssekitiiriitu*
10^{114}		*sserutiiriitu*
10^{117}		*ssekatiiriitu*

They made four observations. Firstly, American usage is inconsistent with German usage. Secondly, from 10^{18} *Trillion*,

German usage progresses with a geometric ratio of 10^6. Thirdly, the *Googol* 10^{100} is somewhat misplaced. Fourthly, my proposal is the most elaborate and systematic of the three "concoctions".

Due to pressure of time our exchanges with the linguists (who, to put it modestly, were at a conceptual disadvantage vis-à-vis the scientists) bordered, at times, on acrimony. But we never lost sight of our common academic goal of probing into the scientific lexicon of Luganda. In this spirit we pleaded for the juxtaposition of expressions for the users to decide on which to adopt. For instance, we suggested that *ssemasomero* be adopted, although we knew that the word *yunivaasite* is the only one used for "university" even in theses written in Luganda. Transparency is taken care of as (10) shows

(10) *sse* + *masomero* → *ssemasomero"*

"the school of schools"

It has to be conceded, though, that *yunivaasite* enjoys historical precedence of acceptability.

Before discussing the performance of the participants, it is proper to present lists of terms for key concepts in the exercises. The lists were drawn up before administering the exercises; they were not shown to the participants prior to the exercises.

(11) Group A Questions

Q.1 *ennamba* "number'

omugobereragano "sequence"

Q.2 *-merengul-* "solve"

Q.3 *olulyebulo* "diagram"

-lyebul- "divide down the middle'

nnassegeragana "parallel"

nna + li + seger + agana + a

-seger- "be at each other's side'

Q.4 *-yasanguliz- mu* "express in terms'

Q.5 *obwandiba* "probability"

Q.6 *-ddiriŋŋan-, -ddiriragan-* "consecutive"

ekyenkano 'equation'

-enkan- 'be equal to'

Q.7 *-lojj-, -ttottol-* 'describe'

eddoboozi 'sound'

ebbanga eryereere 'empty space, vacuum'

Q.8 *ekisiikirize* 'shadow'

okuwuguka 'refraction'

okusiikirizibwa 'eclipse'

Q.9 *endwadde* 'disease'

Q.10 *olugongo* 'backbone'

-gongo + wok + u – gongowofu 'invertebrate'

(12) Group B Questions

Q.1 *akagugubi* 'surd'

-zuul- 'determine'

-omuwendo 'value'

Q.2 *ekikongozzi* 'vector

obuwanvu 'length'

Q.3	*omuziziko*	'axis'
	ekiwandukululo	'graph'
	omusittale	'line'
	akatonnyeze k'okusalagana	'point of intersection'
	ekikonjoboleko	'intercept'
Q.4	*-nsondassat*	'triangle'
Q.5	*-viis-*	'derive'
	ettu ly'omulabba	'quadratic formula'
Q.6	*eddaala kikulakimu*	'uniform ladder'
	obuzito	'weight'
	omuwendoganye	'coefficient'
	obukuubi	'friction'
	-seerer-	'slip'
	-weweevu	'smooth'
Q.7	*-lag-*	'show'
	ebitakyuka wawu	'real constants'
	omwawulo gwa y nga gufa ku x	'differential coefficient of y with respect to x'

(10) Group C Questions

Q.1	*akagulu*	'ray'
	-a kyenvu	'yelow'
	-tomer-	'be incident. knock into'
	empulizima ya ggiraasi	'glass prism'
	-nnansondassatu	'triangular'
	-enkanyanjuyi	'equilateral'
	-bal-	'calculate'
	ensonda ezirambiddwa	'angles marked'
	-yasanguz-	'state'

	-nnyonnyol-	'explain'
	-keng-	'observe
	ekitangaala ekyeru	'white light'
Q.2	*-zimawaz-*	'verify'
	amazima	'truth'
Q.3	*etteeka lya Ohm*	'Ohm's law'

(11) Group D Questions

Q.1	*okufuufuwazibwa*	"pollination"
	enfuufu	"dust"
	ekibumbujjo	'process'
Q.2	*-w-*	'give'
	obutegeke bw'embogo	'taxonomy of the buffalo'
Q.3	*ekigezeso*	'experiment'
	obukyukirirakitangaala	'phototropism'
	okutangaalawirira	'phototropism'

Q.2 4 cf. Sec IV.2 and V.2

Group A attempted Q.1, 2 and 7. The rapporteur's verbalisation in Q.1 and 2 was, in my view, impeccable.

Group B/C attempted Q.1 4(B) and Q.1(C). In Q.1 (B) the group skirted round the concept of a surd. But it came up with *–wendowaz-* for 'determine the value'. In Q.4(B) *ddiguli* should be the plural form of *ddiguli*. There was a slight hitch with *ensonda entobeke* 'alternate angles'. and *ensonda ezikiriziganya* 'corresponding angles. The subjunctive form *leka ABC ebeere* belongs here. In Q.1(C) *ekifaananyi* 'picture'

is not quite precise. *Nnamutole omutangaavu* for 'prism' and *akamenyero* for 'refractive index' are quite off target.

Group D resorted to my biological affixes without being cued to do so. Indubitably, Group D assimilated the proposed affixes.

I now bring this Section to an end by arguing for the position that all along I was seeking the participants' accommodation (rather than their acceptance) of my proposed systems for the terminological modernisation of Luganda. My PEGITOSCA–based argument necessitates prior further particularisation of the PEGITOSCA Criterion in (15)

(15) $$\tau = \phi\,(P, E, G, I, T, O, S, C) + \psi\,(p, r, e, s, c, l, a, s^*, a^*)$$

where the terminologicality τ depends on the appropriateness ϕ and acceptability ψ of an expression. I define precision (P), purpose (p), receptor characteristics (r), linguistic usage (l) as the primary subcriterion and infracriteria. Next I define economy (E), generativity (G), global internationality (I) systemicity (S) consistency (C) and antecedence (a) as the secondary subcriteria and infracriterion. Thirdly, I define transparency (T), non-obscenity (O), ecology (e), social system

(s) cultural system (c), style (s*) and speech-act (a*) as the tertiary subcriteria and infracriteria. Finally, I reproduce the weighting of the subcriteria and infracriteria according to

Table 5.

TABLE 5

PEGITOSCA WEIGHTING

Primary 3	Secondary 2	Tertiary 1
P	E	T
p	G	O
r	I	e
l	S	s
	C	c
	a	s*
		a*

I take the controversial rendition of "x-ray" into Luganda as an example. (16a) is the popular adoption while (16b) is my systematic rendition of a concept cluster including "x-ray."

(16a) "x-ray" *ekisire*

(16b) "x-ray" *akagulu* –x

"α-ray" *akagulu*-α

"β -ray" *akagulu*-β

"ȣ-ray" *akagulu*-ȣ

"light rays" *obugulu bw'ekitangaala*

In popular parlance, *ekisire* is unobjectionable. However, in scientific parlance, I set p = -3, G = -2, S - 2, a = + 2; hence, p + G + S + a = -5. I, therefore, accept or reject *ekisire* depending on the context. I would certainly accept it even in scientific parlance, if I were inclined to use the expressions in (17) as terms.

(17) *alfare* "α-ray"
betare "β-ray"
gammare "ɣ-ray"

An individual term or a system of terms may be

(a) appropriate and unacceptable
(b) inappropriate and acceptable
(c) inappropriate and unacceptable
(d) appropriate and acceptable

Since I was proposing what I held to be appropriate and acceptable, i.e. terminological, my role in the interaction with the participants was to teach them the ϕ-function and plead for their accommodation of my proposals.

VI.3 Writing Workshops

From May 27 to June 01, 1996, from 27 to 31 January 1997, and again from October 17 to 25, 1997, I directed additional workshops in collaboration with REDENET at the Faculty of Education, Makerere University. I pursued two main objectives, namely, to consolidate the work done with the same

participants at the earlier workshops and to embark on writing a bidirectional English Luganda dictionary of natural science (i.e. Physics, chemistry and biology) and mathematics for primary and secondary school teachers.

At that junction I had to find an empirically satisfactory answer to the question: "Who should spearhead the actual dictionary writing - the teachers of science and/or mathematics, or the linguists amongst the participants or, rather, should it be a joint effort of the teachers of science and/or mathematics and the linguists from the Institute of Languages and the Department of Language Education, Makerere University?"

In conformity with my contention that the task of elaborating the scientific and mathematical lexicon of any language should ideally be in the province of the scientists and mathematicians themselves, I hypothesised that if all the participants were exposed to Luganda word formation and my extrapolations of it, then the science and mathematics teachers would become more resourceful in the terminological elaboration of Luganda in science and mathematics than their Luganda specialised colleagues.

In 30 hours of consolidation of aspects of Luganda word formation previously treated at the December 1995 workshops I argued and pleaded for further extrapolative moves.

At the December 1995 workshops we had secured the explicit approval of the Luganda-specialised participants of the extrapolation of the suffixes in (18) to form verbs from nominal and adjectival stems

(18) *-w + Ir → -wIr*

-w + Ul → -wUl

-w + Ik → -wIk

-w + an → -wan

At the May/June 1996 workshop I argued that the adjectivising affix – *nna-* as in (19) should be assigned more load so as to enable adjectivisation of nouns

(19) *-nna + kampala→ -nnakampala* 'Kampalan'

-nna + kenya→ -nnakenya 'Kenyan'

-nna + ddiini→ -nnaddiini 'religion' 'religious

The extrapolative move involving *-nna* makes it possible to coin Luganda terms for, say, *humanisation, reification, deification, privatisation* as in (20)

(20) N(*obu* + V(Adj(*nna* + N(*muntu*) N)Adj + *wal* + *y*) V+ *i*)N→ 'human" *obunnamuntuwazi* 'humanisation'

N(*obu* + V(Adj(*nna* + N(*kintu*)N) Adj + *wal* + *y*) V + *i*)N→ 'thing' *obunnakintuwazi* 'Lat.'res' 'reification'

N(*obu* + V(Adj(*nna* + N(*katonda*)N)Adj + *wal* + *y*/V + *i*)N→ 'god' *obunnakatondawazi* Lat.'deus' 'deification'

N(*obu* + V(Adj(*nna* +N(*nnyini*)N)Adj +*wal* + *y*)V + *i)*N→

'owner' *obunnannyiniwazi*

'privatisation'

N(*ka* +Adj(*nna* +(*kubala)* N)Adj)N→*kannakubala*

'counting' 'mathematics'

'mathematician'

Well-meaning sceptics were reminded of their own aversion to *pulayivatayizesoni, disentulalayizesoni* and *modanayizesoni as* lugandanisations of 'privatisation', 'decentralisation', and 'modernisation' which are current terms in Ugandan public debate. Their sceptical attitude was assuaged by drawing their attention to a very recent Kiswahili response to the necessity of articulating the concept of privatisation in (21)

(21) N(*u* + V(Adv(*bi* + N(*nafsi*)N+)Adv + *sh)*V + *aji)*N→

'self' *ubinafsishaji*

I then coined Luganda terms for 'decentralisation'and 'modernisation' as is shown in (22)

(22a) N(*obu* + V(Adj(*nna* + N(*ntabiro*)N)Adj + *wul* + *ul*)

V + *i)*N→

'centre'

obunnantabirowuluzi

(22b) N(*obu* + V(Adj(*nna* + N(*mulembe*)N(Adj + *wal* + *y*)

V + *i*)N→

'modernity'

obunnamulembewazi

Their accommodation of (22a) amounted to tacit accommodation of the recursive nature of our extrapolated expression formation rules as is shown in (23) including a German example (23d).

(23a) N(*n* + V(*tab*)V + *o*)N → *ntabiro*

'joint at' → 'centre'

(23b) N(*li* + V(*gunj*)V + *o*)N → *ggunjo*

'institute' 'institute'

(23c) N(*obu* + V(Adj(*gunjo*) Adj + *wal* + *y*)V + *i*)N→

'institutional'

obugunjowazi

'institutionalisation'

(23d) N(V(*ver* + Adj (N(N(V(*wissen)*V)N + *schaft*)

'to know' 'knowledge''science'

N + *lich*) Adj +)V + *ung*)N→

verwissenschaftlichung

'scientification'

(23e) N(*ka* + (*nna* + N(*kumanya*)N) Adj)N→*kannakumanya*

'knowledge' 'science'

'scientist'

(23f) N(*eki* + V(Adj(V(*sal*)V + *o*) Adj + *wal* + *y*)V + *o*)N→cut

ekisalowazo

'definition'

Without losing sight of the fact that scientists were at a linguistic disadvantage vis-a-vis the linguists just as in the same

breath linguists were at a conceptual disadvantage vis-a-vis the scientists, I went ahead to administer the following assessment test "Final Test on the Articulation of Scientific Concepts in Luganda" to the participants after exposing them to Luganda expression formation for the 30 hours.

RESEARCH AND DEVELOPMENT NETWORK

30th May, 1996

EBIBUUZO NSALESALE KU NJASANGUZA Y'EBITEGEERO BYA KANNAKUMANYA MU LUGANDA

1. Yatuukiriza obuwakatirwa obweyambisibwa mu Luganda okwasanguza ebirojja ebiri mu bisumuluzo by'ebitegeero bino wammanga:

(a) π_1 h π_2

(b) π_1 j π_2

(c) π_1 v π_2

(d) π_1 g π_2

(e) π_1 s π_2

(f) π_1 m π_2

(g) π_1 i C

(h) π_1 q C

(i) π a π

(j) (π_1 a π_2) j (π_2 a π_1)

(k) (π_1 a π_2) $\vdash$ (π_2 a$^-$ π_1)

(l) π_1 v π_2

(m) π c (π_1 c π_2)

(n) π_1 c((π_2 h Q) v(π_2 h Q')

(o) π f C

(p) π_1 p $\pi_2 \vdash \pi_2$ p$^-$ π_1

(q) π_2 g π_1

(r) π_1 e π_2]m π

2 (a) Wandiika ebikolwa kkumi (10) nga biva mu kuwanvuya ekikolwa *-kwat-*

2 (b) Viisa C ne Q mu *-tuukitir-*

3 Teeka amannya gano wammanga mu mbu zaago:

"*Lubuga, omulyango, enkula, omuseetwe*
Omumisiri, omusiri, ssiringi amakulu

amalusu,	*amaddu,*	*ebbavu,*	*emmindi*
akeediimo,	*eggwiso,*	*eggwiiso,*	*akatale*
ettegula,	*akawungeezi,*	*evvu,*	*ebbaluwa*
gonja,	*omugonja,*	*lumonde,*	*kawo*
evvivi,	*effirimbi,*	*bulangiti,*	*ebbwa*
emmundu,	*essuula,*	*ewuzi,*	*erangi*
wiiki,	*nsotoka,*	*enku,*	*enkonko,*
			obuto
obutwa,	*entambi,*	*obulo,*	*eccupa"*

4 Laga obuwakatirwa n'enduli ebiri mu bigambo mu kibuuzo Ekyokusatu (3).

5 Yiiya oba zuula ebigambo ebigondera PEGITOSCA mu Luganda ebitegeeza bino eby'Olungereza:
"stylistics, literature, desertify, devocalise, denazify, Bureau de Change, legalise, thyroid, graphisation, nasalisation, computerisation, nominalisation"

Translation of the Test

Q.1 "Name the affixes which are employed in Luganda to articulate the bonds in the following conceptual formulae" sought to elicit their understanding of the bridge from a concept to an expression.

Q.2 (a) "Write down ten (10) extensions of the verb *–kwat-* 'touch'" and

Q.2 (b) "Derive C and Q from *–tuukirir-* 'occur, happen, be completed/achieved, be perfect' sought to test Luganda word formation.

Q.3 "Classify the following nouns" was meant to test awareness of the Luganda nominal class system.
Q.4 "Show the affixes and stems of the words in Q.3" was meant to test the ability to segment Luganda nouns.

Q.5 "Coin or find Luganda equivalents for the following English terms in conformity with the PEGITOSCA Criterion" would be the threshold in terms of our extrapolated expression formation.

The three-hour test was done in five groups. Each group handed in one set of answers. On a scoring scale ranging from 1 ("very good") to 5 ("very weak") the results of the test were as follows:

	Q.1	Q.2	Q.3	Q.4	Q.5	Average
Group A	5	3	2	4	2	3, 2 (3)
Group B	5	2	3	5	2	3, 4 (3)
Group C	5	1	2	5	2	3, 0 (3)
Group D	5	1	1	3	4	2, 8 (3)
Group E	3	1	1	1	2	1, 6 (2)
Average	4, 6 (5)	1, 6 (2)	1, 8 (2)	3, 6 (4)	2, 4 (2)	

Questions 2, 3 and 4 were very well answered by the linguists (who formed Group E) most probably because that is their academic province. But Q.2 and Q.3 were scored quite well by the scientists which proves that it is possible to strengthen them linguistically. Q.1 exposes a weakness in linking conceptual formalisation with expressional formation. Q.4 reveals that the scientists are still weak in linguistic analysis; but Q.5 suggests that they have attained some kind of parity with linguists. My coinages in (24) were discussed in terms of the PEGITOSCA Criterion.

(24a) *ngeri* 'way(s)'

N(ka + Adj(*nna* + N(*ngeri*)N)Adj)N→*kannangeri*

'stylistics'

(24b) *biwandiiko* 'written things'

N(ka + Adj(*nna* + N(*biwandiiko*)N)Adj)N→*kannabiwandiiko*

'literature'

(24c) *ddungu* 'desert'

V(NS(*lungu)*NS + *wal* + *y*)V→*lunguwaz*

'desertify'

(24d) *ddoboozi* 'voice'

V(NS(*loboozi)*NS + *wul* + *ul*)V→*lobooziwulul*

'devocalise'

(24e) *-waanyis-* 'exchange'

(li + V(V(*waanyis*)V + ir + y)V + o)N→*ggwaanyisizo*

'Bureau de Exchange'

(24f) *mateeka* 'laws'

V(Adj(*nna* + N(*mateeka*)N)Adj + wal + y)V→

nnamateekawaz

'legalise'

(24g) *ngabo* 'shield'

(V)NS(*gabo*)NS + *wal)*V + *u*)Adj→*gabowavu*

'thyroid'

(24h*)* *nnukuta* 'letter'

okunukutawazibwa 'graphisation'

(24i) *nnyindo* 'nose'

'okuyindowaza 'nasalisation'

(24j) *okukompyutawaza* 'computerisation'

(24k) *linnya* 'name'

okunnalinnyawaza 'nominalisation'

(24l) *-naziwulul-* 'denazify'

If the period of exposure to Luganda word formation had been, say, 120 hours and more specialised concepts had been selected for articulation in Luganda, then most certainly the scientists would have outdistanced the linguists.

At the January 1997 workshop we turned to issues of lexicography. After reviewing the Principle of Concept Marking , I introduced the participants to problems of Bantu lexicography.

The participants agreed on writing a bidirectional English-Luganda dictionary of school science and mathematics for teachers, thus holding back a monolingual one for a later date.

In order to ensure reasonable comprehensiveness of the dictionary (50,000 entries) the projected dictionary would not include information on spelling, syllabification, pronunciation, etymology, usage and grammar.

The projected dictionary will be in three parts. Part I will be conceptually arranged with the entries being alphanumerically coded. Part II will contain the already alphanumerically coded English entries arranged alphabetically. Similarly in Part III the already alphanumerically coded Luganda entries will be arranged alphabetically.

The participants argued quite convincingly that this dictionary design will promote their conceptualisation in Luganda and also make the process of learning of specialised terminology in Luganda much easier.

It is clear that obtaining Luganda equivalents for English terms has to be preceded by formation of conceptual sets. There are three interrelated steps of arriving at conceptual sets.

First, I can proceed by the conventional branches of the discipline. For mathematics these could include (25).

(25) mathematics *(kannakubala)*
algebra *(aljebra)*
arithmetic *(kannambala)*

geometry	*(kannankoloboze)*
calculus	*(embala)*
probability theory	*(omutetenkanyirizo gw'obwandiba)*
set theory	*(omutetenkanyirizo gw'ebikuukuulu)*
statistics	*(kalojjabungi)*
mathematical logic	*(kannansonga omunnakubala)*
topology	*(kannabifo)*
trigonometry	*(kannansondassatu)*
number theory	*(omutetenkanyirizo gw'ennamba)*

On the basis of the conventional branches of the discipline I can easily be led to fairly well-defined conceptual clusters as in (26) for mathematics.

(26)

numbers	*(ennamba)*
angles	*(ensonda)*
triangles	*(zinnasondassatu)*
logarithms	*(olugabiro)*
circles	*(enkulungo)*
areas	*(ebibangirizi)*
mathematical reasoning	*(ensongawaza mu kannakubala)*
functions	*(emikolo)*
coordinate systems	*(emiyungo ginnabifowanyo)*
series	*(ennindi)*
conic sections	*(ensalemu zinnalusogo)*
equations	*(ebyenkano)*

mathematical theories	*(emitetenkanyirizo mu kannakubala)*
groups	*(ebibinja)*
formulae	*(ebisumuluzo)*
integrals	*(emigattiriro)*
operations	*(ebikolwako)*
tests	*(ebigezesa)*
theorems	*(ebikakase)*
probability	*(obwandiba)*
curves	*(engote)*
points	*(obutonyeze)*
mathematical symbols	*(obubonero mu kannakubala)*
polygons	*(zinsondannyingi)*
expressions	*(ebyogero)*
samples	*(endegako)*
vectors	*(ebikongozi)*
matrices	*(omuzaazi)*
sets	*(ebikuukuulu)*
transformations	*(ebikyuko)*
rules	*(ebifuga)*
mapping	*(emmapuwaza)*
graphs	*(empandiikiriro)*

Taking equations and angles as conceptual clusters I could exhibit a fragment of part 1 of the dictionary as in (27)

(27) NA 000 angle *nsonda(e-)*

NA 001 central angle *nsonda(e) nnantabiro*

NA 002	straight angle	*nsonda(e-) engolokofu*
NA 003	inscribed angle	*nsonda(e-) empandiikemu*
NA 004	vertical angle	*nsonda(e-) y'obulanga*
NA 005	negative angle	*nsonda(e-) eŋŋaanyi*
NA 006	acute angle	*nsonda(e-) ensongovu*
NA 007	obtuse angle	*nsonda(e-) enfufuggavu*
NA 008	right angle	*nsonda(e) ennesimbu*
NA 009	plane angle	*nsonda(e-) nnamuseetwe*
NA 010	solid angle	*nsonda(e-) eŋŋumu*
NA 011	degree	*digri*
NA 012	radian	*sekagulu*
NA 013	steradian	*ssempulubavu*
NA 014	equal angles	*nsonda(e-) ezenkana*
NA 015	alternate angle	*nsonda(e-) entobeke*
NA 016	corresponding angle	*nsonda(e-) ezikkiriziganya*
NA 017	supplementary angle	*nsonda(e-) enzitaanyi*
NA 018	subtend	*-bojj-*
NA 019	exterior angle	*nsonda(e-) ey'ebweru*
NA 020	triangle	*nsondassatu(e-)*
NA 021	polygon	*nsondannyingi(e-)*
NA 022	angle in a semicircle	*nsonda(e-) mu kyakubiri kyenkulungo*
NA 023	angle between two lines	*nsonda(e-) wakati w'enkoloboze ebbiri*
NA 024	angle between two planes	*nsonda(e-) wakati w'emiseetwe ebbiri*

NA 025 angle from one line to another *nsonda(e-)okuva ku lukoloboze olumu okugenda ku lulala*

NA 026 angle of intersection of curves *nsonda(-e-)z'obusalaganiro bw'engote*

NA 027 angle at the circumference *nsonda(e-) ku lubugirizo*

NA 028 angle of contact *nsonda(e-) y'okwekuusaako*

NA 029 angle of elevation *nsonda(e-) y'obuyimufu*

NA 030 angle of inclination *nsonda(-e) y'obwesigami*

NB 000 equation *kyenkano(e-)*

NB 001 quadratic equation *kyenkano(e-) kinnamulabba*

NB 002 linear equation *kyenkano (e-)kinnalukoloboze*

NB 003 simultaneous equation *kyenkano(e-) kinnalumu*

NB 004 conditional equation *kyenkano(e-) kinnakakalu*

NB 005 identity *kyenkanonkano(e-)*

Nb 006 solution *kimerengulo(e-)*

NB 007 root of an equation *kikolo(e-) ky'ekyenkano*

NB 008 variable *kikyuka(e-)*

NB 009 dependent variable *kikyuka(e-) ekyesigama*

NB 010 independent variable *kikyuka(e-) ekiteesigama*

NB 011 constant *kitakyuka(e-)*

NB 012 function *mukolo(o-)*

NB 013 equality *kwenkana(o-)*

NB 014 homogeneous equation *kyenkano(e-) kinnakikula kimu*

NB 015	literal equatio	*kyenkano(e-) kinnannukuta*
NB 016	radical equation	*kyenkano(e-) kinnakikolo*
NB 017	system of equations	*mutegekaganyo(o) gw'ebyenkano*
NB 018	exponential equation	*kyenkano(e-) ekiwenyi*
NB 019	extraneous root	*kikolo(e-)ekiwabye*
NB 020	inconsistent equation	*kyenkano(e-) ekitakwatagana*
NB 021	inequality	*butenkana(o-)*
NB 022	Laplace's differential equation	*kyenkano(e) kinnamwawulo kinnaLaplace*
NB 023	differential equation	*kyenkano(e-) kinnamwawulo*
NB 024	to satisfy an equation	*okumatiza ekyenkano*

As stated earlier the already alphanumerically coded entries will be alphabetically arranged. In other words, this dictionary will be both a conventional and conceptual one. From either Part II or III, the user can easily find the English or Luganda equivalent term in Part I.

VI.3 Divergent Coinages and Selections of Expressions for Term Status.

Having been exposed to my proposals, the participants embarked on the compilation of term lists. Currently, they are writing a dictionary encompassing Primary School Mathematics and Integrated Science. Later on they intend to augment that

dictionary so as to meet the needs of the Secondary School level.

What is particularly noteworthy is their self-confidence and determination as clearly exhibited by their independent coinages and selections of expressions for term status. In (28) I present a sample list of their own terms.

(28)

Term	Collaborators' Equivalent	Kiingi's Equivalent
formula	*ekisumuluzo* (+)	*ettu(-)*
set	*ekikuŋŋaanyo(+)*	*ekikuukuulu(-)*
graph	*ekirojjerero(+)*	*oluwandiikiriro(-)*
equality	*omwenkanonkano(-)*	*okwenkana(+)*
index	*obuyinza(-)*	*akalagiso(+)*
standard form	*kumutindo(-)*	*ekikula kinnamutindo(+)*
square	*ekikolo ky'ennamba*	*ekikolo*
root	*eky'ebbiri*	*kinnamulabba(+)*
square	*omulabba(+)*	*omulabba(+)*
circle	*enkulungo(+)*	*enkulungo(+)*
cube	*ssemulabba(+)*	
sphere	*ssenkulungo(+)*	
abacus	*amadinda(+)*	
algebra of propositions	*aljebra w'ebikakase(-)*	*aljebra w'ebitegeezo (+)*
amplitude	*obugulumivu(-)*	
arithmetic progression	*omugendo gwa kannambala(+)*	
ascending powers	*obuyinza obulinnya(+)*	
axis	*omusittale(-)*	*omuziziko(+)*
closed interval	*ekiseera ekigere(-)*	*olumagga oluggale(+)*
conical surface	*olwenyi olusogowav(+)*	

complex	*ennamba*	*ennamba*
number	*enzibu(+)*	*nnanzibu(+)*

I accept (plus +) or reject (minus -); a blank means that I have no equivalent of my own.

VII CONCLUSIONS FROM THE ENQUIRY

VII.1 Contributions of the Inquiry

I now wish to present a summary of what, in my circumspect view, constitutes my contribution to the field of terminology. Terminology, as I have endeavoured to exhibit in this study, is the meeting place of conceptology, formal logic, linguistics, natural language and a subject field. I have grappled with problems in terminology in general and of the terminological elaboration or modernization of Luganda in particular.

To put it succintly, my contribution resides in:-

(a) the formulation and application of the PEGITOSCA Criterion,

(b) the origination of the Periodic System of Conceptual Elements,

(c) the construction of the Conceptual calculus on the basis of the Periodic System,

(d) the construction of the Theory of Scientific Terminology on the basis of the PEGITOSCA Criterion and the Conceptual calculus,

(e) the exposition of the universal significance the Concept Transformation Rules in the Principle of Concept Marking for the marking of concepts in scientific European and Luganda,

(f) the extrapolation of the already existing Luganda expression formation rules so as to further meet the PEGITOSCA Criterion,

(g) the advocacy of a method of terminological elaboration which is explicitly concept-based,

(h) the development of terminological systems in Luganda,

(i) the conceptual parallelisation of the Kiganda clan system to the European system of social hierarchisation implicit in the neo-Latin biological nomenclature in order to develop an even more systematic biological nomenclature in Luganda, and

(j) showing that my proposals with regard to the terminological elaboration of Luganda are accommodable to a group of teachers of science and mathematics.

The hypothesisation of the Principle of Concept Marking afforded me empirical support for my Theory with T (the Theory), P (the Principle of Concept Marking), D (data) and R (result). I reasoned as in (1).

(1a) $T \vdash P$

(1b) $P \rightarrow [D \rightarrow R]$

$T \rightarrow P$ from (1a)

(1c) $T \rightarrow [D \rightarrow R]$ from (1b)

In (2), I give a logical discussion of (1c) using the values 1 (for True) and 0 (False) as truth-values.

(2)	T	→	[D	→	R]
	1	1	1	1	1
	0	1	1	1	1

On the basis of (2), I can justifiably claim that T was sustained. Now, suppose I consider the auxiliary assumption that the Theory applies to all natural languages. Then the discussion would proceed as in (3).

(3)		[T	Λ	A]	→	[D	→	R]
	(a)	1	1	1				
	(b)	1	0	0				
	(c)	0	0	1	1	1	1	1
	(d)	0	0	0				

Cases (b)-(d) are possible negative scenarios. Ideally, one would have to examine the Theory for every natural language. However, if I assume that scientific conceptualisation is intrinsically possible in all languages of the world, then T should be tenable.

One perennial problem in terminological practice, as it emerged during my collaboration with linguists, and teachers of science and mathematics, is that of choice between an already established term (antecedence) and a coinage, or between a native term and a lugandisation. This PEGITOSCA-related problem was disposed of as follows.

In chemical and biological nomenclature, global internationality leads to Eurocentric internationality. Transparency is inevitably compromised.

Antecedence and systemicity may be mutually exclusive as in (4)

(4) *ekisire:* P + a + S + G = 3 + 2 - 2 - 2 = 1

akagulu -x: P + a + S + G = 3-2 + 2 + 2 = 5

For popular parlance, I do not reject *ekisire* (cf. Sec.VI.2 (16))

A coinage based on the native lexical stock may be imprecise as in (5)

(5) *kannabutonde*, Gk *physis* "nature":

T + P = 1 - 3 = -2 (rejected)

fizika: P + T = 3 - 1 = 2

At times an antecedent term may compete with a tranparent coinage and an opaque lugandisation as in (6)

(6) *okubala:* P + r + a + T = -3 - 3 + 2 + 1 = -3

mathematika: P + r + a + T = 3 + 3 - 2 - 1 = 3

kannakubala: P + r + a + T = 3 + 3 - 2 + 1 = 5

where the receptors are secondary school learners.

If, however, Eurocentric internationality were a coveted state-of-affairs, then (6) could become (7)

(7) *mathematika :* 3 + I = 5

kannakubala : 5 + I = 3

The example in (8) shows that Eurocentric internationality can carry the day even where a long native coinage would be winning.

(8a) *kannajjululwabbugumu:* P + r + E + a + T = 7

thermodyunamika: P + r + E + a + T = 5

(8b) *kannajjululwabbugumu:* 7 + I = 5

thermodyunamika : 5 + I = 7

Some collaborators, especially linguists, contended that coinages like those in (4), (6) and (8a) would be unlearnable citing their (Eurocentric) non-internationallity. By way of a polite rejoinder, I argue that if Chinese, a full-fledged language of modern science, technology and economics, is hardly capable of phonological assimilation of European terms like "geography", Ger. *Geographie* because of its basic monosyllabic structure, then Eurocentric internationality is not an absolute imperative.

School-going Chinese learn and get used to scientific Chinese just as school-going Luganda speakers will, with some effort, decipher their "strange, mysterious" specialised Luganda and end up internalizing science more firmly than they would otherwise be able to if most terms were adopted from English. Incidentally, science articulated in native German is not entirely easy, although it is easier than when it is couched in German replete with "foreign" words (of Greco-Latin origin).

VII. 2 Suggestions for Further Research

There are at least three definable problem clusters which issue from my study. First, intimately related to the study are the following pointers to further research:

(a) How predictable in view of (9), is concept marking in Luganda by means of nominal prefixes?

(9) *ekinaabiro* "bathroom"
ennimiro "garden"
eddwaliro 'hospital'
olufunyiro 'fold'
omumiro 'foodpipe'
obutuuliro 'buttocks'

whereby the general conceptual formula is obtainable as in (10).

(10) [C m L] = L[Cm]o

(b) How comparable are the groups in the Periodic System with roles in the many versions of Role Theory?

(c) Similar studies on Luganda could be conducted in other subject fields such as economic, legal science and psychology.

Secondly, on a more general fundamental level, four further problems come to light.

(d) Does the conceptual syntax of the Conceptual Calculus offer a good basis of conducting comparative analysis of languages as far apart typologically as German and Luganda?

(e) Could the universal conceptual structure shared by sentences with the same meaning be a stating point for a universal grammar?

(f) Could the PEGITOSCA Criterion be extended in its

scope of application from the lexical or phrasal level to the textual level? In other words, could the Theory of Scientific Terminology then become a theory of translation?

(g) Could concept–based dictionaries, i.e. thesauri, be explicitly compiled with the aid of the Conceptual Calculus?

Thirdly, one could direct one's attention to other languages.

(h) A similar study could be carried out on Kiswahili or any other Language whose lexicon is actually being modernised.

(i) All Bantu languages could be harmonised and standardised into a Union Bantu, a full-fledged language of scientific, technological and economic communication with some two hundred million speakers.

(j) Alternatively, in keeping with a more realistic language policy, specific Bantu clusters could be harmonised and standardised into Union Bantu languages. For instance, the Interlacustrine Bantu could be developed into a language which would effectively neutralise all ethnolinguistic conflict while at the same time ensuring linguistic emancipation.

Finally it should be be stressed that this has been a pure and applied exploratory study. A theory of scientific terminology has been applied to a hypothetical case: the terminological elaboration of Luganda. It was, therefore, outside our mandate to focus on actual issues of language policy in Uganda although Article 6 of the Constitution of the Republic of Uganda (1995) states:

> 6. (1) The official language of Uganda is English.
>
> (2) Subject to clause (1) of this article, any other language may be used as a medium of instruction in schools or other educational institutions or for legislative, administrative or judicial purposes as may be prescribed by law.

APPENDIX A:
SOME RULES OF GRAPHOMORPHOPHONEMIC CHANGE IN LUGANDA

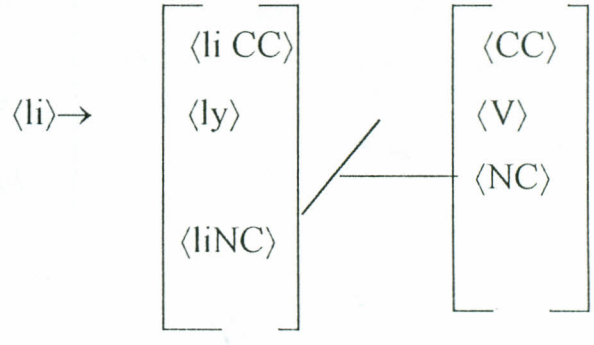
The rules of sound change (1)-(9) listed below involve the following:

(a) ⟨li-⟩ as a nominal or adjectival prefix

(b) ⟨n-⟩ as a subject or object (1st person), nominal or. adjectival prefix

⟨li-⟩ is retained according to (1)

(1)



-ggwa	*liggwa*	"thorn"
-ato	*lyato*	"boat"
-nnyo	*linnyo*	"tooth"
-ntu	*lintu*	"giant"

If ⟨C⟩→{⟨p⟩, ⟨t,⟩, ⟨c⟩, ⟨k⟩, ⟨f⟩, ⟨s⟩, ⟨b⟩, ⟩, ⟨d⟩, ⟩, ⟨j⟩, ⟨g⟩, ⟨v⟩, ⟩, ⟨z⟩}

<li-> is elided; the initial consonant is changed and doubled according to (2),

(2) ⟨li⟩ → <CC>/—<C>,

where <C> → {<p>, …, <z>}

-paapaali	*ppaapaali-*	"pawpaw"
-kubo	*ekkubo*	"path"
-viivi	*vviivi*	"knee"
-gi	*ggi*	"egg"

 is elided; the initial consonant is changed and doubled according to (3).

(3) ⟨n⟩, ⟨l⟩, ⟨y⟩, ⟨w⟩ → ⟨dd⟩, ⟨dd⟩, ⟨jj⟩, ⟨ggw⟩ / — (sometimes) (always)

-nene	*ddene*	"a big one"
-lume	*ddume*	"a male one"
-yinja	*jjinja*	"stone"
-wanga	*ggwanga*	"nation"

If ⟨n⟩ + labial, then the sound change is effected according to (4).

(4) {⟨p⟩, ⟨w⟩} → ⟨mp⟩ / ⟨n⟩ ———

-papula	*mpapula*	"papers"
-wanvu	*mpanvu*	"long ones"

If ⟨n⟩ + nasal, then the sound change is effected according to (5).

(5) $\begin{bmatrix} \langle m \rangle \\ \\ \langle n \rangle \\ \langle ny \rangle \\ \\ \langle ŋ \rangle \end{bmatrix} \rightarrow \begin{bmatrix} \langle mm \rangle \\ \\ \langle nn \rangle \\ \langle nny \rangle \\ \\ \langle ŋŋ \rangle \end{bmatrix} / \langle n \rangle \_\_\_\_\_$

-muli	*mmuli*	"reeds"
-naku	*nnaku*	"days"
-nyago	*nnyago*	"spear shafts"
ŋo	*ŋŋo*	"banana buds"

The changes in (4) and (5) are not affected by a nasal in the second syllable.

If the second syllable is non-nasal, then (6).

(6) $\begin{bmatrix} \langle b \rangle \\ \langle l \rangle \\ \langle g \rangle \\ \langle y \rangle \end{bmatrix} \rightarrow \begin{bmatrix} \langle mb \rangle \\ \langle nd \rangle \\ \langle ng \rangle \\ \langle nj \rangle \end{bmatrix} / \langle n \rangle \_\_\_\_\_$

-bugo	*mbugo*	"bark clothes"
-lere	*ndere*	"riems"
-gero	*ngero*	"stories"
-(y)ala	*njala*	"finger nails"

If the second syllable is nasal, then (7).

(7) ⟨b⟩, ⟨l⟩, ⟨g⟩, ⟨y⟩ → ⟨mm⟩, ⟨nn⟩, ⟨ŋŋ⟩, ⟨nny⟩ / ⟨n⟩ ———

-bengo	*mmengo*	"grind stones"
-limi	*nnimi*	"tongues"
-gendo	*ŋŋendo*	"journeys"
-yimba	*nnyimba*	"songs"

If ⟨CC⟩ → {< bb, tt, jj, kk, gg, vv, ss, zz}, then (8)

(8) ⟨CC⟩, ⟨dd⟩ → ⟨nziC⟩, ⟨nzir⟩ / ⟨n⟩ ———

-zzi	*nzizi*	"wells"
-dd	*nzira*	"I return

If ⟨n⟩ is followed by a double nasal or nasal compound, then (9)

(9) ⟨mm⟩, ⟨nn⟩, ⟨nny⟩, ⟨mp⟩, ⟨mb⟩, ⟨ng⟩ → ⟨nnyim⟩, ⟨nnyin⟩, ⟨nnyiny⟩, ⟨nnyimp⟩, ⟨nnyimb⟩, ⟨nnying⟩ / ⟨n⟩ ——

-mm-	*nnyima*	"refusal"

-nnyo	*nnyinyo*	"stretchers"
-mbe	*nnyimbe*	"sicknesses"
-mpi	*nnyimpi*	"short ones"
-ngi	*nnyingi*	"many"

APPENDIX B:

GLOSSARY OF GRECO-LATIN AFFIXOIDS IN EUROPEAN SCIENTIFIC TERMINOLOGY TRANSLATED INTO LUGANDA

(1)	abdomin-	=	olubuto
(2)	abiet-	=	effumu
(3)	acanth-	=	eriggwa, ensoomi
(4)	acerv-	=	entuumu, okutuuma
(5)	acet-, acid-	=	okukaawa, okukambagga
(6)	acm-	=	akasongezo, entikko, akasanso
(7)	acr-[1]	=	akasongezo, entikko, akasanso
(8)	acr-[2]	=	okubaalaala
(9)	acrid-	=	enzige
(10)	act-	=	okukola, omulimu
(11)	actin-	=	akagulu
(12)	acu-[1]	=	okusongola
(13)	acu-[2]	=	okuwulira
(14)	acule-	=	eriggwa
(15)	acut-	=	-songovu
(16)	adamant-	=	okuguguba
(17)	adelph-	=	oluganda
(18)	aden-	=	enkenga
(19)	adip-	=	amafuta, amasavu, omuzigo
(20)	adolesc-	=	okuvubuka, okukula
(21)	aeg-	=	embuzi
(22)	aelur-	=	ekkapa
(23)	aepy-	=	okugulumira
(24)	aequ-	=	okwenkana

(25) aequor- = ennyanja
(26) aer-[1] = empewo
(27) aer-[2] = ekikomo (Cu)
(28) aest- = ekyeya
(29) aesthe- = okuwulira
(30) aestu- = okubooga, okubimba
(31) aet- = empungu
(32) aether- = eggulu
(33) ag- = okukola, okujjulula
(34) agon- = okukontana
(35) agr- = okulima, ennimiro, omusiri
(36) agrost (id)- = omuddo, essubi
(37) al-[1] = enkwawa, ekiwawa
(38) al-[2] = okuliisa, emmere
(39) alb- = -eru
(40) alectr- = enkoko
(41) aleur- = okusa, obutta, ensaano
(42) all- = -lala
(43) allax- = okukyusa, okuwaanyisa
(44) alloe-, alloi = -lala, okweyawula
(45) alopec- = ekibe
(46) alt- = obugulumivu, obussi
(47) altern- = okutobeka
(48) amar- = okukaawa
(49) ambly- = -nafu
(50) ambula- = okugenda, okutambula
(51) amm- = omusenyu
(52) amoeb- = okukyuka, okukyusa

(53) amyl- = ekimaanyiwaza
(54) anat- = embaata
(55) ancestr- = jjajja
(56) anch- = okutuga
(57) ancyl- = okuweta, okugota
(58) andr- = omusajja
(59) anem- = embuyaga
(60) angi- = ensawo
(61) angu(i)- = omusota
(62) angul- = ensonda
(63) angust- = okufunda
(64) anim- = ensolo
(65) ann- = omwaka
(66) annel-, annul- = empeta
(67) anser- = embaata
(68) anter- = -a mu maaso
(69) anth- = ekimuli
(70) anthem- = ekimuli
(71) anther- = okumulisa
(72) anthrac- = amanda, eryanda
(73) antiqu- = -kadde
(74) apert- = okuggulu
(75) apex- = entikko, ensanso, engule
(76) aphr- = ekyovu
(77) aphrodit- = obukaba
(78) ap(i)- = enjuki
(79) apt- = okusaanira
(80) aqu- = amazzi

(81) arachn-, arane- = nnabbubi

(82) arbor- = omuti

(83) arch-[1] = okutandika, ensibuko, okusooka

(84) arch-[2] = ekinyo

(85) arct- = eddubu

(86) arcu- = okugota, okuweta

(87) aren- = omusenyu

(88) argent- = ffeeza

(89) argyr- = ffeeza

(90) arid- = -kalu, okubengeya

(91) arist- = omukungu

(92) arn- = endiga

(93) arrhen- = omusajja

(94) arthr = ennyingo

(95) articul- = ennyingo

(96) arv- = okulima, ennimiro

(97) arytaen- = okutonda, okugunja

(98) asc- = eddiba, ensawo

(99) asin- = endogoyi

(100) asper- = okukalabula

(101) aspid = engabo

(102) aster-, astr- = emmunyeenye

(103) asthen- = -nafu, -yongobevu

(104) atav- = jjajja

(105) atm- = omukka

(106) atr- = okuddugala, okuziga

(107) atri- = ekisenge

(108) auchen- = ensingo
(109) audi- = okuwulira
(110) aul- = endere, omulenge
(111) aur- = zzaabu
(112) aur(i)- = okutu, okuwuliriza
(113) austr- = obukiikaddyo
(114) aut- = -kka
(115) autumn- = ekyengera
(116) aux- = okwongera
(117) auxili- = okuyamba, okuwagira
(118) av- = jjajja
(119) av(i)- = ennyonyi
(120) axill- = enkwawa
(121) bacill- = akaggo
(122) bacteri- = akaggo
(123) badi- = omuwemba
(124) baeni- = okwetogoonyola
(125) balaen- = lukwata
(126) balant- = endyanga
(127) barb- = ekirevu
(128) bar(y)- = -zito
(129) bas- = omusingi
(130) bat- = okusangika
(131) bath- = obugulumivu, obussi, obuziba
(132) batrach- = ekikere
(133) bell- = okuwuuta
(134) bel- = akasaale, okulasa
(135) benth- = obussi, obuziba

(136) bi-[1] = -biri

(137) bi-[2] = obulamu

(138) bil- = akalulwe

(139) bin- = omugogo

(140) blast- = omutunsi

(141) blatt- = ennyenje

(142) blem (at)- = okusawuka

(143) blenn- = eminyira, olunaanu

(144) blep- = okulaba

(145) blephar- = ekikowe

(146) bo- = ente

(147) bol- = okusawuka

(148) bolet-, bolit- = akatiko

(149) bor- = -li(okulya)

(150) bore- = obukiikakkono

(151) bos, bov- = ente

(152) bosc- = okulya

(153) botan- = ekimera

(154) bothr- = olunyaafa

(155) botry- = omuzabbibu

(156) brachi- = omukono

(157) brachy- = -mpi, -tono

(158) brady- = olulembe, okulemba, okusooba

(159) branchi = endaka

(160) brassic- = emboga

(161) brev(i)- = -mpi, -tono

(162) bronch- = omumiro

(163) brum- = obutiti

(164) bry- = enkonge, okutinta

(165) bu- = ente

(166) bucc- = oluba, ejjuuga

(167) buccin- = eddenge

(168) bun- = akatunnumba

(169) burs- = eddiba

(170) byth- = obuziba

(171) caco- = -bi

(172) cad- = okugwa, omutulumbi

(173) caec- = -zibe

(174) caed- = okutta

(175) caement- = sseminti

(176) caen- = -gya

(177) cal-[1] = -lungi

(178) cal-[2] = okwokya, ebbugumu

(179) calc- = ennoni

(180) calce- = engato

(181) calic = entamu

(182) call- = -lungi, -balagavu

(183) calv- = okumwa, ekiwalaata

(184) calypt- = okukweka, okusaanikira, okusiikiriza

(185) cambi- = okuwaanyisa

186) camel- = eŋŋamiya

(187) camp-[1] = ekisaawe

(188) camp-[2] = okugota

(189) campan- = ekide

(190) can-1 = -eru, -eruyeru

(191) can-[2] = okuyimba
(192) canal- = omukutu
(193) cand- = okutukula
(194) can(i)- = embwa
(195) canta- = okuyimba
(196) cap- = okutegeera
(197) capill- = oluviiri
(198) capti- = omutwe
(199) capr-[1] = embuzi
(200) capr-[2] = engiri
(201) caps- = okukavvula
(202) carbo(n)- = amanda
(203) carchar- = okusongeza, -songovu
(204) cardi- = omutima
(205) carin- = omugango
(206) carn- = ennyama
(207) carp-[1] = ekibala
(208) carp-[2] = ekiseke
(209) cary- = ekinyeebwa, omulamwa
(210) caten- = olujegere
(211) caud- = omukira
(212) caul- = enduli
(213) caus- = okuleetera
(214) cavern- = empuku
(215) ceb- = enkima
(216) celer- = okwanguwa
(217) celid- = eggondo
(218) cent-[1] = ekikumi

(219) cent-[2] = okufuta
(220) centr- = amassekati, amakkati, wakati
(221) cephal- = obwongo, omutwe
(222) cer- = envumbo
(223) cer(at)- = ejjembe
(224) cer- = omukira
(225) cereal- = empeke
(226) cerebri- = obwongo
(227) certe- = -kakafu
(228) cervic- = ensingo
(229) cess- = okudda
(230) cest- = olukoba, olutambi
(231) cet- = lukwata
(232) cib- = emmere
(233) cili- = ekikowe
(234) cinet- = okwejjulula
(235) ciner- = evvu
(236) circ- = enkulungo
(237) cirr- = akabooya
(238) citr- = omulimaawa
(239) clad- = ettabi
(240) clav- = olwala
(241) clav-(i) = ekkufulu
(242) clin- = okwesigama
(243) clitor- = akasozi
(244) clus- = okusiba
(245) cnem- = oluteega
(246) cocc- = omulamwa

(247) cochl- = ekkovu

(248) coel- = ekiwowongole

(249) coen- = -a awamu, -onna

(250) coet- = enfo

(251) cole- = ekiraaato

(252) coll-[1] = ensingo

(253) coll-[2] = ennoni

(254) coll(i)- = olusozi

(255) color- = erangi

(256) colp- = olulaato

(257) columb- = ejjuba

(258) columell- = empagi

(259) colymb- = okuwuga

(260) comit- = okuwerekera

(261) commun- = ekinywi

(262) conch- = essonko

(263) condyl- = enkufu

(264) coni- = enfuufu

(265) cont- = effumu

(266) cop-[1] = okunafuya

(267) cop-[2] = enkasi

(268) copr- = amazi

(269) copul- = okugatta

(270) cord- = omutima

(271) cordyl- = enkufu

(272) cori-[1] = eddiba

(273) cori-[2] = ekiku

(274) corn- = enkonge (y'omuti)

(275) cornu(-) = ejjembe

(276) coron = engule

(277) corpor-, corpus(-) = omubiri

(278) cortex-, cortic- = olukuta

(279) coryn- = embuukuuli

(280) cost- = olubiriizi

(281) cox- = akabina, embinabina

(282) crani- = ekiwanga

(283) crass- = -ziyivu

(284) crater- = ekibya, omuzindaalo

(285) cre- = ennyama

(286) cre(a)- = okuleebeeta

(287) crepid-, crepis- = okusinziira

(288) cri- = endiga

(289) cribr- = ekikuŋŋunta

(290) cric- = omukuufu

(291) crin-[1] = enviiri

(292) crin-[2] = eddanga

(293) cri-[3] = okufulumya

(294) crisp- = okufunyafunya

(295) cruc(i)- = omusaalaba

(296) cru(or)- = omusaayi

(297) crur, crus- = ekisambi

(298) crust- = ekikalappwa

(299) cry- = -nnyogovu

(300) crypt- = okukweka

(301) cten- = ekisanirizo

(302) cub- = okwebaka

(303) cubit- = olukokola
(304) cucul- = kakaamukuukulu
(305) culim- = effumbiro
(306) culmen- = entikko
(307) cultr- = akambe
(308) cumul- = entuumu
(309) cune- = empano
(310) conicul- = akamyu
(311) cup- = ekikopo
(312) cupr- = ekikomo
(313) curv- = okuweta
(314) cuspid- = akasongezo
(315) cut- = olususu
(316) cyan- = bbululu
(317) cycl- = enkulungo
(318) cymb- = eryato
(319) cyn- = embwa
(320) cyph- = okuweta
(321) cyst- = ensunduba
(322) cyt- = akasenge
(323) cha-, chas-, chaen- = okwayuuya
(324) chaer- = okusanyuka
(325) chaet- = ejjoba
(326) chalaz- = omuzira (enkuba)
(327) chalic- = ennoni
(328) char(i) = essanyu
(329) chas- = olunyaafa
(330) cheimat- = obutiti

(331) chel- = makansi
(332) chen- = embaata
(333) chil- = omumwa
(334) chimaer- = embuzi
(335) chion- = omuzira
(336) chlamyd- = ekizibaawo
(337) choer- = embizzi
(338) chol- = akalulwe
(339) chondr- = empeke
(340) chord = omuguwa
(341) chori- = olususu
(342) chort- = okulunda
(343) chrom (at)- = erangi
(344) chron- = ekiseera
(345) chrys- = zaabu
(346) chthon- = ettaka
(347) dac- = okubojja
(348) dacry- = amazigga
(349) dactyl- = engalo, ebigere
(350) dasy- = okuviiriwala
(351) dect- = okulumwa
(352) del- = okulabika
(353) delic- = -lungi, -woomu
(354) delphy- = nnabaana
(355) dem- = omuntu
(356) dendr- = omuti
(357) dens- = -ziyivu
(358) dent- = erinnyo

(359) der- = ensingo
(360) derm(at)- = olususu
(361) desm- = olwebagyo
(362) deut(er)- = okuddirira
(363) dextr- = ddyo, omukugu
(364) di- = -biri
(365) dicho- = okwawula
(366) dicty- = akatimba
(367) didym- = omulongo
(368) digit- = engalo, akasammambiro
(369) din-[1] = okutiisa
(370) din-[2] = okuzunga
(371) dipl- = okulongowaza
(372) dir- = ensingo
(373) dis- = okulongowaza
(374) disc- = ekipapajjo
(375) diss- = okulongowaza
(376) dist(a)- = okwesuula
(377) divers- = okwawuka
(378) divid-, divis- = okugabanya
(379) doli- = ettogero
(380) dolich- = -anvu, -gazi
(381) dom- = eka
(382) domin- = ssemaka, okufuga
(383) dors- = omugongo
(384) dory- = omukiikiro
(385) dox- = okukkiriza
(386) draco(n)- = omusota

(387) drepan- = okusala

(388) dril- = olusiriŋŋanyi

(389) drom- = okudduka

(390) dros- = omusulo

(391) dry- = omuti

(392) dubi- = nnankulubbirye

(393) duc(t)- = okugenza(*), okutambuza

(394) dum- = ekisaka

(395) duoden- = kkumi na -biri

(396) duplic- = okulongowaza

(397) dur- = -gumu

(398) dy- = okusabika

(399) dynam- = amaanyi

(400) dyt- = okwebikka

(401) ebur- = essanga

(402) echi- = omusota

(403) echin- = nnamunnungu

(404) echthr- = okukyawa, omulabe

(405) elaph- = ettaka

(406) elasm- = olubangali

(407) elast- = okunaanuula

(408) elat-[1] = okutandulula

(409) elat-[2] = okukuumiira

(410) electr- = amasannyalaze

(411) elegant- = okulondoba

(412) element- = ennementi, elementi

(413) elephant- = enjovu

(414) eleuther- = okwetaaya

(415) elytr- = ekisabikiro*

(416) emet- = okusesema

(417) empir- = okwemanyiiza

(418) emunct- = okukyuluza

(419) encephalo- = obwongo

(420) enchely- = ensonzi

(421) ens(i)- = ekitala

(422) enter- = enda

(423) epeir = olukalu

(424) ephesti- = ku masiga

(425) ephippi- = embalaasi

(426) equ- = embalaasi

(427) erem- = eddungu

(428) ereps- = okumulungula

(429) erg- = okukola

(430) eri- = ekyoya

(431) erodi- = ssekanyolya

(432) err- = okwetaaya

(433) erythr- = -myufu

(434) esculent- = okuliika

(435) eth- = empisa

(436) ethm- = akakuŋŋunta

(437) etym- = ennono, wawu

(438) eury- = -gazi, okugaziwa

(439) excels- = okusukka

(400) exigu- = -tono

(441) eximi- = okujagalala

(442) exter-, extern- = ebweru

(443) extrem- = akasammambiro
(444) fab- = ekijanjaalo
(445) faber- = omukugu
(446) faci- = ekyenyi, kungulu
(447) fiss- = okwasa
(448) fistul- = omulere
(449) fix- = -nywevu
(450) flabell- = embooko
(451) flagell- = kibooko
(452) flamm = omuliro
(453) flat(t) = okufuuwa
(454) flav- = kyenvu
(455) flect-, flex- = okuweta, okufunya
(456) flor- = ekimuli, okumulisa
(457) flur- = okukulugguka
(458) fluctu- = omwala, okukulugguka
(459) fluvi- = omugga, okwalaala
(460) foc- = ekyoto
(461) fodi- = okuziika, okusima
(462) foet^{-1} = akakonkomi
(463) foet-^{2} = okuwunya
(464) foli- = olulagala
(465) foll(i)- = omuvubo
(466) fom- = olufuuzi
(467) fons-, font = ensulo
(468) fora- = okubotola
(469) forfic- = makansi
(470) form- = ekikula

(471) formic- = enkuyege
(472) fornic- = ekiyitirirwa
(473) foss- = okuwuukuula
(474) fove- = olunyaafa
(475) fract-, frag- = okumenya
(476) fren- = olukoba
(477) frequent- = jjenjeero, okuddiŋŋana
(478) frig- = okutiitiwala
(479) frond-, frons- = eddagala
(480) frons-, front- = ekyenyi
(481) fru-, fruct-, frug- = ekibala
(482) frutic- = ekisaka
(483) fuc- = akayaliga*
(484) fug- = okudduka, okugoba
(485) fulg- = okumyansa
(486) fuligin- = enziro
(487) fulv- = -myukirivu
(488) fum- = omukka, okwoteza, okukoomera
(489) funct- = omukolo
(490) fund-[1] = okugunja, omusingi
(491) fund-[2] = okuyiwa, okwalaala
(492) fune- = okukungubaga
(493) fung-[1] = okukola, okutuukiriza
(494) fung-[2] = akatiko
(495) fun(i)- = omuguwa
(496) furc- = ewuuma
(497) fus-[1] = okuyiwa

(498) fus-[2] = okulanga
(499) fusc- = -ddugavumu
(500) fae- = ensi
(501) galact- = amata
(502) gale- = eggunju
(503) gale-, glaer- = enkoofiira
(504) gall- = enkoko
(505) gam- = okuwasa, okuwasibwa
(506) gan- = ekkula
(507) gangli- = ensunduba, ensundo
(508) garr- = okulokompoka
(509) gastr- = olubuto
(510) ge(i)- = ensi
(511) geiton(-), geton(-) = muliraanwa, okuliraana
(512) gel- = okukwata
(513) gemin- = omulongo
(514) gemm- = omutunsi
(515) gen-[1] = okukoza, okusibuka
(516) gen-[2] = oluba
(517) gener- = okuzaala, eggwanga
(518) geni- = oluba, ekirevu
(519) genicul-, genu- = evviivi
(520) genit- = okuzaala, omuzadde
(521) geny- = oluba
(522) ger- = okukongojja, okwetikka
(523) geran- = nngaali
(524) germin- = omutunsi
(525) geront- = omukadde

(526) gest- = okukongojja, okwetikka
(527) gibb- = ebbango
(528) gigant- = -wagguufu
(529) glabr- = -mwe
(530) glaci- = omuzira
(531) gladi- = ekitala
(532) gland- = enkenga
(533) glauc- = ensenke
(534) glen- = eriiso
(535) gli- = ennoni
(536) glob- = omupiira, enkulungo
(537) gloe- = omusanda, amasanda
(538) glomus- = okwetukuta
(539) gloss-, glott- = olulimi
(540) glut- = obutuuliro
(541) glutin- = okusengeka
(542) glyc (er)-, glis(er)- = -woomerevu
(543) glyph- = okuwoola
(544) gnath- = oluba
(545) gno- = okutegeera
(546) gono(i)- = evviivi, ensonda
(547) gracil- = okukenduka
(548) grad- = okudaalawala, eddaala
(549) gramin- = omuddo
(550) gramm(at)- = ennukuta, ekiwandiike
(551) gran- = empeke
(552) grand- = -nene
(553) graph = okuwandiika, okukola

(554) grav- = -zito

(555) greg- = okukuŋŋaana

(556) gress- = okudaalawala, eddaala

(557) gris- = -ambubi

(558) gross- = -nene

(559) gul- = omumiro

(560) gutt- = ettondo

(561) gymn- = busa, bukunya

(562) gyn(ae)- = omukazi

(563) gyr- = -ekulungirivu

(564) habit- = okubeera

(565) habr- = -weweevu

(566) hadr- = okusuumuka, okwetuuka

(567) haem(at)- = omusaayi

(568) haer-, haes- = okukwatira

(569) hal-[1] = omunnyo

(570) hal-[2] = okubuuka

(571) halluc- = olwala

(572) halt- = okubuuka

(573) ham- = eddobo

(574) halp- = -angu

(575) harp- = okuvumba

(576) haps-, hapt- = okukwataganya

(577) hast- = effumu

(578) haust- = okumalamu, okugwayo

(579) hedy- = akaloosa

(580) hel-[1] = akateebe, olutobazzi

(581) hel-[2] = ebbango

(582) heli- = enjuba

(583) helic- = ekkovu

(584) helminth- = olusiriŋŋanyi, enfaana

(585) hemer-[1] = olunaku, emisana

(586) hemer-[2] = -teefu,-gonvu

(587) hepat- = ekibumba

(588) herb- = omuddo

(589) herp- = okwewalula, okwekulula

(590) hesper- = eggulo, bugwanjuba

(591) heter- = -lala

(592) hibern- = obutiti

(593) hiem- = obutiti

(594) hil- = olwayi

(595) himant- = olukoba

(596) hipp- = endogoyi, embalaasi

(597) hirc = embuzi ennume

(598) hirudin- = ekinoso

(599) ign- = omuliro

(600) il- = amakendegere

(601) imagin- = okufumiitiriza

(602) immun- = okusibaga

(603) impera- = okufuga

(604) incus- = oluyijja

(605) insect- = ekiwuka

(606) insul- = ekizinga

(607) integr- = ekirambirira

(608) intern- = -a munda

(609) intestin- = ebyenda

(610) irid- = musoke
(611) irrita- = okunyiiza
(612) is- = okwenkana
(613) ischi- = obutuuliro
(614) isol- = okuzinga, okubunguluza
(615) isthm- = akagolomolo
(616) -it- = okugenda, olugendo
(617) jac-, -ject- = okukanyuga, okusawuka
(618) jejun- = enjala
(619) jub- = ejjoba
(620) jug- = enkoligo, okukoligowaza
(621) jugul- = ensingo
(622) junct- = okugatta, okutaba
(623) jung- = okuyunga, okugatta, okutaba
(624) juven- = omuvubuka
(625) kallin- = -lungi
(626) kastra- = okulaawa
(627) kin- = okwejjulula
(628) klin- = okweweta, okwebaka
(629) koll- = ennoni
(630) kolossa- = -nene
(631) kri- = okusala
(632) kybern- = okugoba, okugenza, okutwaza
(633) kym- = ejjengo
(634) lab- = okusagaasagana
(635) labi- = omumwa
(636) labid- = magalo, okuvumba
(637) labor- = okukola

(638) labr- = omumwa

(639) lac- = amata

(640) lacer- = okutaagula, -taagufu

(641) lacert- = omunya

(642) lachn- = -a byoya

(643) lacrim-, lacrym- = amaziga

(644) lact- = amata

(645) lacu- = ennyanja

(646) lacun- = omuwaatwa

(647) laem- = ensingo

(648) laes- = okuyonoona

(649) laev-[1] = -weweevu

(650) laev-[2] = kkono

(651) lag- = akamyu

(652) lagen- = ensumbi

(653) lamin-, lamell- = olupampagalu

(654) lamp- = okumulisa, ettala

(655) lan- = ekyoya

(656) lani- = okukavvula

(657) lapid, lapill- = ejjinja

(658) larv- = okukisa

(659) lasi = a- byoya, ssebyoya

(660) laryng- = eddookooli

(661) lat- = -gazi

(662) late- = okukweka

(663) later-[1] = oluuyi

(664) later-[2] = ettegula

(665) lathr- = okukisa, enkiso

(666) lax- = okulagaya

(667) lect-[1] = okukuŋŋaanya

(668) lect-[2] = ekitanda

(669) leg-[1] = okweroboza, okulonda

(670) leg-[2] = etteeka

(671) lei- = omuseetwe

(672) lemm- = okusabika

(673) leo(n), leont- = empologoma

(674) lep-, lepid- = okukalakata, eggamba

(675) lepor- = akamyu

(676) lept- = akanyikuuli, olunyikuuli

(677) let- = okutta, okufa

(678) leuc- = -eru

(679) lev- = -angu

(680) libell- = minzaani

(681) liber- = okwetaaya

(682) liga- = okunyweza

(683) lign- = omuti

(684) ligul- = olulimi

(685) lim-[1] = ebbumba

(686) lim-[2] = okuwemmenta

(687) limit-, limin- = ensalo

(688) limn- = olutobazzi

(689) line- = okukoloboza

(690) lingu- = olulimi

(691) lip-[1] = amafuta

(692) lip-[2] = okubulwa

(693) liqu- = ekikuluggusi, ekikulukuta

(694) liss- = -weweevu

(695) lith- = ejjinja, olwazi

(696) litor-, littor- = olubalama

(697) lob- = empaggwa

(698) loc- = ekifo

(699) locust- = enzige

(700) log- = emboozi, ekigambo, sentensi, ekyokuyiga mu sayansi

(701) lonch- = effumu

(702) long- = -wanvu

(703) loph- = enkoona, enkoto

(704) lor- = olukoba

(705) loric- = ekikalappwa

(706) lox- = -efunye-, -ekiise

(707) luc- = ekitangaala

(708) luct-, lug- = okukungubaga

(709) lumb- = ekiwato

(710) lumen- = ekitangaala

(711) lun- = omwezi

(712) lup- = omusege

(713) lut- = ettosi

(714) lav- = okunaaba

(715) ly-, lys- = okwawulula, okuyungulula

(716) lyc- = omusege

(717) lychn- = omumuli, okumulisa

(718) lym- = okwonoona

(719) lymph- = ensulo

(720) macer- = okunafuya

(721) mach- = okulwana
(722) macul- = ebbala
(723) magn- = -nene
(724) maj- = -nene
(725) mal- = -bi
(726) malac- = okugonda
(727) mall- = enviiri
(728) malle- = ennyondo
(729) mam-, mamm- = ebbeere
(730) mand- = okugaaya
(731) mane- = okusigala
(732) manu- = omukono
(733) manubri- = omuyini
(734) mar- = ennyanja
(735) margarit- = luulu
(736) margin- = olubugirizo
(737) marsup- = ensawo
(738) mascul- = omusajja
(739) mass- = ekitole
(740) masse- = okugaaya
(741) mast- = ennywanto
(742) mastic- = okugaaya
(743) mastig- = kibooko
(744) matr- = maama, okuzaala
(745) maur- = -ddugavu
(746) maxill- = oluba
(747) maxim- = okusinga
(748) mea- = okuyita, okugenda

(749) mec- = -nene
(750) mechan- = okuyamba
(751) medi- = massekati, wakati
(752) medic- = okuwonya
(753) medull- = obusomyo
(754) mei(o)- = okukendeera
(755) mel- = embuzi
(756) melan- = -ddugavu
(757) mel-, mell(i)- = omubisi gw'enjuki (omuyuki)
(758) membr- = ekitundu
(759) membran- = eddiba
(760) men-[1] = emmere, emmeeza
(761) men-[2] = omwezi
(762) mening- = akawompo
(763) mens-[1] = ekitundu
(764) mens-[2] = ekisambi
(765) ment- = akalevu
(766) mer-[1] = ekitundu
(767) mer-[2] = ekisambi
(768) merg- = okubbika
(769) meridi- = ettunttu
(770) mers- = okubbika
(771) mes- = wakati
(772) metall- = ekirombe
(773) metop- = ekyenyi
(774) metr-[1] = okupima
(775) metr-[2] = maama, nnabaana

(776) mic- = empulunguse
(777) mica- = okumyansa
(778) migra- = okusenguka
(779) mili- = omuwemba
(780) milit- = omujaasi
(781) mim- = okugeegeenya
(782) min-[1] = -tono
(783) min-[2] = ekinnya
(784) mine- = okukukunala
(785) mir- = okwewuuyisa
(786) miracidi- = akalenzi
(787) miss- = okusindika, okutuma
(788) mit- = ewuzi
(789) mitt- = okusindika, okuweereza
(790) mix- = okutabula
(791) mnem- = okujjukira
(792) mobil- = okujjulula, okutambuza
(793) mod- = okugera, okupima
(794) mol- = okubenga, okusa
(795) moll- = okugonda
(796) monil- = omukuufu
(797) mont- = olusozi
(798) monstr- = ekikulekule
(799) mord- = okuluma, okuwemmenta
(800) mori- = ekitundu
(801) morph- = ekikula
(802) mors- = okuluma, okulumba
(803) mort- = okufa, omufu, omulambo

(804) mosch- = ennyana
(805) mot-, move- = okujjulula
(806) moc- = eminyira
(807) mucro(n)- = okusongola
(808) mulg- = okukama, okukamula
(809) multi- = -ngi
(810) mur-[1] = ekisenge
(811) mur-[2] = emmese
(812) muric- = ekkovu
(813) musc-[1] = ensowera
(814) musc-[2] = enkonge, ebikukujju
(815) mustel- = eggunju
(816) muta- = okukyuka
(817) mutu- = okugasagana, okwolekesagana
(818) my- = emmese
(819) myc-(et) = akatiko
(820) myel- = obusomyo
(821) myi- = ensowera
(822) myl- = olubengo
(823) myri- = akakumi
(824) myrmec- = munyeera
(825) mystac- = ekirevu
(826) myx-[1] = eminyira
(827) myx-[2] = okunuuna
(828) naev- = ebbala
(829) nan(o)- = omumbuti
(830) nar- = emivubo
(831) narc- = okulemaza, okulemesa

(858) nict- = okutemya

(859) nid- = ekisu

(860) nigr- = -ddugavu

(861) niph- = omuzira

(562) nit- = okumasamasa

(563) niv- = omuzira

(864) noct- = ekiro

(865) nod- = ekifundikwa

(866) nom- = omuze, empisa, etteeka

(867) nomen- = erinnya, okutuuma

(868) norm- = okugera, okufuga, okulijjowaza

(869) nos- = obulwadde, endwadde

(870) not-[1] = omugongo

(871) not-[2] = obukiikaddyo

(872) not-[3] = akabonero

(873) nub- = ekire

(874) nuc- = ekinyeegwa

(875) nuch- = enkoto

(876) nucle- = omulamwa

(877) nud- = obukunya, -ereere

(878) null- = obutannaba, obutaba

(879) numer- = ennamba, -ngi, okubala

(880) numm- = ensimbi, ekisente

(881) nuta- = obukunduka, okukoteka

(882) nutri- = okuliisa

(883) nyct- = ekiro, enzikiza

(884) nymph- = omuwala, embeerera

(885) o- = eggi

(886) obliqu- = olubege

(887) obscur- = okukweka, enzikiza

(888) obtura- = okuzibikira, okuzibiza

(889) obtus- = enkuggu, okufuubeetera, okufumbeera

(890) ocean- = eriyanja

(891) ocell- = eriiso

(892) ochr- = okuseenyuuka, -seenyuufu

(893) ocul- = eriiso

(894) ocy- = okupakuka

(895) -odon- = erinnyo

(896) odm- = ekigungu

(897) odont- = erinnyo

(898) odor- = okuwuunya, akaloosa

(899) -odus- = erinnyo

(900) oec- = amaka

(901) oed- = okuzimba

(902) oen- = evviino

(903) oesophag- = olumiro

(904) oestr- = okulundugga, okuziyiza

(905) officin- = okukolera, okugasa

(906) oic- = amaka

(907) ole-[1] = omuzeyituuni

(908) ole-[2] = okuwunya

(909) oler- = enva

(910) ordin- = okutegeka

(911) organ- = ekikozesebwa

(912) orient- = ebuvanjuba
(913) orifici- = okumwawaza
(914) origin- = okusibuka
(915) orna- = ettiribona, okuwunda
(916) ornith- = ennyonyi
(917) orth- = okutengerera, okutereera
(918) oryct- = okuwuukuula
(919) oryx- = omupunga
(920) os-[1] = omumwa, ettama
(921) os-[2] = eggumba
(922) osm-[1] = ekigungu
(923) osm-[2] = okukoona, okutomera
(924) osphr- = okuwunyiriza
(925) oss- = eggumba
(926) ost(e)- = eggumba
(927) osti- = omulyango, oluggi
(928) ostrac- = essonko
(929) ot- = okutu
(930) ov- = eggi
(931) ov(i)- = endiga
(932) pabul- = ekyokulya
(933) pach(y)- = ekitole, ekiwumi
(934) paed- = omwana
(935) pag- = bbalaafu
(936) palat- = akabuno
(937) pale- = ekisusunku
(938) palli- = ekizibaawo

(940) palm-[2] = olukoma, olukindu

(941) palm-3 = okulasira

(942) palp- = okukoonako

(943) palpebr- = ekikowe

(944) palud- = olutobazzi

(945) pan-[1] = -ona, okubuna

(946) pan-[2] = omugaati

(947) pancre- = ennuuni

(948) pand-, pans- = okugaziwa, okubuna, okuyisa

(949) panic- = omuwemba

(950) papilio(n)- = ekiwojjolo

(951) papill- = ennywanto

(952) papyr- = ekitoogo

(953) par-[1] = okwenkana, okutabagana

(954) par-[2] = okuteekateeka, okuzaala, okukola, okuteekateeka

(955) paramaeci- = -wanvuyirivu

(956) pard- = engo

(957) pare- = okulabika, okutangaala

(958) pare(i) = oluba

(959) parent- = omuzadde

(960) parti- = ekitundu

(961) parthen- = omubiikira

(962) parv- = -tono

(963) pasc- = okulya

(964) pass-[1] = okulumwa, okugumiikiriza

(965) pass-[2] = okuyita

(966) passer(i)- = enkazaluggya

(967) past- = okulunda, omusumba

(968) pat- = okwegaziya

(969) patell- = enso

(970) pater(-) = taata

(971) path-, pati- = okulumwa

(972) paus-, paur-, paup- = -tono, okukeewa, omunyoto

(973) paus- = okuleka, okuyumiriza

(974) pavo(n-) = ssekkoko

(975) pectin- = essule, ejjoba

(976) pector- = ebbeere, ekifuba

(977) ped- = ekigere

(978) pedicul- = ensekere

(979) peduncul- = ekigere, akagere

(980) pel- = ebbumba, olutobazzi

(981) pelag- = obwengula

(982) pelarg- = enkoonamasonko, ennundansige

(983) pelecy- = embazzi

(984) pell- = eddiba

(985) pelm(at)- = amala

(986) pelt- = engabo

(987) pelv- = ekinnyi

(988) pend-, pens- = okwesuuba, okuleebeeta

(989) penetra- = okusensera, okuyingira

(990) pen(i) = oluwasiso

(991) penicill- = penisilini
(992) penn- = ekiwawa, ekyoya
(993) peps- = okufumba
(994) per- = egguniya
(995) perd- = okwonoona
(996) peregrin- = omugwira, okusenguka
(997) periss- = okusuusuuba
(998) peristaltic- = okusindika
(999) person- = omuntu, akakookoolo, okwefuusa
(1000) perth- = okutta
(1001) pet- = okweyunira
(1002) petal- = olulagala
(1003) petr- = olwazi
(1004) pez- = ekigere
(1005) pi- = -gonvu, -wombeefu
(1006) picr- = okukaawa, okufumita
(1007) pict- = eggondo
(1008) pig- = eggondo, ebbala
(1009) pil-[1] = oluviiri
(1010) pil-[2] = okuluka, okusona
(1011) pil-[3] = omupiira
(1012) pile- = enkuufiira
(1013) pin- = okunyuunyunta, okuwuuta
(1014) pingui- = amasavu
(1015) pinn- = ekyoya, eggindu
(1016) pio(n)- = amasavu

(1017) piper(-) = kaamulali
(1018) pisc- = ekyennyanja
(1019) pistill- = okusotta, okugotta
(1020) pithec- = enkobe, enkima
(1021) pituit- = eminyira
(1022) placent- = ekisungwa
(1023) plagi- = okukiika
(1024) plan-[1] = omuseetwe
(1025) plan-[2] = okwetaaya
(1026) plant-[1] = amala
(1027) plant-[2] = okusimbuliza
(1028) plas-, plasm(at)-
plas-, plast- = okuzimba
(1029) plec(t)- = okuluka
(1030) plei-, pli- = okusingako
(1031) pleist- = okusinga
(1032) pleo(n)- = okuwuga
(1033) pler- = okujjula, -jjuvu
(1034) plesi- = okuliraana
(1035) pleur- = olubiriizi
(1036) plex- = okuluka, okubaza
(1037) plic- = okufunya
(1038) plumb- = essasi, empulumbo
(1039) plur- = -ngi
(1040) pluvi- = enkuba
(1041) pneum(at)- = omukka, okussa
(1042) pneumon- = eriwuggwe
(1043) pneust-, pno- = okussa

(1044) po- = omuddo

(1045) pod- = ekigere

(1046) poe- = okuleetera

(1047) poecil- = eggondo

(1048) pogon- = ekirevu

(1049) pol- = empagi

(1050) poli-[1] = okuwoola

(1051) poli-[2] = okweruukirira

(1052) pollen- = enfuufu

(1053) polllec-, pollic- = ekinkumu

(1054) poly- = -ngi

(1055) pom(at)- = ekisaanikizo

(1056) pon- = okuteeka

(1057) pont- = olutindo

(1058) pont-[2] = ennyanja

(1059) popul- = abantu

(1060) por- = okuyitamu, ekyangwe

(1061) porc- = embizzi

(1062) porphyr- = kakobe

(1063) port- = omulyango

(1064) portio(n)- = ekiwumi, ekitundu

(1065) posit- = okuteeka

(1066) poster- = okuddirira

(1067) postul- = okusaba, okupeeka

(1068) pot- = okunywa, okunnyuunyunta

(1069) potam- = omugga

(1070) potent- = okusobola, amaanyi

(1071) praecox- = okweyanguyiriza
(1072) praegn- = okuwasa, okuba olubuto
(1073) press- = okunyiga
(1074) prim-[1] = okusooka, -kulu
(1075) prim-[2] = okunyigiriza
(1076) princip- = okusooka, omusingi
(1077) pri(on)- = omusumeeno
(1078) prior(-) = okusooka, okusoosa
(1079) prisma(t) = empulizima
(1080) prist- = omusumeeno
(1081) prosc- = omukono gw'enjovu, ekigalabi
(1082) proct- = ekinyo
(1083) profund- = eddubi
(1084) prol- = ezzadde, okuzaala
(1085) propaga- = okwaza,okuzaala
(1086) propri- = nnannyini
(1087) prote- = Mukasa
(1088) prot(er)- = okusooka
(11089) proxim- = okumpi
(1090) psalid- = makansi
(1091) psamm- = omusenyu
(1092) pselaph- = okukomako, okukwatako
(1093) pseud- = okulimba
(1094) psil- = -ereere, okukunama
(1095) psittac- = enkusu
(1096) psych- = omwoyo
(1097) psychr- = okuwola

(1098) psyll- = enkukunyi

(1099) pten- = okubuuka

(1100) pter- = okubuuka, ekiwawa

(1101) pteryg- = ekiwawa

(1102) ptil- = okugwa, omutulumbi

(1103) pto- = okuwanda

(1104) pty- = okuwanda

(1105) ptych- = okufunyira

(1106) pub-, puber (-) = obusajja, okusajjakula, okusonyiwala, ensonyi

(1107) pud- = okusonyiwala, ensonyi

(1108) pugn- = ekikonde, okulwana

(1109) pulch(r)- = -lungi

(1110) pulic- = enkukunyi

(1111) pulmo(n) = eriwuggwe

(1112) plup- = ennyama

(1113) puls- = okubobba, okukoona

(1114) pulver- = enfuufu

(1115) pulvin- = omutto

(1116) pumil- = omumbuti

(1117) punct-, pung- = okufumita, okutonyeza

(1118) purpur- = kakobe

(1119) –pus = ekigere, okugulu

(1120) pusill- = akatinniinya

(1121) pustul- = okuvulula

(1122) put(r)- = okuwunya

(1123) py- = amasira

(1124) pycn- = -ziyivu

(1125) pyg- = ekinyo

(1126) pygmae- = omumbuti

(1127) pyl- = omulyango

(1128) pyr- = omuliro

(1129) pyramid- = entuumu

(1130) pyren- = omulamwa

(1131) pyrrh = omuliro

(1132) phag- = okulya

(1133) phaen- = okulaga, okweraga, okulabika

(1134) phalacr- = ekiwalata

(1135) phalang- = ennyingo

(1136) phall- = oluwasiso*

(1137) phan-, phaner- = okulabisa, okwolesa

(1138) pharyng- = omumiro

(1139) phas- = okulabisa, okwolesa

(1140) phascol- = endyanga

(1141) phell- = ekizibikizo

(1142) phil- = ekwagala

(1143) phleb- = ensuwa

(1144) phob- = okutya, okukyawa

(1145) pholid- = eggalagamba, eggamba

(1146) phon-[1] = eddoboozi

(1147) phon-[2] = ettemu

(1148) phor- = okutwala, okukongojja

(1149) phos-, phot = ekitangaala

(1150) phragm(at)- = olukomera

(1151) phryn- = ekikere

(1152) phthor- = okwonoona
(1153) phy- = okukula
(1154) phyg- = okudduka
(1155) phyl- = eggwanga
(1156) phylact-, phylax- = okukuuma, okwerinda
(1157) phyll- = olulagala, ekikoola
(1158) phys-[1] = okutonda
(1159) phys-[2] = okufuuwa
(1160) phyt- = ekimera
(1161) quadr- = nnya, -na
(1162) qual- = engeri
(1163) quant- = obungi
(1164) quart- = ekyokuna
(1165) quinque- = -taano
(1166) racem- = ekibala
(1167) rad- = okukeketa, omulandira
(1168) radi- = akagulu
(1169) radic- = ekikolo, omulandira
(1170) ram-[1] = ettabi
(1171) ram-[2] = ekikere
(1172) raph-, rhaph- = okutunga, okutabira
(1173) rap(t)- = okunyakula
(1174) recent- = jjuuzi
(1175) rect- = -tuufu, okutuuka, golokofu, okufuga
(1176) reg- = kabaka, okufuga
(1177) regn- = obwakabaka
(1178) regul- = -a bulijjo, okufuga

(1179) relict = okuleka
(1180) rem- = enkasi
(1181) ren- = ensigo
(1182) rep(t) = okwewalula
(1183) rest(i) = omuguwa
(1184) ret-, retin- = akatimba
(1185) rib- = ekimera
(1186) rid-, ris- = okuseka
(1187) rip- = olubalama
(1188) rim- = okwatika
(1189) riv- = omugga
(1190) rod-, ros- = okukeketa
(1191) rostell-, rostr- = ekigalabi
(1192) rot- = nnamuziga
(1193) rub- = okumyuka
(1194) rud- = ekitanafiibwako
(1195) ruf- = -myufu
(1196) rug- = omutaafu
(1197) rumin- = okuzza obwenkulumu
(1198) rup- = olwazi
(1199) rur- = ettale
(1200) rutil- = -myukirivu
(1201) rhabd- = oluti
(1202) rhach(i) = omugongo
(1203) rhe- = okukulukuta
(1204) rhin-[1] = ennyindo
(1205) rhin-[2] = eddiba
(1206) rhiz- = ekikolo

(1207) rho- = okukulukuta

(1208) rhomb- = ennomba

(1209) rhynch- = ekigalabi

(1210) rhytid- = omutaafu

(1211) sabell-, sabul- = enkokoto

(1212) sacc- = ensawo

(1213) sacchar-, sachar = ssukaali

(1214) sacr- = -tukuvu

(1215) sagitt- = akasaale

(1216) sal- = omunnyo

(1217) saliv- = amalusu

(1218) salpingo- = omulere

(1219) salt- = okuzina

(1220) scav- = okutakula

(1221) scal- = eddagala

(1222) scand-, scans- = okulinnya

(1223) scaph- = eryato

(1224) scapul- = enkwakwa

(1225) scat- = amazi

(1226) scel-[1] = okugulu

(1227) scel-[2] = okukala

(1228) schis-, schist- schiz- = okubajjuka, okwasa

(1229) sci- = ekisiikirize

(1230) scind- = okubajjula

(1231) sciur- = ekisiikirize

(1232) scler- = okukala, okukakanyala

(1233) scop-[1] = okuluubirira

(1234) scop-[2] = okwera

(1235) scorpi- = enjaba

(1236) scot- = okuzikiza, okuziba

(1237) scrib-, script- = okuwandiika

(1238) scrob(i) = olukonko, ekinnya

(1239) sculpt- = okuwoola

(1240) scut- = okuwoola

(1241) scyph- = engabo, empaawo

(1242) secal- = omulaayi

(1243) sec(t)- = okusala

(1244) secund- = okugoberera, -okubiri

(1245) secur(i) = embazzi

(1246) sed- = okutuula

(1247) seget- = ennimiro

(1248) segment- = okusula

(1249) seism- = musisi

(1250) selen- = omwezi

(1251) sell- = entebe

(1252) sem(at)- = akabonero, amakulu

(1253) semin- = ensibo

(1254) semper- = bulijjo, olubeerera

(1255) sen- = -kadde,omuzeeyi

(1256) sens- = okukenga

(1257) sent(i) = eriggwa

(1258) sep- = olukomera, okukomera

(1259) sep- = okuvunda

(1260) sept- = okutana

(1261) septem- = omusanvu

(1262) septentrion- = obukiikakkono

(1263) seri- = okugatta
(1264) seric- = liiri
(1265) serotin- = okukyerewa
(1266) serp- = okwewalula
(1267) serr- = omusumeeno
(1268) sert- = okugatta
(1269) sess- = okutuula
(1270) set- = oluviiri
(1271) sex- = omukaaga
(1272) sexu = engabanwa
(1273) sial = amalusu
(1274) sicc- = okukala, -kalu
(1275) sid- = okutuula
(1276) sider-[1] = ekyuma
(1277) sider-[2] = emmunyeenye
(1278) sign- = akabonero
(1279) silic- = olwazi
(1280) silv- = ekibira
(1281) simi- = enkima
(1282) simil- = okufaanana
(1283) simul- = okufaanana
(1284) sin- = akabi
(1285) simplic- = -mu, -angu
(1286) sinister- = kkono
(1287) sinu- = okugota
(1288) sipho(n)- = oluseke, omulenge
(1289) –sisti- = okunyweza
(1290) sit- = emmere

(1291) situ- = ekifo

(1292) soci- = ekinywi

(1293) sol-[1] = enjuba

(1294) sol-[2] = obwomu

(1295) solen(-) = omulenge, oluseke

(1296) solid- = -gumu

(1297) som(at)- = omubiri

(1298) son- = eddoboozi

(1299) sorb-, sorpt- = okunywa

(1300) spars- = okumansa, okumansira, okusansa

(1301) spat(h)- = omulawo

(1302) speci- = okulaba, okulabika

(1303) spect- = okulaba, okwekkaliriza, okwekkaanya

(1304) spel- = empuku

(1305) sper- = okusiga

(1306) sperm(at) = ensigo

(1307) sphaer- = omupiira, enkulungo

(1308) sphen- = empano, olubanda

(1309) sphinct- = ewuzi

(1310) spic- = akasongezo, akasaale

(1311) spil- = ekko

(1312) spin- = eriggwa

(1313) spir- = okunyoola

(1314) spira- = okussa (omukka)

(1315) splanch- = enda

(1316) splen- = akataago

(1317) spend- = okwaka
(1318) spondyl- = olugongo, enkizi
(1319) spong(i)- = ekyangwe
(1320) spontan- = -kka
(1321) spor- = ensigo
(1322) spu- = amalusu, okuwanda
(1323) spum- = ekyovu, okubimba
(1324) spuri- = okukondoba
(1325) squal- = okukalabula
(1326) squam- = eggamba
(1327) sta- = okuyimirira
(1328) stabil- = okutebenkera
(1329) stabul- = ekiraalo, ekisibo
(1330) stachy- = ekirimba
(1331) stagn- = okuyimirira, ekidiba
(1332) stas- = okuyimirira
(1333) stat- = okuyimirira
(1334) staur- = empagi, omusaalaba
(1335) steat- = omuzigo
(1336) steg-,stegan- = okubikka
(1337) stel- = empagi
(1338) stell- = emmunyeenye
(1339) stemm(at)- = engule
(1340) sten- = -funda
(1341) steph-, stephan- = empeta, engule
(1342) stereor- = empitambi
(1343) stere- = -kalambavu
(1344) steril- = -gumba

(1345) stern- = ekifuba

(1346) sterr- = -kalambavu

(1347) steth- = ekifuba

(1348) stich- = okugenda

(1349) stict-, stigm(at) = okufumita

(1350) stimul- = okukyamula

(1351) stom(at)- = omumwa, omulyango, ekituli

(1352) stramin- = essubi

(1353) streph- = okunyoola

(1354) streps- = okunyoola

(1355) strobil- = okubonga

(1356) stroph- = okunyoola

(1357) stru-, struct- = okuzimba

(1358) styl- = empagi

(1359) suav- = akaloosa, obuwoomu

(1360) suber(-) = okuzibikira

(1361) subit- = embagirawo

(1362) sud- = okutuuyana

(1363) sug- = okunywa

(1364) sulfur(-) sulphur(-) = ekibiriiti

(1365) sum(pt)- = okutwala

(1366) sut- = okutunga, okutaba

(1367) syc- = omutuba

(1368) syring- = endere

(1369) system(at) = okuzimba, omugala, okuwunda

(1370) tabul- = olubaawo

(1371) tach(y)- = okwanguwa
(1372) tact-[1] = okukwatako
(1373) tact-[2] = okusaggula
(1374) taeni- = ekiwero
(1375) tal- = eggumba
(1376) tang- = okukwatako
(1377) tapet- = ekiwempe
(1378) tard- = olulembe
(1379) tars- = ekigere
(1380) taur- = ente
(1381) tax- = okutegeka, okusaggula
(1382) tect- = okukweka, okubikka
(1383) teg- = okukweka, okubikka
(1384) tel-[1] = enkomerero, okuluubirira
(1385) tel-[2] = akatimba, okuluka
(1386) tele- = ewala
(1387) tempor-[1] = ekiseera
(1388) tempor-[2] = okwebakira
(1389) ten- = okunywera
(1390) tend- = okuleega
(1391) tenebr- = enzikiza
(1392) tent-[1] = weema
(1393) tent-[2] = okuwagamira
(1394) tenta- = okukwatako
(1395) tenu- = okuweweera
(1396) terebr- = okuwummula
(1397) terg- = omugongo
(1398) term- = enkomerero

(1399) termin- = enkomerero, ensalo
(1400) terr-[1] = ensi, ettaka,
(1401) terr-[2] = okukanga
(1402) terti- = -a kusatu
(1403) test- = ettegula
(1404) test(i) = ekinege
(1405) testudin- = enfundu
(1406) tetr(a)- = -na
(1407) text- = okulika, okulanga
(1408) tigr- = entiguli
(1409) toc- = okuzaala
(1410) tom- = okusala
(1411) ton- = okulega
(1412) top- = ekifo
(1413) tormin- = obulumi
(1414) torp- = okulemala
(1415) torqu-, tort- = okunyoola
(1416) tot- = -onna,-nna
(1417) tox- = omutego
(1418) tox(ic)- = obutwa
(1419) tracheo- = omumiro, okussa
(1420) trachel- = ensingo
(1421) tract- = okukalabula
(1422) trag- = embuzi
(1423) trah- = okusika
(1424) trapez- = emmeeza
(1425) traum(at)- = ekiwundu
(1426) trem- = okuyuuguuma, okuyuuya,

okusukunda

(1427) trem(at)- = ekituli

(1428) trep- = okunyoola

(1429) tres-, tret- = okubotola

(1430) tri- = -satu

(1431) tribu- = eggwanga

(1432) trich- = oluviiri, ejjoba

(1433) trin- = -satu

(1434) trist- = okunyiikaala

(1435) trit-[1] = -satu

(1436) trit-[2] = okukuuba

(1437) tri- = -satu

(1438) tritic- = eŋŋaano

(1439) troch- = okwetogoonyola

(1440) trochle- = okwetogoonyola

(1441) trog- = okumeketa

(1442) trogl- = empuku

(1443) trop- = okukyukira, okweyunira

(1444) troph- = okuliisa

(1445) trunc- = enduli

(1446) tryp-[1] = okubotola

(1447) tryp-[2] = okubetenta

(1448) tub- = omulenge

(1449) tum- = okuzimbirira

(1450) tunic = okwambala

(1451) turb- = okubonga

(1452) turg- = okuzimba, okuwulubala

(1453) turr(i)- = omunaala

(1454) -tus- = okuggundu, okukuba
(1455) tyl- = omusumaali
(1456) tympan- = enngoma
(1457) typhl- = muzibe
(1458) thalam- = ekibeero
(1459) thalass- = ennyanja
(1460) thall- = ettabi, okututunuka
(1461) thamn- = ekisaka
(1462) thaum(at) = ekyewunyo
(1463) the- = okuteeka
(1464) thec- = ensawo, etterekero
(1465) thei- = ekibiriiti
(1466) thel- = ennywanto
(1467) thely- = omukazi, okuyonsa
(1468) ther-[1] = ensolo, okuyonsa
(1469) ther-[2] = ekyeya
(1470) therm- = ebbugumu
(1471) thigm- = okukwatako
(1472) thorac- = ekifuba
(1473) thix- = enviiri
(1474) thromb- = ekibembe, okubemba
(1475) thylac- = ensawo
(1476) thym- = okwoteza
(1477) thyre- = engabo
(1478) ubi- = -onna, wonna
(1479) uligin- = okutoba
(1480) umbell- = ekisiikirize
(1481) umbilic- = ekkundi

(1482) umbo- = engabo
(1483) umbr- = ekisiikirize
(1484) un- = -mu, emu
(1485) unc(in) = eddobo
(1486) und- = ejjengo
(1487) ungu- = olwala
(1488) ur-[1] = omukira
(1489) ur-[2] = enkali, okunyaala
(1490) ur-[3] = okwokya
(1491) urb- = ekibuga
(1492) urs- = eddubu
(1493) urtic- = okwokya
(1494) ust- = okwokerera, okubabula
(1495) us-, ut- = okukozesa
(1496) uter- = nnabaana
(1497) vacc- = ente
(1498) vacu- = -ereere
(1499) vag- = okukyukakyuka
(1500) vagin- = olulaato*
(1501) vapor(-) = omukka
(1502) vegeta- = okulama
(1503) veh- = okusika
(1504) veller- = ekyoya
(1505) veloc- = okwanguwa
(1506) ven- = omusuwa
(1507) vena- = okuyigga
(1508) vent-[1] = okujja
(1509) vent-[2] = kibuyaga

(1510) ventr- = olubuto
(1511) verg- = okwolekera
(1512) verruc- = ensundo
(1513) ver- = amazima
(1514) vers-, vert- = okutabika, okukyuka
(1515) vertebr- = olugongo
(1516) vertic = okwesimba
(1517) vesc- = okuliika
(1518) vesic- = ekyovu
(1519) vesper(-) = -a ggulo
(1520) vest(i) = olugoye, okwambala
(1521) veterin- = ensolo
(1522) vexill- = ebbendera
(1523) vi- = ekkubo
(1524) vibr- = okukankana
(1525) vid- = okulaba
(1526) viginti(-) = abiri
(1527) vimin- = okuluka
(1528) vin- = evviino
(1529) vir-[1] = omusajjja
(1530) vir-[2] = obutwa, akaviiro
(1531) virg- = ettabi
(1532) virgo- = omubiikira
(1533) vis-[1] = okulaba
(1534) vis-[2] = amaanyi
(1535) viscer- = ebyomunda
(1536) vit- = obulamu
(1537) viv- = -lamu

(1538) voc- = eddoboozi

(1539) vol- = okubuuka

(1540) vor- = okulya

(1541) vulp- = ekibe

(1542) xanth- = kyenvu

(1543) xen- = omugenyi, omugwira

(1544) xer- = -kalu

(1545) xiph- = ekitala

(1546) xyl- = omuti

(1547) zo- = ensolo

(1548) zon- = bbunwe, olubunwe

APPENDIX C:

DOCUMENTS RELATING TO FIELDWORK

(1) Letter of Invitation

(2) Pre-workshop Questionnaire

(3) List of Participants (2nd December, 1995)

(4) List of Participants (9th December, 1995)

(5) List of Participants (16th December, 1995)

(6) Problems for Group Work

R E D E N E T

RESEARCH AND DEVELOPMENT NETWORK
P. O. Box 2525, KAMPALA, Uganda Tel: 231709

November 24, 1995

TO: _____
_____
_____
_____

RE: WORKSHOP ON FORMATION AND TESTING OF SCIENTIFIC CONCEPTS IN LUGANDA

You are cordially invited to participate in a one-day workshop on the formation and testing of scientific concepts in Luganda. The workshop will be held in the Faculty of Education, Makerere University on December 1995 from 9.am to 4.30 p.m. We shall provide allowances to cover the cost of lunch and refreshments. Your travel expenses will also be refunded.

The main objective of the workshop is to enable participants to:

- Learn about the approaches and methods used in building concepts in Mathematics, Physics, Chemistry and Biology.

-Examine and give their critical opinion about how these concepts have been expressed in Luganda on the basis of a systematic method of terminological elaboration achieved by a Ugandan linguist who has also trained in the formal sciences.

Terminological elaboration consists in enabling a language to function as a medium of specialised discourse. This is done by enriching it with expressions and expressional elements which are precise, economical, generative, international, transparent,non-obscene, systematic and linguistically acceptable in terms of expression formation, orthography, historical precedence, pronunciation and expression ordering.

Only a tiny portion of formal and natural science is at present expressed in Luganda especially at the secondary and tertiary levels of education. Therefore, the main task of the workshop is to arrive at a blueprint for elaboration of a list of scientific terms in Luganda.

If you accept to participate, we shall be grateful if you could fill in the attached questionnaire which will form an important in-put in the proceedings of the workshop. The questionnaire should be handed in before the opening of the workshop.

The tentative workshop agenda is as folows:

1. Welcome by the Coordinator of REDENET.
2. Self introduction by participants.
3. Familiarisation of the participants with criteria for terminology and Concept Formation Rules(CFRs).
4. Marking of scientific concepts in Luganda.
5. Extrapolation Luganda Expression Formation Rules (EFRs).
6. Application of scientific terminology (mathematics, physics, chemistry, biology) in Luganda.
7. Division of participants into subject groups to:
   (a) critique terminological systems and translated texts on the basis of the criteria for terminology.
   (b) make their own translation of term lists and short texts.

8. Plenary discussion of the results, under (7).
9. Presentation and discussion of questionnaire findings.
10. Evaluation of the workshop by participants.

Thanking you and looking forward to seeing you at the workshop.

E. Mukasa
COORDINATOR

R E D E N E T

RESEARCH AND DEVELOPMENT NETWORK
P.O. Box 2525, KAMPALA, Uganda Tel: 231709

QUESTIONNAIRE ON ATTITUDES TO THE ROLE OF LUGANDA IN SCIETIFIC AND TECHNOLOGICAL DEVELOPMENT IN UGANDA. 1995

(Please write or mark with [X] where it applies)

1. Date: .....
2. Name: .....
3. Age
   - ☐ 21-30
   - ☐ 31-40
   - ☐ 41-50
   - ☐ 51-60
   - ☐ 61-70
   - ☐ 70-
4. Sex Male ☐ Female ☐

5.Occupation .....
3. Do you work in a rural or urban area? .....
4. Education:
   - ☐ Secondary
   - ☐ Tertiary

8. Have you ever worked outside your home region Yes ☐ No ☐
   If yes, where and for how long?
9. Have you ever worked outside your home region? Yes ☐ No ☐
   If yes, where and for how long? .....

11. Which language do you speak?

☐ Luganda English☐ Others ☐

.....

11. Were you ever taught science subjects in Luganda .....
Up to what class? .....

12. Did you ever study Luganda as a subject? .....
Up to what level? .....

13. Which language is most likely to give you power and influence if you speak it very well? .....

14. Do you think languages has any relationship to scientific and technological development?

☐ Yes

☐ No

(a) If yes, why?

.....
.....
.....
.....

(b) If no, why?

.....
.....
.....
.....
.....

(15) Have you ever thought of the possibility of learning science and technology in Luganda?

☐ Yes

☐ No

(10) Do you think Luganda can express scientific ideas at the

Primary level? ☐

Secondary level? ☐

Tertiary level? ☐

17. If you think Luganda express scientific ideas at the Primary ☐ Secondary ☐ Tertiary ☐ Levels, could the language be developed to be able to express scientific ideas?

Yes ☐

No ☐

If yes, why do you think this has not been done?

.....
.....
.....
.....

18. If it were possible to study science and technology even at University level in Luganda, do you think most people in your profession would be happy with the idea?

☐ Yes

☐ No

If no, why?

.....
.....
.....
.....

19 Do you think it would be easier at school if science were taught in Luganda?

☐ Yes
☐ No

If yes, what advantages and disadvantages could this bring?

.....
.....
.....

19 Do you think there ia any chance of expressing scientific and technological ideas in Luganda at some point in the future?

.....

.....

.....

(21) Would the idea of expressing scientific and technological ideas in Luganda make English unncessary?

☐ Yes

☐ No

Please explain

.....

.....

.....

Thank you for your co-operation.

FIRST WORKSHOP ON FORMATION AND TESTING SCIENTIFIC CONCEPTS IN LUGANDA HELD AT MAKERERE ON 02/12/1995

LIST OF PARTICIPANTS

NAME	SUBJECT/FIELD	INSTITUTE/ADDRESS
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KABOGGOZA MUHAMMED	LUGANDA/ ENGLISH	BUSUNJU ISLAMIC PRIMARY SCHOOL P.O.BOX 30 BUSUNJU
KATIKAJJIIRA HAMIDU	MATHEMATICS/ STATISTICS	S.K HOLDING P.O.BOX 4105 KAMPALA, UGANDA
KAZIRO B.K	CHEMISTRY	MAKERERE COLLEGE SCHOOL P.O.BOX 16391 KAMPALA, UGANDA
KENTARO JILL	ENGLISH	MAKERERE PRIMARY SCHOOL P.O.BOX 16049 KAMPALA, UGANDA
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HARRIET MAYANJA	PHYSICS/ CHEMISTRY	GAYAZA HIGH SCHOOL P.O.BOX 709 KAMPALA, UGANDA
MUKASA E.	PROJECT COORDINATOR	REDENET P.O.BOX 2525 KAMPALA, UGANDA
MUNGOMA P. MWALYE	CURRICULUM	MAKERERE UNIVERSITY P.O.BOX 7062 KAMPALA, UGANDA
NABALOGA BETTY	SCIENCE	GAYAZA GIRLS' PRIMARY SCHOOL P.O.BOX 16715 KAMPALA, UGANDA
NAKAMYA REBECCA	BIOLOGY CHEMISTRY	ITEK/BISHOP SENIOR SCHOOL MUKONO P.O.BOX 1 KAMPALA, UGANDA
NAKIMERA SSEMANDA.	GEOLOGY	DEPARTMENT OF GEOLOGY MAKERERE UNIVERSITY P.O.BOX 7062 KAMPALA, UGANDA
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SSEMMONDO JOHN	CHEMISTRY/ PHYSICS	MENGO SECONDARY SCHOOL P.O.BOX 1901 KAMPALA, UGANDA
ZINUNULA ROSE D.	LUGANDA/ SCIENCE	OMEGA PRIMARY SCHOOL MULAGO

SECOND WORKSHOP ON FORMATION AND TESTING OF SCIENTIFIC CONCEPTS IN LUGANDA

HELD AT MAKERERE ON 09/12/1995

LIST OF PARTICIPANTS

NAME	SUBJECT/FIELD	INSTITUTION /ADDRESS
KABUGO MERIT	LINGUISTICS	MAKERERE UNIVERSITY P.O. BOX 7062 KAMPALA, UGANDA
KAKEMBO SAM	BIOLOGY/ CHEMISTRY	NDEJJE SECONDARY SCHOOL P.O.BOX 193 BOMBO
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KIRIGGWAJJO A.	FRENCH/ ENGLISH	MAKERERE UNIVERSITY INSTITUTE OF LANGUAGES P.O.BOX 7062 KAMPALA, UGANDA
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NAKIBUULE BETTY	SCIENCE/ MATHEMATICS	RUBAGA GIRLS PRIMARY SCHOOL P.O.BOX 1347 KAMPALA, UGANDA
NAKIWALA BETTY	SCIENCE	NKUMBA PRIMARY SCHOOL P.O.BOX 66 ENTEBBE, UGANDA
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NDWADDE PAULINE	MATHEMATICS	ST. JOSEPH'S GIRLS SECONDARY SCHOOL NSAMBYA P.O.BOX 6091 KAMPALA, UGANDA
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SEMBATYA BADRUDIN	BIOLOGY/ GEOGRAPHY	NEW BUSUNJU COLLGE P.O.BOX 30 BUSUNJU, UGANDA
SENKUBUGE DANIEL	MATHEMATICS	MUKONO HIGH SCHOOL P.O.BOX 353 KAMPALA, UGANDA
SSEBULIBA GEORGE	CHEMISTRY/ BIOLOGY	CALTEC ACADEMY P.O.BOX 30921 KAMPALA, UGANDA
SSEMUJJU J. WASSWA	MATHEMATICS/ GEOGRAPHY	NABISUNSA GIRLS SCHOOL P.O.BOX 3027 KAMPALA, UGANDA
ZINUNULA VINCENT	GERMAN/FRENCH	INSTITUTE OF LANGUAGES MAKERERE UNIVERSITY P.O.BOX 7062 KAMPALA, UGANDA

THIRD (COMBINED) WORKSHOP ON FORMATION AND TESTING OF SCIENTIFIC CONCEPTS IN LUGANDA

HELD AT MAKERERE UNIVERSITY ON 16/12/1995

LIST OF PARTICIPANTS

NAME	SUBJECT/FIELD	INSTITUTE/ADDRESS
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NAMYALO SAUDAH	LANGUAGES	MAKERERE UNIVERSITY P.O.BOX 7062 KAMPALA, UGANDA
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SEKITTO EDWARD	SCIENCE	GAYAZA JUNIOR SCHOOL P.O.BOX 4073 KAMPALA, UGANDA
SEMBATYA BADRUDIN	BIOLOGY/ GEOGRAPHY	NEW BUSUNJU COLLEGE P.O.BOX 30 BUSUNJU, UGANDA
SENKUBUGE DANIEL	MATHEMATICS	MUKONO HIGH SCHOOL P.O.BOX 353 KAMPALA, UGANDA
SSEBULIBA GEROGE	CHEMISTRY/ BIOLOGY	CALTEC ACADEMY P.O.BOX 30921 KAMPALA, UGANDA
SSEGGIRINYA J. K.	MATHEMATICS/ CHEMISTRY	NAMILYANGO COLLEGE SCHOOL P.O.BOX 7091 KAMPALA, UGANDA
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SSEMMONDO JOHN	CHEMISTRY/ PHYSICS	MENGO SECONDARY SCHOOL P.O.BOX 1901 KAMPALA, UGANDA

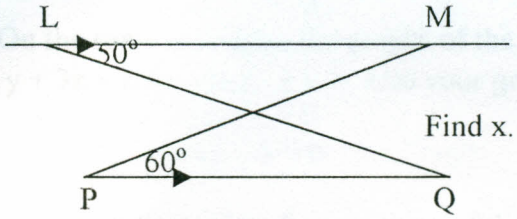
SSEMUJJU J. WASSWA	MATHEMATICS/ GEOGRAPHY	NABISUNSA GIRLS SCHOOL P.O.BOX 3027 KAMPALA, UGANDA
ZINUNULA VINCENT	GERMAN/FRENCH	INSTITUTE OF LANGUAGES MAKERERE UNIVERSITY P.O.BOX 7062 KAMPALA, UGANDA

THIRD WORKSHOP ON FORMATION AND TESTING OF SCIENTIFIC CONCEPTS IN LUGANDA HELD AT MAKERERE UNIVERSITY ON 16/12/1995

PROBLEMS TO BE TRANSLATED INTO AND SOLVED IN LUGANDA

GROUP A

1. Find the next number in the sequence 9, 3, 1, 1/3 .....
2. Solve $y/2 - 3 = 5$
3. In the diagram below, LM is parallel to PQ



4. Mary is x years old. She is twice as old as Peter. Express Peter's age in terms of Mary's age.
5. In a class, there are 60 girls and 30 boys. What is the probability of choosing a girl as a Class Monitor?
6. By forming an equation, find 3 consecutive numbers which add up to 135.
7. a) Describe how sound is produced.
   b) Why is it difficult for sound to travel across or through a vacuum?
   c) Give two examples of devices (objects) which are used to store and reproduce sound.
8. a) Draw two diagrams to show:-
      i) the two parts of a shadow;
      ii) refraction of light.
   b) When does a lunar eclipse occur?
   c) Besides helping plants to make their food, give one other importance of light to human beings.
9. Great amounts of sugar in our bodies is dangerous, because it leads to a disease called .....
10. Which group of invertebrates has been described as follows: no wings, two body parts, four pairs of legs?

THIRD WORKSHOP ON FORMATION AND TESTING OF SCIENTIFIC CONCEPTS IN LUGANDA

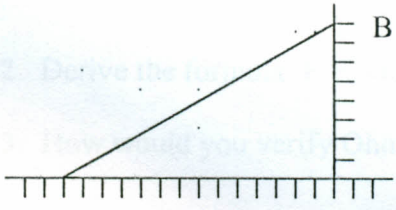
HELD AT MAKERERE UNIVERSITY ON 16/12/1995

PROBLEMS TO BE TRANSLATED INTO AND SOLVED IN LUGANDA

GROUP B

1. Given that $5/\sqrt{5} + \sqrt{20} = a\sqrt{5}$, determine the value of a.
2. If vectors $\mathbf{a} = \begin{pmatrix} 3 \\ -2 \end{pmatrix}$ $\mathbf{b} = \begin{pmatrix} 1.5 \\ 3 \end{pmatrix}$, find the length of $\frac{1}{2}\mathbf{a} + 3\mathbf{b}$.
3. On the same axis draw the graphs of the lines $y-2x = 1$, and $y + 3x = 6$ for $-3x \leq x \leq 3$. Use your graphs to solve the equations:
   $y - 2x - 1 = 0$
   $y + 3x - 6 = 0$

   Hence determine the equations of the line passing through the point of intersection of the two equations above whose y- intercept is 2.
4. Prove that the angle sum of a triangle is 180°.
5. Derive the quadratic formula.



B The adjoining diagram shows a uniform ladder AB of of weight W length l leaning against a wall.
It makes an angle θ with the ground. If the coefficeint of friction at A is μ and the wall is smooth, how far can a worker of weight W' climb up the ladder before it slips?

6. Show without using a formula, that if $y = a x^2 + c$, where a and c are real constants, then $dy/dx = 2ax$.

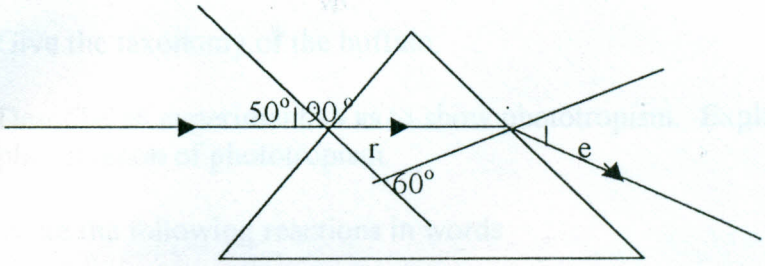
THIRD WORKSHOP ON FORMATION AND TESTING OF SCIENTIFIC CONCEPTS IN LUGANDA

HELD AT MAKERERE UNIVERSITY ON 16/12/1995

PROBLEMS TO BE TRANSLATED INTO AND SOLVED IN LUGANDA

GROUP C

1. (a) The diagram shows a ray of yellow light incident at an angle of 50° on one side of an equilateral triangular glass prism of refractive index 1.52.



(i) Calculate the angles marked r and e.

(ii) State and explain what would be observed if the ray above were of white light.

2. Derive the formula **F** = **ma**.

3. How would you verify Ohm's Law?

THIRD WORKSHOP ON FORMATION AND TESTING OF SCIENTIFIC CONCEPTS IN LUGANDA HELD AT MAKERERE UNIVERSITY ON 16/12/1995

PROBLEMS TO BE TRANSLATED INTO AND SOLVED IN LUGANDA

GROUP D

.1. (a) What is pollination?
(b) Describe the process that takes place after pollination in a flowering plant.
(c) Give three differences between insect pollinated and wind pollinated flowers

2. Give the taxonomy of the buffalo.

3. Describe an experiment so as to show phototropism. Explain the phenomenon of phototropism.

4. Write the following reactions in words

(a) $PbO + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_20$

(b) $CaC0_3 + 2HNO_3 \rightarrow Ca(N0_3)_2 + C0_2 + H_20$

(c) $Cu + 4HNO_3 \rightarrow Cu(N0_3)_2 + 2N0_2 + H_20$

(d) $NaOH + HNO_3 \rightarrow NaNO_3 + H_20$

(e) $Fe + 2HCl \rightarrow FeCl_2 + H_2$

(f) $NH_3 + H_2O \rightarrow NH_4OH$

(g) $NaOH + HNO_3 \rightarrow NaN0_3 + H_20$

(h) $2H_2 + O_2 \rightarrow 2H_2O$

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