# The Distinction between Terminology versus Orismology and Its Application to Mathematical Chemistry

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The definition of terms, especially in the sciences, often is "adjusted" as new knowledge and insights are gained. Such alterations frequently focus attention on slight differences in the desired denotation of words, which, until that new perspective, had previously been **absolutely** synonymous. The metonymic misusage of words in chemistry and mathematics can have deleterious effects versus the usually inconsequential effect of a similar misusage in common parlance. Two important terms—*terminology* and *orismology*—are examined, assigning the currently accepted definition of a term in a specific discipline to *terminology* and the evolutionary history of that term to *orismology*.

## 1. INTRODUCTION

**Words! Words! Words!** The same irritation expressed by Eliza Doolittle in the song from *My Fair Lady* is precisely the sentiment expressed by some chemists whenever the subject of terminology is raised. Like Eliza, they wish that all articles about chemistry would "Show Me", or at the very least, because this is the printed media and not a laboratory, describe some "real" chemistry. All attempts, especially by the more mathematically inclined members of our profession, to formalize ***any*** aspect of terminology raises hackles. In fact, the entire subject of the precision of meaning of words to describe various subtle differences in the message being transmitted is, to many, merely a nuisance. Nevertheless, despite such a prejudice, the search for understanding and knowledge **cannot** be separated from the words that are used.

In order that the desired transfer of information from transmitter to receiver take place, words **must** be capable of describing both everyday objects and occurrences, as well as those more abstract ideas that can be formulated using only our thought processes. Toward this end we note that *word*, in common parlance, is defined as[1] "a speech sound or series of sounds that symbolizes and communicates a meaning without being divisible into smaller units capable of independent use". However, in science, need for a far greater degree of precision resulted in creation of the words *term* and *terminology*; *term* is defined as "a word or expression that has a precise meaning in some uses or is peculiar to a science, art, profession, or subject",[2] and the suffix *-ology* in terminology denotes "the study (or science) of".

Inasmuch as science, in particular (as well as practically every other human endeavor), is an on-going study, we observe that as more knowledge is acquired, we continuously refine and continually[3] re-define the words that we use. Furthermore, in science, the interchange of "nearly identical" words often results in the creation of significant problems in communicating complex ideas; problems that could be easily side-stepped in less demanding communications. For example, the misuse of the word "podium" in place of "lectern"[4] or "extemporaneous" when the meaning is "impromptu"[5] in public speaking may sound dissonant to an aficionado in the subject; however, *except in* ***very*** *rare instances*, there is no loss of communication, even to the expert, by such sloppiness. Because this practice is so common, it is expressed as an important figure of speech, called "metonymy".[6,7] In general, the metonymic **misuse** of a word is readily interpreted **correctly** by the receiver of the information, with the concomitant result that the desired communication is completed, *without error or ambiguity*.

The misuse of a word in science, on the other hand, frequently conveys the **wrong** information. For example, we have recently been concerned by the media's use of the word "flu", when "influenza" was the intended medical denotation. The problem arises because, despite the obvious etymology of "flu" from "influenza", the former is a layman's word referring to *any* serious respiratory virus versus the medical term that is limited to exactly two (or perhaps three) specific virus strains. Consequently, when medical researchers report on a new drug to treat influenza,[8] the media,[9] and even the chemistry media,[10] often does not fully understand either the chemistry or the biology involved. As a consequence, through the misuse of terminology, the media misreports this information, thereby raising unrealistic expections in the general public.

## 2. SOME IMPORTANT TERMINOLOGY IN GEOMETRY

Note that problems with what meaning various words were to have has been a recurring theme in all of recorded history, especially in the mathematical sciences. One need only look at the first consistent codification of mathematical thought by Euclid[11] about 300 B. C. and his use of two distinct words: *axiom* (derived from the Greek meaning *common conceptions of thought*, which, according to Young,[12] "...are intended to state fundamental notions of logic in general, which may be regarded as valid in any science"); and *postulate* ("... seem to be intended as primitive propositions

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concerning space") versus the modern perspective in teaching geometry in which there is no such differentiation. This definition is in contradistinction to the prevailing cultural bias of the times that gives to the term *axiom* the connotation of an unproved proposition that is thought to be perfectly clear to all; that is, a self-evident truth versus the term *postulate*, which, while also referring to an unproved proposition (which has equally been admitted as true without proof), is accepted for pragmatic reasons rather than "self-evidence". Note that Webster's New Collegiate Dictionary defines *axiom*[13] as 1. a maxim widely accepted on its intrinsic merit, and 2. a proposition regarded as a self-evident truth, whereas *postulate*[14] is defined as 1. a hypothesis advanced as an essential presupposition, condition, or premise of a train of reasoning, and 2. axiom.

Because of the advances of sciences, especially in the twentieth century, scientists no longer consider that *any* proposition is self-evident and thus the historical distinction has been discarded. The aforementioned coalescing of two diverse ideas into a single one is very much the exception today. In fact, with most advances in science, as new knowledge is gained, diverse ways of describing some phenomenon are seen as leading in different directions. Consequently, two terms that were previously *strictly synonymous* before the new perspective was gained may now be differentiated, with one term taking on one connotation and the other a slightly different one exactly as the words "flu" versus "influenza" already mentioned.

## 3. HISTORICAL INTRODUCTION OF THE TERM *ORISMOLOGY*

We are now ready to introduce a new and important branch of knowledge that overlaps nearly all of both science and language, called **orismology**. Note that this word is derived from the Greek word **horismos** meaning "definition" and the same suffix **ology** that we had used in *terminology*. Although the original denotation of this word was absolutely synonymous with *terminology*, according to the Oxford English Dictionary,[15] the word was first used in 1816 with the intent of achieving linguistic purity because the common word *terminology* had mixed etymology, that is, the first half of the word was derived from Latin "terminus" = "expression," whereas the second half was from Greek. The word *orismology*, conceived "... to avoid the barbarism of a word compounded of Latin and Greek", apparently never was well-received in the general community and it is only in very recent times that a special nuance of meaning, distinct from that implied by the use of the word *terminology*, has arisen in science that has resurrected this otherwise neglected word.

Rather than tracing the development of language and it uses for both sociopolitical as well as scientific purposes, let us instead focus strictly on our ability (or lack thereof) to convey information. Unless we are willing to live in a Lewis Carroll world, we cannot accept Humpty Dumpty's premise[16]: "When I use a word, it means just what I choose it to mean—neither more nor less!"

## 4. ORISMOLOGY AND CHEMISTRY

Our first encounter with the concept we now refer to as "orismology" occurred in 1968[17] in an article in which we noted that the line of demarcation between what the chemistry community now refers to as "chirotopic" (from the Greek word for "hand," as in the mirror image relationship between our left and right hands) versus "stereogenic" (from the Greek word for "solid"; i.e., three-dimensional)[18] could be traced to the fact that with coordination equal to four, mirror image differences were identical to three-dimensional positioning of different ligands about a central atom—as was common with the set of then-known molecules, especially the sugars. We then noted that for higher coordination compounds (viz., those with coordination = 6) with differentible ligands, this equality was no longer valid and that an entire new class of chemical compounds would be viable.

At that time we noted that the various familiar organic chemistry textbooks of the time had used two different words to describe this mirror image/coordination = 4 equity, enantiomer or enantiomorph, with absolutely no distinction between the two terms. (The etymology of these two words is from the Greek *enantios* = opposite and either *-mer* = part or *-morph* = form[19].) Consequently, in our proposed expansion to higher coordination we **arbitrarily** assigned the suffix *-mer* to the mirror property and *-morph* to the metric property. In other words, in that report we described 30 potential enantiomorphs of a hexa-substituted sulfur compound, which occurred as 15 pairs of enantiomers (mirror images).

In the intervening time, as far as chemistry is concerned, we note that for the most part, the word *enantiomorph* seemed to have been relegated to the dustbin. Although not listed as obsolete, it has been replaced almost exclusively by the term *enantiomer* in **all** of the modern chemistry textbooks available in several local public and college libraries that we have consulted. This is notwithstanding the fact that one major **new** usage of this term will be discussed later.

## 5. TERMINOLOGY IN MATHEMATICS AND IN GENERAL USAGE

Next, by contrast, we find a major difference in the choice of words used by nonchemical mathematicians. Here, the term *enantiomorph* is in common usage. For example, in a 1996 book about Lewis Carroll[20]: "The Tweedle brothers are what geometers call enantiomorphs—mirror reflections of each other." Furthermore, in an informal survey that we made of several geometers (who were not also chemists), **not one** had ever used the term *enantiomer* or had ever seen it used in the mathematical literature; however, **all** were familiar with the term *enantiomorph*.

As well as noting the difference between the terminology used in chemistry versus mathematics for this concept of mirror image relationship, we also observe the terminology used in general dictionaries and encyclopedias. Although the concept embodied by *enantiom—* was a chemistry one **long before** it was adopted by the mathematics community, the general reference books (both dictionaries and encyclopedias) either do not include the preferred chemistry term *enantiomer* at all (The Oxford English Dictionary[21]) or else regard *enantiomorph* as the principle term and *enantiomer* as an indistinguishable synonym (Webster;[22] McGraw-Hill;[23] American Heritage;[24] Funk & Wagnalls[25]).

## 6. MORE ABOUT ORISMOLOGY AND CHEMISTRY

Before probing the denotations and connotations of the term *orismology* [as we have used it in a series of articles entitled: "Orismology and the Geometrical Foundations of Chemistry",[26] and our usage of the concept (without including the term) in various seminal reports that lead up to this series, wherein we first examined and then analyzed the hidden meanings in our usage of familiar words, such as "straight", "fused", etc., as well as in our ongoing chemistry studies[27] and in a theoretical calculus study[28]], it is desirable that we return to the one major reusage of the term *enantiomorph* in chemistry mentioned in Section 4; that is Eliel[29] considers that to use this term as a synonym for *enantiomer* is erroneous; instead he assigns as its meaning: "One of a pair of chiral objects, such as molecular models, or crystals, that are nonsuperposable mirror images." In other words, he has anticipated our general recommendation (see Section 8) and has recognized a small niche and then assigned the lesser used of the two terms to be **precisely** (and **only**) applied to describe that niche, while leaving the more used term with its present connotation. Note that by Eliel's perspective, the terminology of *enantiomorph* **as applied to chemistry** should be ONLY the one he has so denoted. In a similar manner, mathematicians assert that the terminology of that same word **as applied to mathematics** should be the mirror image property.

## 7. AN OVERVIEW OF CHEMICAL NOMENCLATURE

The term *nomenclature*, derived from the Latin for "name calling", seems to have been used with two diverse connotations in chemistry. In the first and most common usage, a systematic assignment algorithm is established coupling a molecule with a name. This coupling is accomplished by giving phonemic names to distinct molecular attributes; such as the *a*, *e*, and *y* in alk*a*nes, alk*e*nes, and alk*y*nes, respectively. This corresponds to the terminology of the noun *nomenclature*. Additionally, in the historical development of chemical nomenclature, we note the evolution of distinct taxonomy classes, so that despite its apparent composition as a six-member carbon ring with three double bonds, benzene is not properly represented by the name 1,3,5-cyclohexatriene. This point is salient point in the orismology of chemical nomenclature. In this perspective, orismology involves studying entirely new criteria for canonically organizing and then naming formulations of matter. Two recent examples of such a perspective for orismological systems are nodal nomenclature[30] and our development of Matula numbers to cover heteroatoms and ring compounds.[31]

## 8. A SUPERFICIAL EXCURSION INTO LOGIC

A **not insignificant** item that should be addressed to enhance the distinction between orismology and terminology is supplied by this present sentence. By using a double negative we have "apparently" reaffirmed the original word; that is, *significant*. Note that we assign identical meaning to the combination of the word *significant* with the inclusion of either the negating prefix *in-* or the negating word *not*. Either combination denotes the opposite of the original single word. In pure Aristotlean or Boolean logic, the use of a second negation simply returns the meaning to the original one, inasmuch as such systems are capable of treating only value-neutral, unambiguously defined words and relationships. On the other hand, in normal parlance, we do not have such closed (consistent) systems **AND** the connotation of *not insignificant* is **not identical** to the single word *significant*; namely, there is a stronger affirmation of significance in the single word than in the double negation. Consequently, even in scientific usage, we often encounter some (to the perspective of the pure logician) undesirable expansion of any system by the use of a logical primitive operation; such as negation. The single unambiguous concept that we wish to ascribe to the definition of a word in the context in which it is being used forms the essence of its *terminology*; however, all other connotations that may reasonably be affixed to the word, as well as any further implications that can be deduced, contributes to the historical basis for the *orismology* of that term.

Because of the aforementioned logic, we hereby propose that whenever two absolutely synonomous words have been in common usage, there is negligibly little to be gained by continuing this practice. Instead, we have the opportunity of communicating fine lines of distinction between some special attributes by the proper assignment of exactly one of these words to each of two different nuances. Consequently, we recommend using the term *orismology* to indicate a systematic study of the entire historical evolution of the word being defined versus *terminology*, which is the present denotation that this word has to some specific audience. An equally valid way of considering these two words is to view orismology as functioning at the system level in contradistinction to terminology which operates at the unit level.

## REFERENCES AND NOTES

(1) *Webster's New Collegiate Dictionary*; G & C Merriam: Springfield, MA, 1981; p 1340.
(2) *Webster's New Collegiate Dictionary*; G & C Merriam: Springfield, MA, 1981; p 1194.
(3) Note the difference in nuance of meaning between *continually*, which connotes completed action frequently reoccurring in discrete time intervals versus *continuously*, which connotes ongoing (uninterrupted) action. This difference exists even though both of these words are derived from the same Latin word *continuus* and are listed as absolute synonyms in most dictionaries.
(4) *Podium* denotes the place where a speaker stands, in contradistinction to the piece of furniture, called a *lectern*, behind which they often stand and on which they may place notes or selected props.
(5) An *impromptu* speech is one given immediately with zero time to prepare your thoughts, excluding, perhaps, that of moving from your seat to the lectern. An *extemporaneous* speech, on the other hand, is one in which the speaker is given substantially less time than is usual to prepare such a speech, perhaps 20 to 30 minutes versus the usual weeks of preparation. Consequently, the speaker may make notes to assist them in organizing their thoughts as well as being able to fashion crude props in that time interval.
(6) Metonymy is defined[7] as "a figure of speech consisting of the use of the name of one thing for that of another of which it is an attribute or with which it is associated."
(7) *Webster's New Collegiate Dictionary*; G & C Merriam: Springfield, MA, 1981; p 718.
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(13) *Webster's New Collegiate Dictionary*; G & C Merriam: Springfield, MA, 1981; p 79.
(14) *Webster's New Collegiate Dictionary*; G & C Merriam: Springfield, MA, 1981; p 892.
(15) *The Oxford English Dictionary*, 2nd ed. 1989, Clarendon: Oxford, U. K., 1989; Vol. X, p 936.
(16) Carroll, L. In *Alice In Wonderland*; Gray, D. J., Ed.; W. W. Norton: New York, 1971; p 163.
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(18) Mislow, K.; Siegel, J. Stereoisomerism and Local Chirality *J. Am. Chem. Soc*. **1984**, *106*, 3319−3328.
(19) *Webster's New Collegiate Dictionary*; G & C Merriam: Springfield, MA, 1981; p 371 (for *enantios*). Note that on this page *enantiomer* has as its **only** definition *enantiomorph*. The denotation of the suffix *-mer* (in isomer) is on p 608 and that of the suffix *-morph* is on p 743.
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