

## The Importance of Semiotic Representations in Chemistry Teaching

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Currently, a growing interest in the investigation of processes of scientific meaning is seen as several authors have importance in investigating the use in science teaching. These studies show how ways of understanding have been thought of in the school context.

“There are few uses of sign representation processes by chemistry teachers, since the conceptual and mathematical aspects have been of preponderant use in visual aspects such as the use of images, schemes, graphs and etc.)” Habraken [1,2].

This work, used as a theoretical basis, allows a semiotic view of Peircean, since it builds concepts such as representation, ignorance and significance, and also the Johnstone model for the representation of chemical knowledge.

### Peircean semiotics

Peircean semiotics is a complex discipline, consisting of an architecture of philosophical and linguistic thoughts with a general and abstract character, making use of areas such as aesthetics, logic and metaphysics.

“Semiotics is divided into three branches to be known, speculative grammar, critical logic and speculative rhetoric [3].”

Speculative grammar studies the various types of signs, critical logic studies the different types of inferences, reasoning and arguments, and finally speculative rhetoric which aims to analyze the different methods to which each type of reasoning originates.

We will now show some important concepts of Peircean semiotics.

The image according to Peirce’s semiotics is not constructed by the subject, the image is perceived and related to the construction of a new sign. Therefore, Peirce’s semiotics presents a new view on the processes of construction of chemical knowledge, which, however, is permeated by signs.

The representation of Peirce’s theory point of view is seen as a content apprehended by the senses, by memory and thoughts. In Peirce’s conception, a sign is what represents something to someone, perceived under some of its aspects, taking the place of something else, instead of the entity itself, that is, one only perceives what one is able to interpret.

### Peirce’s semiotic triad

The semiotic relations are triadic, involving the sign, the object that the sign is representing and its interpretant, the sign is considered an element of communication that represents something, the interpretant is the receiver of this sign. We can therefore extend the semiotic triad to the pedagogical area, thus forming a pedagogical triad that involves the following terms: perceiving, relationship and conceptualization. From a didactic point of view, representation can be seen as a dynamic, mediated and systematic process. “We must consider that when proposing a scientific theory involves several moments where the pedagogical triad can lead to several dynamic interpretants” [4].

We can still relate this triad with characteristics of rheme, dicent and argument.

When a sign in relation to its interpretant is a sign that represents quality, it is a rheme. It is a sign of qualitative possibility that represents a type of object.

When the sign is characterized in relation to its interpretant in an existential way, it is called dicent, it determines an action or judgment of the interpretant.

When the sign refers to its interpretant a law, this is characterized as an argument.

### Johnstone's triangle

"According to Johnstone, chemical knowledge can be represented by three levels: the macrochemistry of the tangible, edible and visible, the molecular, atomic and kinetic submicrochemistry and the representational chemistry" [5].

Johnstone proposed that the phenomena that were experienced, observed and described belonged to macrochemistry, the use of chemical and mathematical symbols that communicated concepts and ideas belonged to the symbolic level and the explanatory level that established relationships and explanations at the atomic-molecular level, however, some questions, such as at what level were certain kinetic and thermodynamic properties of atoms, with this the Johnstone triangle was being restructured and reinterpreted.

### Historical approach to chemical symbology

Now our task is to go over the history of chemical symbology through the symbols used by alchemists, Dalton and Berzelius, reaching the symbology of modern chemistry, our goal is to provide a general construction of chemical representations over time.

### Symbols of the alchemists

"The alchemists introduced strange and enigmatic symbols so that only those who understood the symbols could interpret. However, there was not a certain uniformity in the symbology used and nor a certain logic in its use" [6]. The symbology of the alchemists is linked to a holistic view of the world in which nature should be understood as an active, organic and animistic entity. In alchemical language there are analogies of various laboratory operations with zodiac signs such as calcination/ram, freezing/bull, fixation/twins and so on.

The great difficulty in interpreting alchemy texts lies in the fact that these analogies with astrology and astronomy.

### John Dalton symbols

John Dalton made an attempt to rationalize chemical symbology. Dalton used circles with different figures to represent the chemical elements and also represented the compounds according to the combinations of the symbols.

### Berzelius symbols

Dalton's symbols were difficult to write and memorize, so the entire scientific community decided to adopt the symbology proposed by Berzelius. He started to use as a symbol only one or two letters in Latin or Greek, with the first letter capitalized, the second letter allows to avoid a certain confusion in the use of symbols.

The symbology processes in chemistry allow the student to play a role in mental elaboration and conception (Vygotsky, 2000). and yet learning it takes students to effectively understand chemistry the language processes and symbols used giving meaning to learning in chemistry.

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