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An Ideographic and Nomothetic Comprehension of the Nature of Science by Science Teachers

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ABSTRACT. Science teachers are interviewed about their ideas on the statement *"What is this, science?"* Teachers' discourses are understood by means of a phenomenological reduction in the Husserlian perspective. Teachers and their discourses are understood in pre-reflections and in the perspectives of construction of knowledge and of the image of Science given by reflection. Convergence of discourses is forwarded after situation and ideographic comprehension have been reported. They are then grouped into categories which form nomothetic comprehension. The question posed initially "What is this, science?" is finally answered. The paper ends with a phenomenological profile of the teachers about the nature of Science and opens a perspective that would justify a constructivist mode in Physics and in Science teaching.

Key words: Husserl, phenomenology, nature of science.

RESUMO. Uma compreensão ideográfica e nomotética da natureza da ciência por professores de ciências. Alguns professores de ciência são entrevistados sobre suas concepções acerca do *"o que é isto, a ciência?"*. As falas de cada professor são entendidas através da redução fenomenológica, numa perspectiva husserliana. Os professores e suas falas são entendidos em suas pré-reflexões e em suas perspectivas de construção do conhecimento e de uma imagem da ciência dada pela reflexão. Depois de cada situação relatada e de cada compreensão ideográfica realizada, são apresentadas as convergências dos discursos. Elas são então agrupadas em categorias que formam a compreensão nomotética. Este momento conclui a questão posta inicialmente: "o que é isto, a ciência"?". O trabalho finaliza-se com um perfil fenomenológico dos professores acerca da natureza da ciência e abre uma perspectiva que justifique uma visão construtivista da física e do ensino de ciências.

Palavras-chave: Husserl, fenomenologia, natureza da ciência.

Phenomenology as an alternative methodology to research opposes Auguste Comte's positivism (1798-1857). For the latter, science means systematic methodology, limited by facts - events typically verified and with constant relations between them.

According to positivism, knowledge is defined as the achievement of science, whereas non-scientific ideas (myths, beliefs and metaphysical systems) are illusory knowledge. Science is equivalent to truth; as a contraposition, non-science, is considered as non-real.

Comte holds that positive science has the conditions to develop itself by means of a method based upon controlled observations. By this approach it is not possible to make scientific observations without techniques of measurements and controls. Comte considered Physics and Mathematics as Sciences independent of the language. So, some areas were considered "sciences" because they had a mathematical model (Astronomy, Chemistry, Biology). Others were more distant from this model. Psychology, Sociology and History are, therefore, more distant from the positivistic model.

In its endeavor to recover this distance that Psychology started, in the nineteenth century, to be concerned with elaborating laboratory studies mainly in France and England on reflexiology. Comte's positivism developed on a different level in the intellectual movement known as "The Vienna Circle", which introduced mathematical logic as an instrument of human knowledge. Thus, according to neopositivism a discourse carries knowledge

when it is logically consistent. Therefore, the question of validity is the criterion of science. It is necessary that research undertakes the verification of facts and should not be concerned with such concepts as freedom, justice, education. These topics are devoid of scientific meaning.

There is a generalization of the methodology of natural sciences in all the domains of knowledge. In a general way, we may say that this is the context responsible for the rise of Phenomenology as an alternative for human sciences in research work, or rather, as an opposition to positivism. Phenomenology puts in evidence that human beings are not objects and their attitudes cannot be seen as simple reactions.

Phenomenology and Science

Edmund Husserl, was born in 1859, in Proznits, Moravia, and he graduated in Mathematics. He is considered the father of Contemporary Phenomenology. We may say that all the philosophical life of Husserl, since the publication of *Philosophy of Arithmetics* (1891) until the conferences that originated the work *The Crisis of European Sciences* (1935; Merleau-Ponty, 1990:151-2) is dominated by the feeling of a cultural crisis.

In the *Philosophy of Arithmetics*, Husserl deals with the problem of numbers; that is, numbers do not exist in themselves as absolutes. He states that the difference existent between the concept of number and the process of enumeration refers to its logical and philosophical aspect respectively. From his knowledge of Brentano (a philosopher specialized in ancient Greek texts) Husserl starts to censure the adaptation of human sciences to the models of classical physics and its application. He defends a construction of science to lived experiences, or rather, science as a phenomenology concerned with the essence of a phenomenon.

What is a phenomenon ? It is the thing that appears to the conscience and shown to the conscience as a result of an interrogation. In Greek p*hainomenon* means a speech or a discourse with regard to things that show themselves to the interrogating subjects. The verb *phainesthai* means the act of showing and of revealing. So, phenomenon is everything that shows itself and that appears to the subject who interrogates it.

The Phenomenology suggested by Husserl is a return to the world of experiences since this is the foundation of all sciences. This return to the experienced world, a term invented by Husserl, disrupts definitely the claim of an epistemology of human sciences founded upon a model of natural sciences: before objective reality there is a cognizant subject, before objectivity there is a horizon of world and before the subject of theory and of knowledge, there is a dynamic life (Merleau-Ponty, 1990).

Phenomenology is concerned about describing a phenomenon and not about explaining it. Its aim is not the search for causal relations. Its aim is to show and not to demonstrate. And a rigorous description is the way to arrive at the essence of phenomenon.

Returning to the experience problem, phenomenology necessarily uses a way of reflection that includes the possibility to see things as they show themselves. It is a return to things themselves, a third way, an alternative suggested by Husserl between the speculative discourses of metaphysics and the reasoning of positivistic sciences. It is the search for essence, the non-variants of phenomenon. If it is true that the phenomenon is given by the person who interrogates it via the senses, this phenomenon is given full of sense, full of essence. If all phenomenon has an essence, it cannot be reduced to a single dimension of fact; if the essence identifies a phenomenon, it always occurs identical to itself, whereas the circumstances contingent to its realization are discarded.

Qualitative Research in Phenomenology

According to the Husserlian conception, Phenomenology is the science that gives a sense to the human being and to phenomenon within an indissociable association. The phenomenon exists if there is a subject for whom this phenomenon is situated. This relation between phenomenon and experiencing being reveals an intentional conscience.

The work of the phenomenological researcher is to reach this conscience which gives consistence to the fact (fact is understood as a controlled event after the definition given by the subject in his referential) and to the world in which experiences constituent of life occur.

To construct daily life events, locating the researcher himself inside the phenomenon revealed by the being, it is necessary to adopt a particular way of research: a qualitative one. A partial renouncement of quantitative research is necessary. There must exist a replacement of statistical correlations by individual descriptions and a replacement of objective causal connections by subjective interconnections based on lived experiences (Martins et al, 1989).

It is possible to arrive at these descriptions by means of the *intentionality principle*. By this principle, conscience is always understood as conscience of something, that is, a conscience that is only

conscience when it is directed to an object, defined in its relation with the conscience of being; object is understood as object-to-being.

Putting it in another way, the intentionality principle poses a fundamental question: "W*hat is that is?*" (Dartigues, 1973). This question is responsible for the being to take a position in his own logos and to make him search for a sense in the objects of the world related with his own conscience. It is the correlation of *noema*, the thing seen, with *noesis*, the act of seeing or visualizing. It is an exchange relationship: the exchange that constructs the reflection and the possibility to construct the knowledge of the world.

So that one may analyze "What is this that is?", or, more specifically, "What is this, science?", Phenomenology's first lesson is to refuse pre-conceptions about the nature of the proposed theme. The suspension of pre-conceptions is known as *epochè,* or the act of putting the world between brackets, and it is fundamental in the search for the visualization and the construction of the phenomenon in its essence. In the act of *epochè* beings are solicited to describe their experiences in the particular situation of making, learning, teaching science. In summary, they constitute the descriptions of living.

The Phenomenological Way toward Discourses

So that the question "What is this, science?" may be revealed for each one of the persons facing it, the researcher may use the recording or writing transcriptions of discourses. Both methods were used with ten teachers of Physics and Science from State High Schools and Universities. The interview started with the direct interrogation of phenomenon: "What is this, science, for you ?" There wasn't an *a priori* attempt to conduct the description since the *epochè* was in action. The subject was left free to describe his world.

At the end of each description, we had significant discourses to be understood potentially in the revealed essences - the *Wesenschau* (the vision of essences). The comprehension of these discourses was only possible because the subject was seeing as an attributer of meanings (also in his pre-reflections in the construction of speech) that gives a sense to phenomenon (Martins, 1988). In the subject's descriptions the *noethic* references (the activities of conscience) present in the essentialities revealed were evidenced in their *noematic* nature (the object constituted by the activity of conscience).

All descriptions were read with the perspective of making the researcher approach the experiencing subject in the search of the constituents of his world-life.

In these successive readings the main step of Phenomenology starts: it is the *phenomenological reduction*, that cannot be understood as a causalistic reduction of beings with their thoughts and constructions.

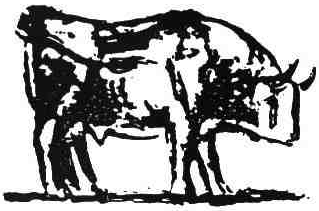
In *Die Idee der Phaenomenologie* Husserl (1986) writes that reduction is employed to attribute zero index to all transcendent things (those not given immanently). Reduction is *brightness*, the comprehension of the possibility to learn, to make, and to the potential possibility to be.

In the reduction process we must capture the discourses in their totality, in the contingencies that construct the web within which the being moves himself. The contingencies are seen as non-gaps, or rather, as the ontological contingencies that immerge the being in his world and make him produce his discourses.

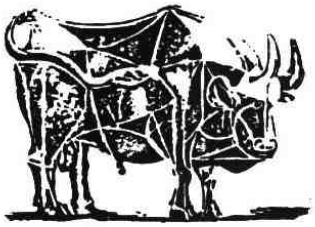
Each discourse is read and re-read with the maximum attention to exclude sections of ingenuous discourses. These sections are composed of apparent inessentialities. From these exclusions the first entities of meaning, pieces of discourses that reveal the essences of phenomenon in question, were born.

This is the reduction in act. At the end of "significant discriminations" (the entities), the discourses appear as sources of pure essences, of *Wesenschau*, to be potentially understood according to the perspective horizons of researchers. The entities of meaning, according to the researcher's referential, cannot be the same to different researchers. In this case, however, it is not possible to escape from the intersubjective encounter.

Reduction work finds an interesting parallel with a drawing by Pablo Picasso, known as "The Metamorphosis of a Bull" (Picasso, 1981) which may be observed in the illustrations below. Illustrations 1 to 3 show a great bull emerging in a full pictorial description, very similar to a photograph. In synthesis, the bull of a painter, lost in the contingencies of representations. From illustration 4 to 6, Picasso made a kind of "taurologic reduction". At the end, we have a naked bull, an essential bull, with sufficiently drawn outlines to allow us to identify the drawing with our original idea of it.



December 5th, 1945
(1)



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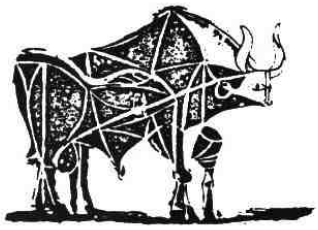

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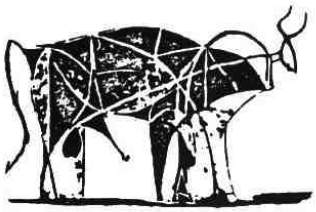
(3)



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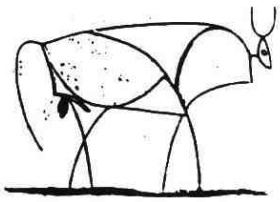

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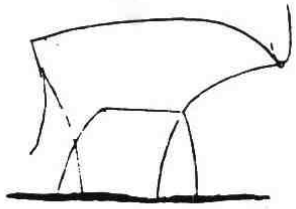
(5)



January 17th, 1946
(6)

Toward a Comprehension of Being: Ideographic and Nomothetic Comprehension

As entities represent the most revealed pieces of discourse of each particularly investigated case, maximum attention is necessary to comprehend each entity of meaning. This step is characterized by a transformation of the expressions used by the subjects in psychological language - a kind of interpretation born from intersubjective encounter. This step has been called "Comprehension of Related Situation in the Unity". Such procedure is possible through the use of reflection and of the imaginative variation by researcher. Imaginative variation means verification at different moments (temporally speaking) of analysis, of the change of meaning of psychological structure. If structures remain unchangeable, it is due to the essentialities of the phenomenon.

At this stage "Ideographic Comprehension" of each subject starts. The word *ideographic* means the representation of ideas (ideograms) that establishes, according to my subjectivity, the representation of being in his essence. The return to the subjects' description is a constant in analysis and aims at improving the reflection and verifying the imaginative variation. In any case, there is no break with the original description of the subject.

With the end of each ideographic representation of subjects, we tried to arrive at the categories or convergences that give a *nomothetic* character (nomothetic > *nomos*, rule) to the initial question: "What is this, science". We thus constructed a nomothetic representation of a set of subjects, the final step of the phenomenological process.

In the process of phenomenological reduction made to comprehend the discourses of science teachers, several points of convergences to the essential question of the nature of science appeared.

Convergences revealed that we are beings destined to experience doubts. However, in the process of "learning" science, something exterior to us censures the path of doubts, or rather, of the

possibility to construct interrogations. This censorship or exclusion constructs a fictional world of certainty. In such a fictional world, doubts must disappear by unquestionable truths. It is positive science with negative results!

In this conformational world, we are submitted to an education that puts us in the way of dogma which may be called certainty. It excludes us from being able to construct doubts and knowledge. In science we have a complex and very abstract mathematical language, leaving out forever the physical phenomenon originally destined to comprehension.

Mathematics by mathematics is imposed on the contrary of the initial qualitative and necessary comprehension of phenomenon. Thus knowledge and phenomenon are not constructed.

Nomos from discourses concludes that science breaks the links with life, acquiring an autonomous life and transmitting ideas and values strange to us.

Merleau-Ponty in his *Phenomenology of Perception* (Merleau-Ponty, 1971) wrote that "phenomenology has the task of revealing the mystery of the world and the mystery of reason". When I ask a teacher the question "What is this, science", I intend to understand and to reveal, from his perspective, the mystery of reason that gives meaning to the things of science. In reality, I conduct myself towards a deep doubt: Is there a science ?

In the analysis of discourses a cancellation of freedom in the construction of science emerges. In the educational process, teachers reported their past full of passive lessons in a process devoid of comprehension. In their discourses a process of reflection emerged. Results revealed subjects who were furious with their memory, with excessive mathematization, with de-motivation, with problems not related to the essential basis of science and to a science without a history.

Excluded from comprehension, these beings (teachers and students) started to walk a way of non-existence in their own conscience. A world of pre-reflection was inaugurated. The vision of the world and the possibility of its comprehension were exiled and disappeared even in pre-reflections. The sense of the world of science is not built up and the being starts to live only in its contingencies, constantly limited by a horizon where memory and repetition construct a deep dark jail of non-comprehension.

The nomothetic comprehension of ten subjects interviewed is very close to that which Husserl established in his work *The Origin of Geometry*. Life, originally intuitive for each subject, is in constant risk of collapsing in the exclusive seduction of mathematics. The mathematical symbols are merely accepted; they give to the subject a very passive attitude about the things of the world. So, a field of passivity is constructed in which symbols start to have their own life without any links with the world. Paradoxically, they constitute symbols with non-symbolization!

Husserl's position about geometry (Bicudo, 1990) is very interesting because it seems to be a historical recapitulation of ancient Greece, where Geometry was conceived as a Science of Truth. However, with the construction of non-Euclidean geometries in the nineteenth century, the criteria of truth were shaken. In geometry, one cannot make any type of experiment since geometry deals with ideal objects and not with real ones.

If I cannot make a test in geometry, is there another criterion of reality? There isn't!!

Mathematics is a formal knowledge whose principal aim is coherence. It doesn't have any empirical content and cannot be tested from experience.

So, fragmentation and prevision educate or de-educate the being toward an empty life, depriving him of coherence and a logic sense towards the world. It is an eclipses of one's own logos!

In this process the subject starts to act as a Borgian Funes-like creature. In Jorge Luis Borges's *Funes* (Borges, 1986) the protagonist Funes was not capable of general and platonic ideas. It was hard for him to understand that the generic symbol, dog, was so large as to comprehend different subjects of different sizes and forms. He was bored that the dog of fourteen past three (seen from one side) would have the same name as that of the dog of four past three (seen frontally) ... he was not capable of thought.

Really this work reveals much more the phenomenon "what is not this, science", than the initial interrogation proper, "What is this, science".

The vision or construction of the image of science from subjects interviewed in the context of the educational process is reduced to the Borgian dog. Nothing is the same; there is no link with essences. Essences don't exist. There is only memorization, repetition, mathematics, and an ideal and virtual world, as the Japanese *tomagochies* (the virtual pets given to children). It is, finally, a science without life, without a soul. In synthesis, it is a non-science.

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