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### Summary

This article presents reflections on what it means to do science in the context of epistemology. Its presuppositions are an understanding of methodology as critical knowledge of the paths of the scientific process, which inquires and questions about its limits and possibilities. Epistemological research implies and composes the word that designates the concept, so that we can then face the inevitable propositions of epistemology, which can be defined etymologically as the rational discourse of science, and is defined as that which philosophically seeks the term epistemology to designate the meaning well broad range of general studies of speculative and scientific knowledge of science, theology, philosophy, techniques, histories, organizations and operations. To avoid vagueness and conceptual confusion, it favors analysis through the study of actions, carrying out an intensive examination of the historical epistemological process. In this context, we reflect on the problems involved in this type of research, and revisit procedures that culminated in the predominance of the epistemological approach. In conclusion, the article proposes that today the most important thing is to produce educational knowledge that, in addition to being useful, is explicitly a conception aimed at solidarity, conformity and creativity to benefit the science of education.

**Key words:** Epistemology. Science. Knowledge

### Abstract

This article presents reflections on what it means to do science within the scope of epistemology. It has as presuppositions an understanding of methodology as the critical knowledge of the paths of the scientific process, that questions and questions about its limits and possibilities. Epistemological research implies and composes the word that designates the concept, to then face the inevitable propositions of epistemology, which can be defined etymologically as rational discourse of science and is defined as that which philosophically seeks the term epistemology to designate sense well broad of general studies of the knowledge, speculative and scientific of the science, theology, philosophy, techniques, histories, organizations, and functions. To avoid vagueness and conceptual confusion it privileges analysis through the study of actions by performing an intensive examination in the epistemological historical process. In this context, it is reflected on the problems involved in this type of research, and it summarizes procedures that culminate with the predominance of the epistemological approach. In conclusion, the article proposes that today the most important thing is to produce an educational knowledge that, besides being useful, is explicitly a conception aiming at solidarity, conformity, and creativity in benefit to the science of education.

**Keywords:** Epistemology. Science. Knowledge

## 1. INTRODUCTION

What is Epistemology? Like any attempt at definition, we can begin with an investigation of the meaning of the significant parts that make up the word that designates the concept, and then face the inevitable pitfalls.

*Epistemology* can be defined etymologically as rational discourse (*logos*) of science (*episteme*). The Greek word *episteme* can be translated as established knowledge, secure knowledge. The Greek word *logos*, owner of various meanings, can be translated here as "rational theory". Therefore, our book is about Epistemology, the "rational theory of secure knowledge", the theory of science (CASTAÑON, 2007, p. 6).

[...] at the same time, some French-influenced philosophers also started to use the term

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*Epistemology* to designate the very broad sense of general studies of “knowledge”, speculative and scientific (science, theology, philosophy, techniques), their histories, organizations and functioning. To avoid vagueness and conceptual confusion, from now on we will agree on the following specific meanings for some central terms used in this book. The word *Epistemology* will refer here to the broadest meaning among those already given to it. It is the general study of the methods, history, criteria, functioning and organization of systematic knowledge, whether speculative (theology and philosophy) or scientific. (CASTAÑON, 2007, p. 6-7).

For the narrowest sense of Epistemology, we will use the term *Philosophy of Science*, that is, the systematic study of the conditions of possibility, methods and criteria of this special body of knowledge, scientific knowledge. Finally, we will designate *Theory of Knowledge* the philosophical discipline that studies the conditions of possibility of any and all knowledge (not just scientific knowledge), namely: *possibility* to know, the *origin* of knowledge, the *essence* of the object of knowledge, the *types* of knowledge and the *methods* of obtaining knowledge (CASTAÑON, 2007, p.7). As Japiassú (1997) argues, the new epistemological synthesis that brings us the Scientific Revolution is that between mathematics and experience. This synthesis has a name, and it is experimentation. We can attribute the emergence of this revolutionary synthesis to Galileo Galilei. His task was to develop a concept of experience and theory based on the unprecedented use of mathematics, an unprecedented model in the history of rational knowledge. He achieves what no one has achieved before: he formulates a mathematical description of the movements of bodies. His epistemology consists of the unity of experience and mathematics. This unity can happen because Galileo admits the assumption that nature is organized in a mathematical way. Thus, mathematics must define, in nature, the accessible systems of observable phenomena. (CASTAÑON, 2007, p. 21).

[...] in the set of the phenomenological method, we have a fundamental initial movement, which is the last basic concept of Phenomenology that we will appreciate here. This is the *epoché*, or *phenomenological reduction*. A *epochê* is the operation by which the effective existence of the external world is placed in parentheses, so that our investigation concerns itself only with the operations carried out by consciousness, without entering into the question of whether or not the things targeted by it exist independently of it. Husserl (1973) states that this reduction aims to suspend the “natural thesis of the world”, that is, the spontaneous belief that external things exist as they are seen. So the *epochê* is the suspension of judgment on everything that doctrines, philosophy and common sense affirm, in order to find solid, evident and indubitable points on which philosophy can be built as a rigorous science. (CASTAÑON, 2007, p. 54).

The phenomenological reduction, which finds a clear parallel with Cartesian doubt, absolutely does not want to affirm that the world does not exist. Rather, he wants to suspend any judgment on this issue, to first investigate how consciousness works. Ordinary beliefs about the world and even about its existence must be set aside at the beginning of the philosophical path because they precisely do not have absolute rational necessity. Although these beliefs may be useful and reasonable, and the philosopher does not doubt them, he cannot use them as the foundation of his philosophy, since philosophy, to be the “rigorous science” that Husserl (1952) postulates, can only have as foundation which is undoubtedly necessary and evident. In other words, I can effectively believe that the world exists, but from this belief I cannot deduce any philosophical proposition, because nothing can prove that the world exists outside of my consciousness. Thus, all philosophical doctrines, all results of science, all beliefs of the natural attitude, are useless in constituting indubitable starting points.

But what can resist *epoché*? In other words, what is that which is indubitable and therefore constitutes a starting point for philosophical reflection? What is so indubitable and necessary that it cannot be put in parentheses? It's consciousness. The consciousness to which phenomena manifest, to which everything that appears manifests. Consciousness is the *phenomenological residu* that resists *epoché*. We have here just one variation of the Cartesian cogito. (CASTAÑON, 2007, p. 54-55).

[...] the true science of nature is the work of the spirit that explores it, and, therefore, is based on the science of the spirit, and not the other way around. Husserl's important conclusion is that the error of the sciences of the spirit is to fight with the sciences of nature for equality of rights. When the former recognize a self-sufficient objectivity from the latter, they succumb to objectivism. Thus, they lose control of their genuine rationality and lead man to the spiritual crisis in which he finds himself, due to an increasing lack of access to reason as an agent of a spiritual worldview. The sciences of the spirit would already have their own method, which would transcend the naivety of an objective world and an illusory and sterile reason, this method is the *phenomenological method*. (CASTAÑON, 2007, p. 62).

Bachelard's main epistemological works appeared at a time – the interwar period – when the

Neopositivism (from the Vienna Circle and American Operationalism) was practically synonymous with Philosophy of Science. Therefore, this discipline presented itself as strongly anti-metaphysical and ahistorical (in the sense of presenting itself as a search for a method that had ahistorical validity). Bachelard presents a radically anti-positivist epistemological reflection, classified by some (such as Bachelard himself) as “Applied Rationalism”, by others (such as Hilton Japiassu, 1988) as “Historical Epistemology”. Although classifying his thought is difficult, realizing the scope and importance that some of his concepts had for epistemological reflection is not: many elements of rationalist inspiration in his doctrine were presented with greater conceptual and methodological rigor by Karl Popper (although developed independently and diversely), and the historicist elements were later developed by important philosophers with great influence on Psychology, such as Georges Canguilhem and Michel Foucault. (CASTAÑON, 2007, p. 64).

## 2 THE EPISTEMOLOGICAL RUPTURE

Bachelard condemned traditional Empiricism for its defense of the “absolute” constituted by immediate data, just as he condemned idealistic Rationalism for seeking a framework *a priori* of what is essential in the scientific function. He claimed that both do not account for what happens with real scientific practice, and that “absolute reason” and “absolute real” are philosophically useless concepts. “Scientific reality” or “scientific data” are not immediate and primary, but always relative to theoretical systems: the scientist never starts from pure experience. This is the meaning of Bachelard's famous statement that “The epistemological vector goes from the Rational to the Real, never the other way around”. Bachelard states that knowledge is always made against previous knowledge. The idea of knowledge that starts from scratch is foolish, it is impossible to cancel or suspend habitual knowledge, *preconceptions*. So, in relation to reality, what we believe we know clearly constitutes an obstacle to what we should know; the scientific spirit is never young: “*he is the age of his prejudices*”. Advancing science means contradicting the past, and this advancement, these successive contradictions of the past, are effective for Bachelard. *epistemological ruptures*, in which there is a denial of something fundamental (assumptions, categories, methods) that supported previous scientific practice. (CASTAÑON, 2007, p. 66).

[...] thus, for Bachelard (1974), the epistemological rupture, also sometimes translated as “epistemological cut”, is a rupture in the continuity of the process of knowledge accumulation, caused by a new scientific theory that, in its assumptions, basic categories or methods, directly contradicts previously existing theory. (CASTAÑON, 2007, p. 66).

Now, the scientific spirit is essentially a rectification of knowledge, an expansion of the frameworks of knowledge. He judges his historical past, condemning him. Its structure is the awareness of its historical errors. Scientifically, if we think of the true as a historical rectification of a long error, we think of experience as a rectification of the common and primary illusion. (BACHELARD, 1974, p. 334).

## 3 THE EPISTEMOLOGICAL OBSTACLE

The progress of Science (which is, therefore, the continuous rectification of previous errors), especially those rectifications that constitute authentic epistemological ruptures, does not occur without great difficulties. These difficulties arise from his shock with what Bachelard called *epistemological obstacles*. These obstacles are not external, such as observation difficulties or the complexity of the phenomena; they are internal, psychological, products of established theories. *Epistemological obstacle* is an idea that impedes and blocks other ideas: it can be a crystallized intellectual habit or a strongly established scientific theory, as well as ideologies, basic metaphysical beliefs, even mere intellectual inertia. In other words, epistemological obstacles are established ideas (whether metaphysical, ideological beliefs and, mainly, scientific theories) that prevent the awareness of an error and the emergence of new scientific theories. (CASTAÑON, 2007, p. 66).

[...] through continuous use, claims Bachelard, ideas acquire an excessive and undue value, and this is the great factor of inertia for the scientific spirit. As Japiassu (1988) states about Bachelard, it is necessary to recognize that in facts, there are sciences coexisting with ideologies. However, unlike postmodern thinkers, Bachelard does not state this with glee or resignation. Far from being a representative of ideologies in Science, Philosophy's mission is to carry out this vigilant criticism, neutralizing ideological discourses and thus preventing, as far as possible, the emergence of epistemological obstacles. Philosophy of Science will have the function of distinguishing, in scientific discourses, what belongs to scientific practice from what comes from ideologies. (CASTAÑON, 2007, p. 67).

Foucault's central epistemological thesis does not differ much from Thomas Kuhn's thought. In “Words and

Things”, original from 1966, Foucault (2002) argues that the history of culture is governed and formed by what he calls “epistemic structures” (or epistemes) that act at an unconscious level, qualifying the different fields of knowledge. Foucault believes that an “epistemic structure” is the set of relationships between the different fields of knowledge that exist in a given historical period. These diverse fields or “discourses” of scientific disciplines are, taken together at a given time, the “episteme” of that time. Foucault named the discipline that would study such “discourses” and “epistemes” “archaeology of knowledge”. This “archaeological science”, according to him, would demonstrate that there is no progress in history, the succession of epistemes is discontinuous and their rise and fall do not make much sense. (CASTAÑON, 2007, p. 69).

[...] in relation to an eternal and historical truth, unattainable, but approachable? And how do you know when you are closest to it? What is the objective evaluation criterion, what is the justification criterion for a scientific theory? How can I do History of Science by identifying scientific activities in other historical moments, if at each historical moment science is a completely different thing? These questions, which constitute the essence of a propositional position in matters of Epistemology, remained obscure in his thought, and throughout the French tradition. (CASTAÑON, 2007, p. 71).

The method of the social sciences, like that of the natural sciences, consists of experimenting with possible solutions to certain problems; the problems with which our investigations begin and those that arise during the investigation. Solutions are proposed and criticized. If a proposed solution is not open to pertinent criticism, then it is excluded as unscientific, although perhaps only temporarily. (POPPER, 1999, p. 16).

[...] “the role of scientific fact is not to falsify or falsify a theory, but to provoke the emergence of a new true theory. It is the true and not the false that guides the scientist, whether truth is understood as a correspondence between idea and thing, or whether it is understood as the internal coherence of ideas” (CHAUÍ, 2003, p. 226).

Epistemology, or Philosophy of science, is the branch of Philosophy that studies scientific investigation and its product, scientific knowledge. A mere leaf on the tree of Philosophy half a century ago, Epistemology is today an important branch of it. To prove the previous statement, it is enough to pay attention to the relative weight of publications and conferences in this field. While half a century ago there were no specialized journals in Epistemology, today there are at least three at an international level -*Philosophy of Science*, *The British Journal for the Philosophy of Science* It is *Synthesis* -as well as some national publications. There are also entire collections of books dedicated to epistemological topics. (BUNGE, 1987, p. 5).

[...] the number of chairs in Epistemology has multiplied (sometimes excessively) and there are more and more universities that have departments or institutes of Epistemology, sometimes together with Logic or History of Science. Numerous national and international meetings are held, in particular quadrennial international congresses organized by the International Union for the History and Philosophy of Science. There are also several regularly functioning national organizations, such as the Philosophy of Science Association (USA), the British Society for the Philosophy of Science, the Canadian Society for the History and Philosophy of Science, and the brand new Asociación Mexicana de Epistemología, Asociación Venezolana de Epistemología and the Sociedad Colombiana de Epistemología, preceded by the now extinct Agrupación Rioplatense de Lógica y Filosofía Científica and the Grupo Uruguayo de Lógica y Epistemología, also extinct. Epistemology has, in short, become an important area of Philosophy, both conceptually and professionally, and therefore it is worth finding out what it is and what it is or could be used for. (BUNGE, 1987, p. 5 - 6).

### 3 THE CLASSIC PERIOD OF EPISTEMOLOGY

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Until half a century ago, Epistemology was nothing more than a chapter in the theory of knowledge, or gnosiology. The semantic, ontological, axiological, ethical and other problems that arise both in the course of scientific investigation and in meta-scientific reflection had not yet arisen. Problems such as the nature and scope of scientific knowledge, as opposed to vulgar knowledge, the classification of sciences, and the possibility of building science inductively based on observations, then predominated. (BUNGE, 1987, p. 6).

[...] during this period, which we can call *classic pain* which extends no less than from Plato to Russell, Epistemology was cultivated mainly by scientists and mathematicians in their leisure time or when giving publicity lectures, and by philosophers without much scientific training. These thinkers were called John Herschel, Auguste Comte,

Adrien Marie Ampère, Bernard Bolzano, William Whewell, Alexander von Humboldt, Claude Bernard, Hermann von Helmholtz, Ernst Mach, Eugen Dühring, Friedrich Engels, Ludwig Boltzmann, Pierre Duhem, Henry Poincaré, Charles Sanders Peirce, Giuseppe Peano, Alessandro Padoa, Bertrand Russell, Alfred North Whitehead, Hans Vaihinger, Wilhelm Ostwald, Abel Rey, Viadimir Illich Lenin, André Lalande, Federico Enriques, Emile Meyerson, Norman Campbell, Arthur Eddington, Ernst Cassirer and Hermann Weyl. (Note the concentration in four countries: Germany, Austria, France and Great Britain. (BUNGE, 1987, p. 6).

It is necessary to recognize that these thinkers, almost all of them amateur epistemologists, wrote more interesting and lasting books, and better written, than most books on Epistemology that are published today. One of the reasons is that they took care of *authentic problems*. *originals* It is *large-scale* instead of facing small, intranscendent problems or limiting ourselves to commenting on what others do, as often happens nowadays. Furthermore, these thinkers of the classical period had their own opinions and defended them eloquently and brilliantly, although not always rigorously. (BUNGE, 1987, p. 7).

[...] the situation that we have just described succinctly changed radically with the founding of the Wiener Kreis, in 1927. For the first time in history, a group of epistemologists, some of them professionals, came together with the aim of exchanging ideas and even to collectively elaborate a new Epistemology, logical empiricism. Individual and isolated philosophical reflection, therefore uncontrolled, was now complemented by teamwork in the image and similarity of what had already been done in the sciences. (BUNGE, 1987, p. 7).

However, the Epistemology that the members of the Vienna Circle created and advocated had a fatal defect: it was tied to the empiricist and inductivist tradition of Bacon, Hume, Berkeley, Comte and Mach, a tradition that was incompatible with the realistic Epistemology inherent to the scientific approach. It is true that logical empiricists respected logic and strived to do exact philosophy. It is also true that they all sought to do scientific Philosophy, that is, in accordance with the spirit and letter of science. No one achieved this, however, precisely because they were subject to a Philosophy - empiricism - capable of accounting for scientific theories, which are anything but a synthesis of empirical data. It was Popper who best understood the inability of logical empiricism to espouse the same science to which it declared its love. Unfortunately, this alienation of logical empiricists from science did not decrease over time: rather it increased, as we will see below. (BUNGE, 1987, p. 8).

[...] artificial epistemology - which strictly speaking is not Epistemology, but intellectual gymnastics, as Einstein would say - closed itself within a small problem that did not attract the attention of scientific researchers. These ignored the writings of contemporary epistemologists. The rift between scientists and philosophers has widened rather than narrowed. Let's see below a characteristic example of exact Epistemology, but it ignores the various attempts to solve epistemological problems with the help of the concept of probability. (BUNGE, 1987, p. 9).

A philosophy of science does not deserve the support of society if it does not enrich Philosophy and is not useful to science. And an Epistemology is useful if it satisfies the following conditions: *(A)* It refers to science itself, not to the puerile and sometimes even caricatured image taken from elementary textbooks; *(B)* It deals with philosophical problems that actually arise in the course of scientific investigation or in reflection on the problems, methods and theories of science, rather than little phantom problems; *(C)* Proposes clear solutions to such problems, in particular solutions consistent with rigorous and intelligible theories, as well as appropriate to the reality of scientific investigation, instead of theories that are confusing or inappropriate for scientific experience; *(d)* Is able to distinguish authentic science from pseudoscience, deep investigation from superficial, the search for truth from the search for daily bread; *(It is)* He is capable of criticizing erroneous programs and even erroneous results, as well as suggesting promising new approaches. Since we aspire to the renewal of Epistemology, and given that to characterize a discipline there is nothing better than showing some of its problems, let us make a brief list of problems that the new Epistemology must address. Although some of these problems are not new, the way of posing them and trying to solve them should be new, that is, adjusting to the criteria of utility *(The)* It is *(It is)* stated above. (BUNGE, 1987, p. 13).

[...] epistemology, according to its philosophical aspect: each branch was a part of one of the chapters of Philosophy. But, if we focus philosophically on any classification of sciences, we will obtain as many branches of Epistemology as there are sciences that appear in that classification. For convenience, we will only distinguish the following branches of science and, to aid understanding, we will highlight some problems that characterize the corresponding epistemologies. 1. *Philosophy of Logic*. What is a proposition, different from the statements that designate it? In factual sciences, is the concept of an existential quantifier sufficient to characterize physical existence? 2. *Philosophy of Mathematics*. What does the existence of

a mathematical object? What relationship do Mathematics and reality have between them? 3. *Philosophy of Physics*. What are relativistic theories about: meters and clocks, or physical systems in general? Does quantum mechanics strengthen indeterminism? 4. *Philosophy of Chemistry*. Does Chemistry have its own laws or are they all reducible to Physics? Does the chemical constitute a level of reality distinct from the physical? 5. *Philosophy of Biology*. Is Biology distinguished from other sciences by its peculiar techniques or by the very way of focusing and understanding vital phenomena? Are biosystems just heterogeneous chemical systems or do they have emergent properties that Chemistry does not study? 6. *Philosophy of Psychology*. What is the mind: a substance *suigeneris*, or a set of brain functions? What relationship exists between mental events and their physiological and conductive indicators? 7. *Philosophy of social sciences*. What is a society: a set of individuals, a totality opaque to analysis, or a system of interacting people? The social is reduced to the biological and, therefore, can Sociology be explained by Biology? 8. *Philosophy of technology*. What are the peculiar features of the technical object, unlike the natural one? And what differentiates technological knowledge from scientific knowledge? 9. *Philosophy of systems theories*. How do general systems theories differ from special scientific theories? Are these theories enough to understand or control real systems? For now, the problems formulated previously will be enough to give a schematic idea of what the new Epistemology that we advocate could be. In the following chapters we will have the opportunity to deal with them in more detail. Let us end this introduction with a brief reflection on the usefulness that this new Epistemology can have. (BUNGE, 1987, p. 16 - 17).

The epistemologist attentive to the science of his time can be even more useful, since he can *participate in scientific development*, albeit indirectly, by contributing to positively changing the philosophical foundations of science research and policy. In particular, the epistemologist linked to science and the formal tools of contemporary Philosophy can make contributions of the following types: (a) *Bring to light philosophical assumptions* (in particular semantic, gnosiological and ontological) of plans, methods or results of current scientific investigations; (b) *Elucidate* it *is systematize philosophical concepts* used in various sciences, such as physical objects, chemical systems, social systems, time, causality, chance, proof, confirmation and explanation; (c) *Help solve scientific-philosophical problems*, such as whether life is distinguished by teleonomy and the psyche by inspatiality; (d) *Reconstruct scientific theories in an axiomatic way*, *that taking advantage of the opportunity to expose his philosophical assumptions*; (e) *Participate in discussions about nature and the value of pure science* it is *applied*, helping to clarify ideas on the matter, including developing cultural policies; *Serve as a model for other branches of Philosophy* - in particular ontology and ethics - which could benefit from closer contact with formal techniques and sciences. (BUNGE, 1987, p. 17).

## CONCLUSION

This work proposes to outline a succinct retrospective of some courses via philosophical and scientific initiatives, preponderant for the development and process of scientific knowledge via the discipline of epistemology. The construction of knowledge can be understood as a diverse process where empirical knowledge, common sense and scientific knowledge as different modalities of approaching the object, will provoke a learning or construction process in the subject.

The understanding of the genesis and the historical epistemological process that constitutes science and explains its scientific intention is constructed by its own learning. In this sense, we seek to find points of convergence between them, and the resulting inferences for scientific knowledge.

We cannot deny the importance of any of these philosophical and scientific currents, since all of them within a historical context contributed in one way or another to scientific progress and to the idea of man, culture, society and cosmos, as well as to the emergence of new sciences.

Social researchers need to choose ideas scientifically to carry out their investigations, and in this context We seek to present those that isolate man as an object and as a researcher in different poles and those that relate them to each other and to the environment, but to arrive at this it is necessary to carry out an epistemological historical retrospective. The process of epistemological paradigmatic change among society, as well as its influences on science today. The needs of the spiritual sciences are to fight with the natural sciences for equality of rights, participating in discussions about the nature and value of pure and applied science, helping to clarify ideas about this, including developing cultural policies, The epistemologist attentive to the science of his time can be even more useful, since he can participate in scientific development, and is capable of criticizing erroneous programs and even results, as well as suggesting new promising approaches. Aspiring to the renewal of Epistemology for the benefit of



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