



Universidad Nacional de Catamarca - Facultad de Humanidades
Instituto de Investigación en Teorías del Arte y Estética
Revista Rigel – ISSN 2525-1945.

Philosophical Models in Epistemology: From Kant's Theory of Knowledge to Bachelard's Applied Rationalism

Dr. Chahrazed Amri

University of Djelfa, Algeria
Email: amri.chahrazed@univ-djelfa.dz

Received: 02/05/2026

Accepted: 07/08/2026

Published: 10/09/2026

Abstract

Epistemology is a critical study of scientific knowledge that investigates the conditions of its formation and the network of epistemological obstacles that limit the development of thought. It differs from classical theory of knowledge and metaphysics in that it does not seek a fixed absolute; rather, it studies the development of the sciences and their history in light of the dialectical relationship between reason and experience. Scientific thought is founded upon a continuous applied rationality that corrects errors and transcends spontaneous ideological conceptions and primary experiences. Epistemology tends toward combining formal logical analysis with the historical and psychological process of concept formation, thereby confirming that scientific certainty is relative and constructed, and that knowledge advances through ruptures and continuous criticism in order to renew its methods and its vision of reality.

Keywords: Epistemology, Philosophy of Science, Theory of Knowledge, Epistemological Obstacle, Primary Experience, Empirical Rationality, A Posteriori Knowledge, Logical Critique, Reflective Mind, Gaston Bachelard.

Introduction

Scientific knowledge is one of the most important fields of human thought, through which human beings seek to understand and explain phenomena and to reach conclusions based on rational and empirical foundations. However, the attainment of scientific knowledge does not occur directly;



rather, it passes through a set of stages in which previous experience, rational thinking, and real-world experimentation interact. It may also encounter certain obstacles that limit the development of scientific thought and affect the construction of knowledge.

From this perspective, epistemology emerged as a field concerned with the study of scientific knowledge, the conditions of its formation, the obstacles it encounters, and the nature of the relationship between thought and reality. Epistemology is also concerned with scientific research as an activity that combines the rational and empirical dimensions and makes the interaction between theory and experiment the basis for attaining more precise and objective knowledge.

Accordingly, this article examines the concept of the epistemological field and the most important obstacles that may confront scientific thought, in addition to clarifying the nature of the epistemology of scientific research and the relationship between theory and experiment in the construction of scientific knowledge.

1- Definition of the Epistemological Field:

Epistemology is a compound term composed of two words: the first is Episteme, meaning science or knowledge, and the second is Logos, meaning theory or study. Thus, epistemology means the theory of sciences, or the philosophy of science; that is, the study of the principles, hypotheses, and results of the sciences through a "critical" study that leads to the highlighting of their logical origin and their objective value. Epistemology therefore differs, on the one hand, from the study of the methods of the sciences and, on the other hand, from the study of the composition of scientific laws. For the first study is a branch of applied logic, whereas the second is a branch of positive philosophy, or the philosophy of the evolution of sciences.

We distinguish between epistemology and the Theory of Knowledge (Théorie de la Connaissance), although the former constitutes a necessary introduction to the latter. This is because epistemology does not investigate knowledge insofar as it is based on the unity of thought, as is the case in the theory of knowledge; rather, it investigates it insofar as it is posterior and detailed knowledge, distributed across the dimensions of the sciences and the dimensions of their objects.

Nevertheless, the term epistemology in English is synonymous with the term theory of knowledge, whereas in the French language it differs from it, because most French philosophers apply it only to the philosophy of science and its philosophical history. If some of them extend its meaning and apply it to the psychology of the sciences, this is due to the fact that the study of the development of the sciences cannot be separated from their logical critique, nor from their concrete sensory content. (Jamil Saliba, 1982)

The fields and domains of scientific knowledge are determined through contemplation (thinking), for ends are influenced by an implicit and indirect subjectivity that we may be able to determine if, one day, we succeed in working toward a science of the social subject by defining a kind of technique for psychology prior to the applied idea. Thus, it does not become merely a simple call toward primordial experience; rather, it is an intensification of what distinguishes and differentiates knowledge in the Cartesian sense of the term. The idea is not on the same level as recollection; it is, for the most part, on the level of perception, insight, and prior knowledge. The idea is not a summary; rather, it is, above all, a program.

Rationality is, as it were, the consciousness of a constituted, modified, and corrected science; it is the mark of the human intellect the contemplative, thinking, serious, controlling, and measuring intellect. The changing universe is nothing but an object of human progress, in the sense of the progress of knowledge. Events thus follow one another more rapidly and more solidly than if they were connected by a network of minds. Thanks to this rationally guided sequence, external events find their place as scientific facts. They become ideas before they become actual events within the rational realm of ideas.

Experimental rationalism must therefore be placed at the level of a philosophy committed to such depth that this philosophy is no longer captive to immediate interests. Rationality is realized through its liberation from interests; it sits upon the throne of values that have been contemplated in depth. This is what may be expressed as the dominance of rational thought over the values of knowledge. (Gaston Bachelard, 1991, pp. 35–36).

1-1. Definition of the Epistemological Obstacle:

Obstacles, and others, possess a necessary functional character. What we wish to demonstrate are the causes of stagnation and even regression; what we seek to uncover are the underlying causes that are referred to as epistemological obstacles. Reality was never absolute, as one might believe; rather, it has always been that which we have thought about, within the framework of errors.

An internal knowledge becomes an obstacle, and the first obstacle to the formation of the scientific mind is primary experience, the fragility of initial knowledge. This experience exists prior to critical examination, which necessarily constitutes an integral element of scientific thought. As soon as criticism does not operate implicitly, experience cannot become a reliable foundation.

- a. **The Realistic Obstacle:** Here we mean the seduction of the idea of matter. There are very deeply rooted material beliefs; we must absolutely not make realism into an instinct. It should be subjected to a kind of psychoanalysis. The psychoanalysis that must be indicated for the treatment of matter is the psychoanalysis of the feeling of possession,

and the complex that must be addressed is the complex of petty interest (Gaston Bachelard, p. 208)

- b. **The Vitalist Obstacle:** Every principle recedes before the vital principle. Living matter is the source of every beginning and the ferment of every growth. It itself confers upon the matter on which it acts an unquestionable value. When matter ceases to be subjected to vital influence, it thereby loses something essential. Matter that leaves a living being loses important properties; bee honey and urine are nothing but wastes of the bodies in which they were contained. (Gaston Bachelard, p. 211)
- c. **The Libido:** Libido exercises a will to power over things and over animals. This is undoubtedly a deviation of the will to power which, in its complete existence, is a power dominating human beings. This deviation may perhaps be a form of compensation. (Gaston Bachelard, p. 212).

2- Epistemology of Scientific Research

Engaging in the philosophy of science remains a matter of great importance in order to become acquainted with the sciences, not as instruments for something else, but to know them for their own sake; that is, to examine science in itself through the study of the methodology of science, its history, and its functions, or through the applications, investigations, and approaches of the theory of knowledge.

Science is a product of human thought, a product that takes into account the laws of our thinking and adapts itself to the external world. It therefore has two sides: one subjective and the other objective, and both sides are equally necessary.

Scientific thought calls for philosophy, and the philosopher must therefore transform his language in order to translate the body of contemporary thought and its movement, and must respect this strange duality which requires the expression of every scientific thought simultaneously in a realistic language and a rational language. There is no metaphysical purity; rather, the duality of the meaning of scientific proof must be maintained, for it is confirmed in experiment, in the confrontation with reality, and in the disposition of reason at one and the same time.

The orientation of the epistemological tendency proceeds from the rational to the real, and does not proceed merely from reality to the general, according to all philosophers from Aristotle to Bacon. (Gaston Bachelard, trans. Adel Al-Awa, 2nd ed., 1983, p. 7)

The application of scientific thought is, first and foremost, the application of a capacity for verification. Scientific thought is verifying thought; it is inductive thought that reads the complex in

the simple and states the law in connection with the fact and the rule in connection with the example Knowledge increases and leads to gradual changes in scientific thought; there is a renewal that takes place within scientific thought. (Gaston Bachelard, trans. Adel Al-Awa, 2nd ed., 1983, p. 85)

All the new forms of science that come after having illuminated and referred us back to the darkness of incomplete knowledge possess the same characteristics of extension, deduction, induction, design, completion, composition, and assemblage. Each of these characteristics implies a substitute for the idea of novelty, and this novelty is profound because it is not the novelty of discovery, but the novelty of method and methodology. (Gaston Bachelard, trans. Adel Al-Awa, 2nd ed., 1983, p. 88)

The relationship between theory and experiment is a very close relationship, to such an extent that it causes every experimental or rational method to doubt its ability to preserve its value We may go even further than this: the excellent method eventually loses its specific character if it does not renew its object.

3- Philosophy and Epistemology:

There is a complex relationship between epistemology and philosophy, involving an attempt to determine the precise epistemological position between the educational and critical enterprise of science, on the one hand, and traditional philosophical systems and subjective scientific conceptions, on the other.

Jean Piaget considers it possible to regard epistemology as one of the human sciences specifically, genetic or developmental psychology with its own particular object of study, namely scientific knowledge, and its specific methods for investigating how knowledge develops and is formed However, Waqidi argues that, although this approach provides epistemology with a new horizon through which it may benefit from the human sciences, it nevertheless fails to remove it entirely from the framework of philosophical thought.

Epistemology is not merely a descriptive human science, nor is it, at the same time, merely a "traditional philosophical reflection" on science, This is because the historical relationship between philosophy and science has often involved the use and justificatory employment of scientific results in the service of metaphysical or ideological purposes lying outside the scope of scientific practice itself.

To demonstrate how classical philosophies interpreted and employed scientific data, we present two prominent philosophical models:

- **The Kantian Model (Theory of Knowledge and the Break with the Absolute):** Immanuel Kant constructed his critical theory of knowledge on the basis of the Newtonian physical and mathematical system, assuming the existence of two a priori forms of sensibility time and space as well as a priori categories of understanding through which experience is organized. The author explains how Kant elevated the relative scientific principles of his age to the level of the absolute and the a priori. However, the development of modern science—the emergence of non-Euclidean geometries, Einstein's theory of relativity, and quantum mechanics demonstrated the relativity of these concepts and their empirical limits, thereby destroying the Kantian illusion of the absolute and leading to a widening gap between philosophical theories of knowledge and the actual philosophy of science.
- **The Bergsonian Model (The Limits of Scientific Knowledge and the Supremacy of Metaphysics):** Waqidi analyzes the position of Henri Bergson, who sought to establish limits for scientific knowledge, considering that the scientific method, through analysis and synthesis, remains confined to relative and formal knowledge of dynamic and evolving phenomena, particularly duration. Bergson maintained that metaphysics, through the method of "intuition," alone is capable of penetrating the interior of the object and grasping its absolute reality, thereby sacrificing scientific knowledge in favor of a metaphysical spiritualist tendency. Waqidi emphasizes that the actual history of science and the development of scientific psychology have surpassed these artificial limitations imposed by Bergson.

As for the concept of the "spontaneous philosophy of scientists," it may be mentioned with reference to the theses of Louis Althusser. The history of science contains, in its very essence, an implicit and objective philosophy that constantly tends toward affirming the reality of the external world, its independence from the knowing subject, and the critical development of concepts. However, the daily practice of scientists is influenced by a contradictory "spontaneous philosophy" composed of two principal elements:

1. **An Internal, Material, and Objective Element:** This arises from the direct practice of experimental research and affirms the objectivity of the world and the effectiveness of the scientific method.
2. **An External, Ideological, and Idealist Element:** This infiltrates the ideas of scientists through their influence by the cultural environment, mysticism, or prevailing philosophies, which may sometimes lead them to doubt the objectivity of science or question the existence of material reality.

True epistemology does not consist in constructing closed metaphysical frameworks, nor in completely submitting to the spontaneous ideological conceptions of scientists. Rather, it consists in establishing a continuous critical reflection that accompanies the actual development of science and draws out its epistemological implications within their relativity and their continually renewed historical context.

(Mohammed Waqidi, pp. 29–80)

4- From the Theory of Knowledge to Epistemology:

The Swiss psychologist Jean Piaget advanced a thesis based on the possibility of removing epistemology from the domain of philosophical thought and considering it one of the human sciences. This would be achieved by relying on a specific object of study, namely scientific knowledge where it becomes a theory of scientific knowledge and on an inductive method derived from genetic or developmental psychology, which studies how knowledge develops and how the mechanisms common to this development are formed.

Although the author acknowledges the possibility that epistemology may benefit from the findings and applications of the human sciences, he ultimately rejects Piaget's project of transforming it entirely into a human science, affirming the continuing philosophical character of epistemological thought.

However, affirming the philosophical character of epistemology does not, under any circumstances, mean reducing it to any model of traditional philosophical speculation about science. History demonstrates that the relationship between philosophy and science has often taken the form particularly within idealist philosophies of an attempt to contain scientific results and forcibly incorporate them in order to justify purposes or values lying outside the domain of scientific practice, such as religious or spiritual objectives. This has resulted in science becoming subject to ideological interpretations and closed philosophical doctrines.

In order to illustrate this thesis concretely, Waqidi presented a critical study of two prominent philosophical models: Immanuel Kant and Henri Bergson.

First: Epistemology and the Theory of Knowledge (The Kantian Model)

The philosophy of Immanuel Kant, as a model for constructing a "general theory of knowledge," reflects the contemporary philosophical interpretation of the scientific results of his age (the Newtonian mathematical-physical system and Euclidean geometry). Kant formulated his critical project around a central question: "How is synthetic a priori knowledge possible?" in order to ensure the legitimacy of mathematics, natural science, and metaphysics as a science. To demonstrate this a

priori character in the sciences, Kant assumed the existence of two pure forms of sensibility, preceding all experience and making perception possible, namely time and space, alongside the a priori categories of understanding (such as causality and substance), which confer intelligibility upon the phenomena of experience.

The Kantian conception of space and time shows that it is based entirely on Newtonian physics, where space and time are considered absolute, homogeneous, and fixed entities. However, subsequent scientific developments, beginning in the nineteenth century, led to the disintegration and breakdown of the Kantian foundation. The emergence of non-Euclidean geometries (with Riemann and Lobachevsky) undermined the assertion of the a priori character of homogeneous Euclidean space, while the emergence of Einstein's "theory of relativity" in modern physics destroyed the Kantian and Newtonian idea of the absolute. In relativistic physics, time and space are not a priori frameworks; rather, they are interconnected time being a fourth dimension of space and relative, being related to the movement of matter and its velocity.

The contradiction of the classical theory of knowledge is also manifested in attributing the qualities of absoluteness and finality to categories resulting from a relative and limited scientific stage. Epistemology differs from the Kantian theory of knowledge in that it does not seek to establish the legitimacy of metaphysics, nor does it investigate the limits of the fixed capacity of reason; rather, it follows the effects left by renewed scientific breakthroughs on the structure of thought and reason itself.

Second: Epistemology and the Limits of Scientific Knowledge (The Bergsonian Model)

The philosophy of Henri Bergson represents the thesis of establishing "limits to scientific knowledge" in favor of a higher metaphysical knowledge. Bergson distinguishes between two methods of knowledge:

- **The method of science (analysis and synthesis):** This is a method that confines itself to moving around the object from the outside and provides us only with "relative" knowledge governed by practical purposes. It leads either to the zero point of analysis or to the infinity of synthesis, transforming the living and moving object into a state of artificial immobility.
- **The method of metaphysics (intuition):** This is the method of direct sympathy and penetration into the interior of the object in order to apprehend its unique and absolute reality without the need for symbols.

The Bergsonian position is completed by its reduction of the value of the sciences through its assertion that the reality of every object in the universe is "**duration**" and continuous change. This scientific incapacity, according to Bergson, is manifested clearly in psychology, as he considers that

psychological analysis divides the self into separate psychological events and strips it of its living duration. This leads him to declare the incapacity of the experimental method in psychology and to restrict its study to **“metaphysical intuition.”**

However, studies ultimately refute Bergson’s position, showing that the actual history of science particularly the rapid developments in psychology and microphysics has demonstrated the ability of scientific methods to penetrate the rigid limits imposed by spiritualist philosophies. Science does not recognize things-in-themselves that are inaccessible to knowledge, and instead of psychology remaining a continuation of metaphysics, it deepened its break with it, thereby revealing the inadequacy of the Bergsonian thesis. (Mohammed Waqidi, pp. 83–211)

5- Epistemology and the Human Sciences:

There is a fundamental issue raised within the philosophical scene, namely the question of the internal philosophical alternative of science, asking: if traditional philosophy, with its speculative systems, is incapable of providing an objective epistemology of science, can science provide its own philosophy from within?

Tracing the objective history of science reveals the emergence of an **“implicit spontaneous philosophy”** produced by the scientific process itself in opposition to idealist interpretations. It is a philosophy that gradually takes shape through successive stages and developments and is founded upon four principal pillars:

1. The affirmation of the objectivity of the reality under study and its independence from any transcendent absolute reality.
2. The affirmation of the real existence of the external world independently of the knowing subject.
3. The demonstration that experience is what provides thought with concepts and categories, instead of maintaining their a priori character.
4. The continuous transcendence of the obstructive epistemological limits that philosophies attempt to impose upon the capacity of science.

What we wish to draw attention to is that this implicit philosophy recorded in the facts of the history of science differs from another concept formulated by the philosopher **Louis Althusser**, namely the **“spontaneous philosophy of scientists.”** Scientists are not isolated from the intellectual and ideological climate of their societies and their times; consequently, the conceptions they hold concerning their scientific practices do not correspond entirely to the objective reality of their scientific activity.

Althusser considers that the spontaneous philosophy of scientists is characterized by an essential internal contradiction because it is composed of two opposing elements:

- **A theoretical element from within science (a material/objective element):** This is formed among scientists as a result of their direct daily practice of experimental research, and it leads them to firmly believe in the existence of the object of knowledge as a real, external, and material existence, as well as in the objective effectiveness of scientific methods in acquiring knowledge.
- **A theoretical element from outside science (an ideological element):** This infiltrates the ideas of scientists from outside scientific practice as a result of their being influenced by prevailing ideological systems and religious or critical idealist philosophies. This element carries values and ideas that sometimes cast doubt on the objectivity of knowledge or call into question the material existence of the object of science.

The role of scientists in epistemological thought has increasingly grown, particularly with the contemporary scientific revolution in quantum physics and relativity, with scientists such as Planck, Einstein, de Broglie, and Heisenberg where increasing specialization has made the traditional philosopher incapable of keeping pace with scientific material. However, the author points out that the exploitation by certain idealist interpretations of the contradictions present in the spontaneous philosophy of scientists has often led to scientific discoveries being diverted from their correct course.

It becomes clear that true epistemology coincides neither with the idealist “theory of knowledge” nor with the “thesis of the limits of science,” and it is not satisfied with the “spontaneous philosophy of scientists,” with all the ideological contradictions it contains. Rather, the task of foundational epistemological thought lies in a dual objective critique: a critique of external philosophical interpretations that exploit science, and the purification of the spontaneous philosophy of scientists from ideological elements extraneous to it, in order to reveal the genuine epistemological values produced by the actual development of science within the structure of human thought. (Mohammed Waqidi, pp. 215–262)

6- Approaches to Epistemology:

This section examines the methodological approaches and the different philosophical and scientific orientations that have dealt with epistemology as a critical study of scientific knowledge. It also examines how epistemology gradually evolved from speculative philosophical practices subordinate to the traditional theory of knowledge into a field that employs rigorous scientific analysis, relying

either on the logical-formal analysis of the language of science or on historical and psychological research into the emergence and development of scientific concepts.

This section also addresses the distinction between the philosophical method and the scientific method in approaching scientific knowledge, clarifying the limits of the Kantian and idealist approaches. It then proceeds to analyze the methodological difference between formal orientations based on the contemporary logical construction of explanatory languages and realist orientations that employ historical and psychological methods to trace the actual transformations of science. The chapter concludes with a discussion of the fundamental principles of genetic (developmental) epistemology in Jean Piaget and the extent of its methodological effectiveness.

- **The Distinction between the Philosophical Method and the Scientific Method:** The old philosophical theories such as Immanuel Kant's *Critique of Pure Reason*, or the works of Lachelier and Boutroux were not epistemology in the precise sense Philosophy treated science as a means or as a preliminary stage for establishing a metaphysical project, or for proving the possibility of knowledge in general through the assumption of fixed and final a priori categories. The scientific method in epistemology, however, makes scientific knowledge itself a direct and independent object of critical study, without seeking to create a new metaphysics.
- **Logical Analysis versus Historical and Psychological Analysis:**
- **The Formal (Logical) Orientation:** This orientation is confined to the static logical analysis of the language of science and its current results. It considers epistemological thought to consist in constructing an explanatory language (*Metascience*) that investigates logical consistency and the formal conditions of the truth of propositions, while disregarding historical and psychological dimensions.
- **The Realist (Historical-Psychological) Orientation:** This orientation rejects reducing science to its final linguistic formulation and considers science to be a process of becoming and continuous construction. Accordingly, it relies on tracing the actual stages through which the human mind has passed in overcoming error and constructing the scientific concept throughout history.
- **Genetic (Developmental) Epistemology according to Piaget:** This is a concept that seeks to explain scientific knowledge by tracing how fundamental principles and concepts such as time, space, and causality are formed in the individual from childhood (*ontogenesis*), and by comparing this psychological development with the historical evolution of concepts in the history of the sciences (*phylogenesis*).

Restricting oneself to the formal logical analysis of the current language of science leads to an extreme nominalist position that separates knowledge from its dynamic reality and from the lived history of the sciences. Conversely, exclusive reliance on psychological and historical methods may fall into naturalism or psychologism, which neglects the rigorous character of logical demonstration. The discussion concludes that modern epistemology tends toward integration: historical and psychological analysis provides the concrete material concerning how concepts are formed, whereas logical and axiomatic analysis provides the precise formulation of the results of knowledge. (Robert Blanché, pp. 61–78)

7- Problems of Epistemology:

It is necessary to address and discuss the general and problematic issues that concern the essence of scientific knowledge as a whole, regardless of particular specializations. Attention is focused on examining the nature of scientific rationality, how laws and theories are formulated, and the problem of truth and certainty in contemporary scientific knowledge, in addition to the question of the classification of the sciences and the mutual relationships among them.

It also addresses the problem of the nature of scientific knowledge between realism and falsificationism/operationalism, and explains the transition from absolute rationality to applied or relative rationality. It further examines how the scientific concept is constructed and how laws and theories are established through the interaction of experimental hypotheses with mathematical models, concluding with the question of the unity of science versus its diversity and the classification of the sciences on the basis of the development of their methods.

- **Applied Rationalism (*Le rationalisme appliqué*):** The author presents the concept of applied rationalism as manifested in the thought of Bachelard, Poincaré, and Meyerson to demonstrate that contemporary scientific knowledge is no longer an a priori rationalism already furnished in advance, nor raw sensory empiricism. It is a rationalism established through a continuous dialogue between reason and experimental data, in which reason actively constructs reality while, at the same time, adapting itself to the resistance presented by experimental testing.
- **The Construction of the Scientific Concept and Law:** The chapter explains that the scientific law is not merely a descriptive recording of living phenomena; rather, it is an abstract formulation and an intellectual construction of the concept. Laws and theories are established through the formulation of formal hypotheses whose validity is verified by means of measuring instruments and complex experiments, making "scientific reality" a constructed and produced reality rather than a reality directly given to the senses.

- **Rupture and Transformation in the Nature of Scientific Certainty:** The author presents the argument that certainty in contemporary science has become relative and provisional. Science no longer develops through regular linear accumulation, but rather through structural crises that require a reconsideration of fundamental assumptions as occurred in the crisis of the foundations of mathematics and with the emergence of quantum physics and relativity. This conceptual transformation demonstrates that scientific truth is an error that has been corrected rather than fixed and absolute truths.
- **The Problem of the Classification and Unity of the Sciences:** The chapter discusses the various attempts to classify the sciences, such as the distinction between formal sciences, including mathematics and logic; experimental/natural sciences; and the human sciences. It reveals the increasing interpenetration among these fields, as the sciences seek to develop their explanatory languages and use formal models, thereby raising once again the question of the unity of scientific knowledge from the perspective of methodological integration.

In conclusion, scientific knowledge is characterized by its open nature and continuous self-revision. Science does not provide absolute or eternal truths; rather, it offers a dynamic system of propositions and theories that are subject to revision and modification. The objective value of science lies in the rigor of the methods employed for verification and in the ability of theoretical frameworks to accommodate crises and structural conceptual transformations. (Robert Blanché, pp. 79–89)

Conclusion:

In conclusion, it becomes clear that epistemology represents a fundamental field for understanding the nature of scientific knowledge and the manner in which it is formed and developed. It is not limited to the study of knowledge in itself; rather, it also investigates the conditions of its production and the factors that may hinder its progress. It has been shown that scientific thought may encounter various obstacles, some of which are related to previous knowledge and experiences, while others are connected to realist conceptions or to matter and life, making the overcoming of these obstacles a necessity for the development of scientific thought.

Scientific research is also based on an integrated interaction between reason and reality, and it is therefore impossible to make a complete separation between theoretical thinking and practical experience. Theory guides research, while experience contributes to testing it and verifying its results. Consequently, the development of scientific knowledge remains linked to the capacity of thought for renewal, criticism, and benefiting from experience, thereby making it possible to construct

knowledge that is more precise, objective, and capable of keeping pace with the development of scientific thought.

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