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The Role of the Scientific-Mathematical Model in the Shaping of Contemporary Epistemological Frameworks

دور النموذج الرياضي والفيزيائي في تقعيد معالم الأنساق الابستمولوجية المعاصرة

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Abstract:

Contemporary mathematical and physical science has contributed to overturing classical epistemological thinking and its concepts such as : rationality,realism,experimentalism,and others . Mathematical and physical scientific theories have been able to formulate the current epistemological discourse and reconstruct its categories and concepts.

Keywords: Philosophy, Sciences, Mathematics, Physics,system, Epistemology, Rationalism.

ملخص باللغة العربية

لقد ساهمت كل من الرياضيات والفيزياء المعاصرة في الإحاطة بالفكر الابستمولوجي الكلاسيكي ومقولاته من عقلانية وواقعية وتجريبية وغيرها،و تمكنت النظريات العلمية الرياضي-فيزيائية من صياغة المشهد الابستمولوجي الراهن وبناء مقولاته و أجهزته المفاهيمية،كما لعبت دورا بارزا في بناء الخطاب الابستمولوجي الراهن وإعادة بناء مفاهيمه ومقولاته.

كلمات مفتاحية: الفلسفة؛ العلم؛ الرياضيات ، الفيزياء، النسق، ابستمولوجيا؛ العقلانية.

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*- Introduction

Epistemological discourse, over the ages, was never to reach completion without the cultural contexts wherein it was conceived as well as the surrounding cognitive discourses, especially, the accompanying scientific theories in its developmental journey over time, which they were never to be separated even in the occasions of apparent disagreement. Because today's era is by excellence the era of scientific and technological theories and given that philosophical discourses are born in the darkest of sociological and even scientific crises, both mathematics and physics played the prominence role in the heart of classic epistemological thinking and concepts from rationalism, realism, empiricism, and others. Accordingly, the problem at hand could be illustrated in the questions of: how did the theories of mathematics and physics managed to shape the current epistemological scene and model its constructs and conceptualization apparatuses. Additionally, to

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what extant these frameworks have influenced the course of contemporary scientific philosophical thinking and its orientations.

.Philosophy and Science: from Methodological Integration to Cognitive Fusion

Philosophy is usually perceived as an integrated system seeking comprehensive, justified, and reasonable knowledge. Within this ambitious quest, it tries to be inclusive of all paralleled fields of knowledge including the diverse sciences. A fact that created a problematic relation between the two -philosophy and science- that is integrative at times and conflicting at others, given the topic, methodology, and outcome differences.

Despite the specialization and multidisciplinary of science, it could not be without philosophy's propositions or even approaches and that is because of the complication of scientific issues with philosophical roots, such as, the origins of the universe and the nature of time and space...etc. In doing so, it tries to give it a scientific, objective dimension through empirical and objective approaching. The relation between science and philosophy is illustrated in the emergence of philosophy of science branch, which in accordance with May Brodbeck aims at the analysis of scientific issues and concepts, and the revelation of its epistemological origins (knowledge) whether empirical, rational, pragmatic, or ontological (Brodbeck, 1953, p. 3.5)

Throughout history, science has gone through several developments that have reestablished its concepts and builds its theories and formulas; as a result, formed the needed background for the emergence of the philosophy of science. Since what was known the age of enlightenment, the theoretical framework of the philosophy of science has reached completion as it concretized and developed as a branch of western philosophy in the nineteenth century. In the twentieth century, this branch has become one of the significant branches of contemporary philosophy and one that mostly illustrates its diverse dimensions and genuinely expresses its orientations (الخولي، 2008، صفحة 07)

Despite the imperativeness that characterized both philosophy and science, prevailing, conflictive relations of disagreement were more than apparent leading to the emergence of irrational views in contemporary philosophy, from Sufism, spiritualism, intuitionism, romanticism, arriving at existentialism, ... and so on. However, these opposing views to the scientific orientation can only be perceived as responses to its prominence and rigorous determinism (الخولي، 2008، صفحة 117)

Under such tumultuous relation, a dialectical aspect to the relation was born between philosophy and science, reason and experience, and between theory and practice; an aspect that disturbed the classical perception of reason and its inherent perceptions. Also, turning reality's perceptual propositions bottom up, which was followed by a radical, conceptual revolution in the propositions

and perceptions of the philosophy of classical science and even in classical philosophies and their principles. In addition to that is the accommodation of contemporary perceptions of contemporary science's developments and various revolutions. From the number of sciences that differentiated between the two paradigms, classical and contemporary, is the contemporary mathematics and physics, represented in the quantum model.

Mathematical Model

Integration of Formal and Empirical Sciences in View of Axiomatics

Since its inception, mathematics might be considered the ideal science for human thinking and the comprehensive model for reasoning, accuracy, and certainty. A model that numerous sciences either empirical or humanistic attempted to emulate, which was challenging enough because of its symbolic, precise language, on the one hand, and its methodological rigor, on the other. Science's influence was neither far nor isolated from philosophy as this model, in both traditional and contemporary forms, contributed to the structural shaping of philosophical reason and the gradual transition from a form of concrete thinking mode to abstract formal forms. The epistemological influence of the mathematical thinking significantly intensified at the end of the nineteenth and early twentieth century foundational crisis with the emergence of what is known as axiomatics.

Axiomatics has contributed to the elevation of thinking from the concrete mode to the abstract as well as the human thinking to a limitless ability of treating the most abstract and generalized of issues. Being considered a tool for abstraction and analysis, axiomatics' methodology widely unlocked the abstraction path for thinking, and constantly presenting new horizons and possibilities to move forward in the abstraction world (بلانشيه، 2004، الصفحات 73-74).In order to fulfil this vision, numerous sciences have attempted to achieve axiomatization and formalization. Axiomatics has played an essential role in the development of concrete, empirical sciences as scientific researchers realized that for any mature scientific theory to be founded on solid grounds, it has to adopt this model. The latter is regarded by Blanché as the fourth stage in the developmental law of any given science after the descriptive, inductive, and deductive (بلانشيه، 2004، صفحة 81). In the clarification of this law or trend, out of the prominent examples in its illustration is physics; it begun as empirical and descriptive with qualitative concerns in Greece, then, inductive, qualitative in the seventeenth and eighteenth century, then, with the prime era of the major deductive theories in nineteenth century, it reached nowadays the level where axiomatic treatment is widely and extensively applicable . (بلانشيه، 2004، صفحة 82)

Soon enough, axiomatic formulation has become a construction prerequisite of the scientific theory because the presentation in such a strict framework maintains the distance from any unscientific flaws or deficiencies. As such, leading Popper to the conclusion of when axiomatically

formulating scientific theories, the prime aim is increasing rational immunity through rigorous, logical modeling. Therefore, axiomatization amenability is considered a fundamental characteristic that illustrates the scientificity of a given theoretical construct (البعزاتي، 1999، الصفحات 36-37). One example of physics benefiting from axiomatic formulation is enabling it to economize in thinking and explain with efficiency, providing structure to the framework as well as significantly advancing the framework towards logical reduction. In addition to that, theoretical physics works towards the discovery and avoidance of potential gaps and contradictions.

Hence, axiomatics has made a significant contribution to the unification of both deductive and empirical sciences, and to the approximation of a seemingly distant scientific theories. Thus, the transformation of these theories into one single abstract theory, which according to Blanché facilitated the integration and combination of these sciences, regardless of how distant they might be, by concluding that in such a manner each science leaves isolation leading to achieving integration by establishing an increasing number of connections between the total parts of knowledge (بلانشيه، 2004، صفحة 69). The invalidation of this fundamental dichotomy that was established by the positivist paradigm between formal sciences as mathematics and empirical sciences results in imbalance; with consideration of the former being a scientific tool in terms of both language and methodology, it offers no empirical truth contrary to the empirical sciences.

The Role of Axiomatics in the Shaping of Contemporary Epistemological Discourse

Through the delivered results, axiomatics sparked both an epistemological and a methodological revolution on the level of both sciences formal or empirical. Axiomatics also contributed to the revival of the problematic relation between theory and practice, especially the relation between formal (mathematical) thinking and practical empirical reality, which was the debate subject among traditional philosophical schools, such as, rationalism, empiricism, and others.

Nonetheless, the invalidation of formal and empirical sciences dichotomy was rapidly disregarded as the most rigorous of science begun resorting to the conceptualizations and, subsequently, reaching abstractions. Additionally, there exist no formal sciences without connections to empirical issues from which they originated, which constitutes for the dialectical integration in the Bachelard Ian view between theory and practice. As a result, the scientific theory became of empirical dimension and the empirical experience became of sensory dimension, eliminating completely the gap between the two. Thence, the traditional philosophical debate on the primacy of reason over experience is no longer of relevance, as scientific truth is no longer dichotomous or dualistic; it has become a two-face coin in which one is formal and the other is empirical. On this idea, Blanché has expressed that in physics, integration was the resolution to the

major obstructing problems of its mathematical conceptualization (R.Blanché, 1984, p. 181) In consequence, in order for the physical reality to be understood, it is now in need of the most immersed theories in formalism and abstraction, resulting in mathematical reality representing physical reality. A fact that led to the formulation of new epistemological discourses founded on a new type of rationalism believing in the dichotomy of reason and experience together within a dialectical framework based on integration, composition, and complexity.

.Quantum Model and its Effects

Quantum mechanics has brought about a radical disconnection with the past as it entirely altered the descriptive language of nature; rather than discussing particles with definite positions and velocities, the discussion has turned into wave functions and probabilities. With the relativity incorporation in quantum mechanics, the world view has evolved (بوالشعير، 2016، صفحة 162) accompanied by a change in the conceptual apparatus of both physical and natural sciences that moved from the classical propositions and principles, which were believed to be absolute and legitimately certain in their entirety. As commonly known, both the quantum and relativity theories have contributed to a seamless transition into a new phase founded on indeterminism and the two principles of preference and probability. Adding to that, introducing the quantum ratios and mathematical functions into the construction of physical reality as well as rejecting the essence and fixed essences idea, resulting in a bottom up study of physics.

With the introduction of quantum theory by Max Blanck, skepticism reached numerous epistemological concepts related to physics that were believed to be true, out of which is determinism, causality, identity, including also the non-contradiction principle. Additionally, reason repositioning and its shaping role of the physical reality, which is no longer sensory, empirical but turning to hypothetical, mathematical, that along, gave new conceptual rise to the physical experience concept and scientific laws as well. In turn, Physics' advancements have aided with the reconsideration of the kind of principles that the human mind-depended on at that time, from which, the complementarity principle emerged in contemporary physics that can, at the same time, be considered a criticism to the principles of identity and non-contradiction (وقيدي، 1983، صفحة 422)

On the account of the above, Bohr's integrative theory invalidated the non-contradiction principle by viewing light as of both wave and particle nature, as being two faces to the same coin. Accordingly, the Copenhagen school worked on the generalization of the complementarity principle to all biological, psychological, and social phenomena. On the quantum mechanics evolution, Niels Bohr expressed that the discovery of the quantum of action illustrates not only the natural limitations of classical physics, but every emerging theory of physics contradicts with Newtonian physics. For this, the lesson to be drawn from atomic physics is that classical physics concepts are

defined within the limitations of macroscopic phenomena, which should be modified if occurrences within the microphysical field are to be understood.

At a time where objectivity as a scientificity condition is emphasized, the problematic relation between subject and object resurfaced in contemporary science. While the measurement tool does not influence the object in classical physics, the issue is entirely different in contemporary physics and microphysics. In the latter, the measurement tools distinctively influence the object, thus, both subject and measurement necessarily collaborate in the creation of the external object (الجابري، 2006، صفحة 384) (In such light, the physical existence has become a simultaneous combination of both subjectivity and objectivity. The subject participates in the creation, conceptualization, and construction of physical existence in accordance with objective frameworks, and its role transcended from mere observation and justification to actual construction. Within the relativity theory, which relates to the macroworld, the subject integrates with the phenomena undergoing measurement while, within quantum theory, conversely, the phenomena integrate in the subject's process of measurement and use of measurement tools.

The quantum revolution, represented by the Copenhagen school, also introduced new conceptualization of the reason and the role it plays in the construction of the scientific theory. Contemporary science places emphasis on the importance and role of reason in the scientific activity; contrary to the classical science that tended to give phenomena a materialistic and mechanistic explanations. Alternatively, it relied on observation as foundation for event explanation. The contemporary science repositioned reason within any given experiential, scientific activity, which is the scenario wherein reason regained its rightful place within the scientific activity. For that, atom understanding, for instance, the atom constructs and the quantum theory... etc, cannot be achieved without both reason and experience. With the transformation of the physical reality and evolution of its concepts, the function of reason also changed, which is now questioning theoretical entities and working on the understanding of their characteristics and intricacies within the framework of experience that in turn is taking a cognitive characteristic.

From this new proclaimed role, the integration of both reason and experience was born as the role of reasoning in the scientific activity is neither detached nor independent from both reality and practice; but rather, practice is the condition of reasoning. Reason does not commence from nothing in the establishing of its dominion; in so doing and as a condition for objective scientific knowledge, it has to return, from the one hand to reality and to practice, from the other. Where objective scientific knowledge is achieved, the scientific reasoning triumphs over the various scientific knowledge obstacles(بوالشعير،2016،ص125). Here, contemporary epistemological discourse came to exist and proclaimed by figure from scholars, such as, Bachelard, Blanché, Brunschvicg, and other.

.Contemporary Epistemological Discourse Features: Contemporary Rationalism as a Model

.Applied Rationalism

The contemporary scientific revolution has broadened both horizons and capabilities of reason and allowed it to transition from science to philosophy and back from philosophy to science. A fact that allowed, in the same time, the conceptualization of a new rationalism founded on the dialectics of reason and reality, theory and practice, as well as other dichotomies, which been parted by classical epistemological discourse. Ergo, rationality and reality are not distant as rationality is not pure in its entirety; it is rather an existing rationality that is founded on debate, correction, and adjustment. The dialect within rationalism is nor automatic neither deduced solely from logic; the dialect rather means the subjecting of reason principles to the scientific development course((بوالشعير، 2016، صفحة 126), which reflects precisely the established rationalism of Bachelarain applied and dialectical rationalism.

In describing his applied rationalism, Bachelard proclaims it to be scientific, open, or open-minded; all of which are distinguishing features from the absolute classical rationalism. A contemporary rationalism that introduced a new epistemology known as the non-Cartesian epistemology (وقيدي، 1983، صفحة 381). Despite the diversity and versatility of features, the totality converges into an emerging new philosophical stream from the results of contemporary science. Also, derives its concepts from the various scientific revolutions with distance from philosophies that relay on classical scientific concepts in scientific knowledge contemplations, which the former is no longer capable of grasping the occurring triumphs and discoveries in the scientific arena. Applied rationalism is founded on both a theoretical and a scientific reasoning where in the former, mathematics significantly works on the concretization of the abstract, and in the latter, physical and natural science work on the substantiation of the abstract and its subjectification to the cognitive physical experience, which gives birth to the dichotomy of empirical reasoning and cognitive experience.

In the Bachelarian view, human reasoning is in a dialectical relation with the knowledge it produces, and its structure is influenced by the knowledge it generates. The view rejects the concept of a structurally fixed reasoning and advocates for a new concept of structurally flexible reasoning (وقيدي، 1983، صفحة 392). Under this view, Bachelard rejects the stand of both empiricism and rationalism with regard to the reason concept. Reason, in the empiricist view, is a faculty with no prior knowledge in counterpart to reality with only receptive and reflective functions of reality's subjects, while confirms the rationalist view that reason holds inherent perceptions and priori propositions. Yet, by contemplating on contemporary scientific indices one can note the existence of

a new concept of reason that thinks and produces knowledge and remains unchanged, only changes structures while thinking.

In all the stated, Bachelard did not overlook the role of mathematics in the shaping of scientific reasoning throughout sciences' history, as he (1984) states that "What makes people believe that the scientific spirit, despite the profoundest of changes, always remains fundamentally the same? The answer, I believe, is that the true role of mathematics in scientific thought has not been generally appreciated. It has been repeated endlessly that mathematics is a language, a mere means of expression. People have grown used to the idea that mathematics is a tool wielded by a self-conscious mind, mistress of a set of ideas endowed with Prema thematical clarity" (p. 55).In his mathematics role discussion, Bachelard added a new value to mathematics, within the various branches of scientific knowledge, represented in the features of abstraction and coherence. The addition is based on the group principle that is regarded as the theoretical thinking guide allowing the organization of experiments around a certain mathematical group .

The concept of coherence or coherentism plays the significance role in the achievement of logical, certain results, as Bachelard expressed that "When one has fully comprehended what for example Gonseth's work shows, namely, that experimentation is always dependent on some prior intellectual construct, then it is obvious why one should look to the abstract for proof of the coherence of the concrete" (Bachelard ,1984,p. 41). In the light of contemporary physics results, Bachelard introduced a new concept of reality in rejection of the classical concept, which considered reality to be a passive inherent of the knowledgeable entity; while instead, reality is the result of both technical and rational activities interplay represented in mathematical frameworks. In consequence, the world is required to surpass existential reality to a cognitive reality that is created solely by the mind. Accordingly, reality, to applied rationalism, is not science's starting point but rather is the arrival point, which it reveals at times and creates at others. Scientific theories, in the end, recreates reality and work either towards its reconstruction and rearranging or construction on the basis of new mathematical input.

Physical subjects in contemporary view are no longer ontological, objective, and independent from their perception within us; rather, they have turned into cognitive, mathematical concepts, creations of the mathematical mind itself. From this, reason in no longer restricted to the reception of experience effects but effectively depends on logical, mathematical means. On the basis of this conceptual and functional revolution, contemporary science transcends in its thinking from the essence of reality or reality itself to the rational structure that connects its essence with other concepts.

Blanché's Mathematical Rationalism

Balnché's(1898-1975) epistemology believes in mathematics' prominence role in knowledge construction. The belief is attributed to mathematical tools interventions, either concepts or methodologies, in the formulation of various scientific theories. The latter represents a framework of mathematical input and a system of geometric relations. On the aforementioned, according to Blanché, when thinking makes the transition from conceptual to mathematical structure, the transition from the absolute or the essence to the gradually constructed on relational basis, an inversion come to exist in the relations of thinking with its subject and knowledge with the object (R.Blanché, 1984, p. 206) Blanché's mathematical rationalism aims at the elimination of the existing gap, from the one hand, between the subject and the object and, from the other, between reason and experience. By doing that, reach the elimination of existing, abstracting barriers between physics and mathematics, all on a quest for a unified, objective truth.

With such classical dichotomies eliminated, the most concrete of sciences grows closer to abstraction while abstract sciences preserve the connection with sensory subjects and so forth. In the case where the scientist wishes to verify the truthfulness of a certain scientific law, he integrates it within a system of abstract relations within, again, a deductive framework. Then, proceeds to the presentation of the fundamental constructing principles in order to form a purely formal construction (البعزاتي، 1999، صفحة 32.33)

Perhaps, the relational problem relating both theory with practice and mathematics with reality is illustrated best in mathematics' relation to physics' theories as demonstrated contemporary science through Blanché (R.Blanché, 1984, p. 187) stating that in physics, integration was the resolution to the major obstructing problems of its mathematical conceptualization .In consequence, in order for the physical reality to be understood, it is now in need of the most immersed theories in formalism and abstraction, resulting in mathematical reality representing physical reality. As such, by separating theory from practice, came the invalidation of the positivist view that was founded on the distinction of the two scientific types empirical and formal.

Blanché"s rationalism criticizes philosophical realism and its conceptual propositions of both reason and reality because reason, in scientific work, may not be predisposed of priori knowledge to achieve knowledge; it stills qualified enough to initiate scientific knowledge construction. Adoption, therefore, of Blanché's mathematical trend is as adopting that reason has methodology and tools as initiative fundaments. The premise tool is illustrated in mathematics that Blanché considers of fundamental role in contemporary scientific knowledge, and this mathematical trend is in opposition with both the realist and positivist philosophies (وقيدي، 1983، صفحة 424)

From that, it is possible to deduce that Blanché's realism is reflective of a comprehensive awareness of the kind of results and new concepts delivered by the scientific revolution, which was metamorphic to both subjects and methodologies of epistemological thinking. Additionally, it also founded for new philosophical propositions that is simultaneously believing in a dynamic, mathematical reasoning and in a rational, technical reality; a perfect illustration of the kind of existing link between science and philosophy.

Conclusion

In conclusion, the debate between scientific and philosophical knowledge is one of the fundaments of contemporary epistemological thinking. As such, both structure and content of contemporary philosophical thinking cannot be understood except through the understanding of the input of contemporary scientific reality either mathematical of physical, distantly from believing in absolute, fixed, and definite input. A fact that strengthens thinking that is open to science, which is the fundament of contemporary epistemological study.

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