THE PLACE OF CREATIVITY IN SCIENTIFIC KNOWLEDGE

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Progress in scientific understanding is a cumulative process characterized by systematic exploration of the implications arising from currently accepted theoretical foundations. Here, logical deduction is important. But when anomalies arise within the framework, modification or replacement of a theory may be needed, and this is nor entirely a matter of logic. In this article we consider the generation of new knowledge and understanding, including historical analysis, and review philosophical and scientific views from the new European philosophy up to the 20th Century. Prospects of research into creative activity in science are considered. We conclude that nonrational, creative thinking is a key element in scientific progress.

Keywords: scientific knowledge, prerequisites, philosophy, rationality, logic, creativity.

A serious question is whether, in addition to systematic logical thinking, creative or nonrational thinking plays a key role in effective scientific research and progress. Unthinkable for the classical philosophy of science, the idea is now gaining currency. Science is traditionally regarded as a field of activity rigidly regulated by a set of rules and oriented to disclosing reality, while creative activity, through the power of imagination, yields novelty which may or may not mirror reality. Hence, the attempt to consider the role of creativity in science, at first glance is paradoxical. However, the more we understand scientific activity, the clearer it becomes that creativity and imagination play a very significant role.

To better to characterize the matter, note that creativity etymologically implies the making of something new, while the leading principles of scientific knowledge are its reliability and the methodological thoroughness of the cognitive procedures producing it. Science is geared to consistent and reproducible implementation of the series of logical actions, and in this sense the creation of something new might be considered a step alien to science. However,

what is regarded as a scientific discovery and has an extreme degree of relevance in science can be either the result of chance (provided that the source of discovery is an unusual consequence of routine procedures) or represents a fundamentally new idea that radically changes the scientific picture of the world. If research activity assumes the consistent implementation of cognitive procedures according to a predefined plan and, accordingly, initially substantiated from the point of view of an established theory, then scientific discovery as the birth of fundamentally new knowledge does not fit into the framework of existing theory. Accordingly, we are talking about a little-studied process of forming a new theory, which is inextricably linked with the creative activity of the researcher.

For a long time, one of the central questions of the philosophy of science was the methodology of scientific cognition. The development of this topic includes the search for methods and techniques that determine, on the one hand, the correct heuristic procedures, and, on the other, the possibility of acquiring fundamentally new knowledge. At the heart of the classical approach, formed in the New European philosophy of science, lies the combination of empirical observation and rational thought aimed at bringing new knowledge from existing theory. A dual path: procedures for acquiring empirical data have improved; logic has advanced. The combination has allowed significant scientific progress. However, these ways of developing scientific methodology are based on assumptions, which lead to contradictory results.

Selecting the prerequisites for cognition is important in the formulation of the question of the methodology of scientific knowledge. Why so? To answer this let us identify the characteristic features that make scientific cognition scientific. The criteria of scientific rationality changed in the course of the development of philosophical and scientific discourse but did not lose their relevance. However, in the New European period, an attempt was made to formulate criteria distinguishing science from pseudoscience, ultimately with limited success, so that perhaps the best distinction to make is between good and bad science.

At the same time, the assumption that science is a rational and methodologically sound activity that excludes distortion of knowledge and contributes to its development has been preserved. This idea, intuitively understandable, for the most part goes beyond critical reflection. At the same time, as S. Toulmin demonstrated, the idea of the logicality and rationality of scientific knowledge is a prejudice, which often hinders the correct consideration of the specifics of the research process [4].

Returning to the formulation of the question of the methodology of scientific cognition, the idea of logicality of scientific discourse presupposes the need to correctly obtain empirical data and to accept true initial assumptions as

the basis for obtaining reliable knowledge. This determines the importance of research in the field of logic and language (with the goal of eliminating errors in the process of cognitive activity), criticism of experience (the latter is the result of attempts to formulate a universal methodology for obtaining reliable empirical data free from theoretical preconceptions) and a consistent study of the premise knowledge. Examination of the first two problems listed above ultimately raises the question of the initial cognitive attitudes.

An example is the problematic of the correct language definition of complex phenomena, as well as an arbitrary choice of the type of logic applied on the one hand, and the problem of the "theoretical loading" of experience on the other. Even the problem of the observer includes the question about the initial expectations during the conduct of a scientific experiment. With this formulation of the question, one of the logical versions of the solution of the problem of the validity of the assumptions was the judgment about their obviousness and absence of alternatives. For example, axiomatic knowledge in geometry and the initial principles of Aristotelian logic were justified. However, with the emergence of non-classical logic and non-Euclidean geometry, it becomes clear that the evidence of the premises is problematic.

Hence an important idea that has developed: if the prerequisites of scientific cognition cannot be justified from the point of view of logic and experience, then they are completely arbitrary assumptions reducing scientific cognition to the level of a conditional explanation, or there is some other method of substantiating knowledge. An important attempt to solve this problem is Kuhn's paradigm theory.

Arbitrariness of the choice of prerequisites makes scientific knowledge problematic, since, with arbitrary choice of initial cognition settings, arbitrary variations of a scientific theory can be formulated. For this reason, the development of the philosophical and scientific discourse went along the path of development of the methodology for limiting the field of premises, which was solved in two ways – through an analysis of the relationship of assumptions and through an appeal to experience, as a "merciless arbiter", determining the appropriateness of certain theoretical constructions [3].

The most consistent development of the idea of the logical interconnection is the theory of the development of scientific paradigms. According to this theory, methods of statement of research problems, the logical-categorical apparatus of science and the numerous initial assumptions in the developed theory are in a state of rigid logical interrelation, which guarantees the uniqueness of the paradigm under the condition of having certain theoretical assumptions, explicated with the help of logic [1]. According to Kuhn, at the level of the paradigm everything is decided from the way of interpreting experience to the way of the formation of concepts and the meaning invested in

them. In this case, the correctness of the initial assumptions is determined by analyzing the correlation between the explored sphere of experience and the scientific theory being built [1]. With this approach, cognitive activity at certain stages does not imply a critical comprehension of cognitive attitudes, but is a successive process of revealing the potential of the already accepted scientific theory, which in its system of thought received the name of normal science.

A key moment in the Kuhnian model is the adoption of a paradigm for it represents a one-time phenomenon, albeit extended in time (mainly due to the long process of acceptance of new theory by the scientific community), but at the same time in terms of the way of the birth of new knowledge. The paradigm, by virtue of the logical connection of its elements, wholly exists, although initially it appears before the scientific community in a collapsed form. This is illustrated by Kuhn's idea of "switching gestalt", describing shifts in the scientific worldview in the process of changing paradigms [1]. This minimizes the creative process of forming the premises, because, in fact, it is realized only at the stage of the origin of the paradigm, which is practically not considered by Kuhn. This is one reason for later criticism of his theory: Kuhn views science mechanistically, as an impersonal process of explicating theoretical knowledge, alternating with short-term phases of changing theoretical models. His position, in particular, cannot explain the existence of variations of the same theory that inevitably arise during the research process, as well as disagreement among scientists. The idea of adopting a paradigm assumes some agreement in the scientific community, while in practice this may not be the case. In itself, the process of the development of science does not imply the existence of any one dominant theory idealized by Kuhn, as evidenced by an appeal to the history of science. Thus, the attempt to preserve the classical model of science and the deduction of the creative process beyond the framework of philosophical and scientific discourse led to contradictory results.

Development of the problem of premise knowledge, associated with an attempt to correctly reflect the process of scientific research activity at the level of philosophical and scientific discourse, was made by Lakatos. At the heart of his theoretical development lies the idea of the modifiability of scientific knowledge in the course of a collision with new problems. In particular, one of the most important ways of working out the problem is to study the change in the scientific theory in the course of a collision with various refutations, logical as well as empirical. Lakatos forms the idea of theoretical assumptions designed to preserve the initial cognitive prerequisite. His theory of research programs presupposes the existence of two types of presuppositional knowledge: the initial, unmodified hypotheses of scientific knowledge, which have been called the hard core of the scientific theory, and auxiliary hypotheses orientated toward explaining the cumulative experience and maintaining the original theory in the

conceptual model [3]. Both the first and the second are prerequisites. However, if the first group of assumptions has the value of the original knowledge explicated by the means of logic, the second group of prerequisites arises already in the process of cognitive activity. In order to understand the significance of this provision, it is necessary to ask about the structure of knowledge, in which individual elements arise independently and do not have the character of logical consequence of the initial settings.

This model allows the emergence of nothing but the necessity of explaining individual facts, ungrounded theoretical constructions in the course of the development of the scientific theory. The absence of a common logical basis, from which all elements of the theory can be deduced, partly calls into question its reliability. At the same time, this approach to reflecting scientific discourse is much more in line with actual scientific practice.

For us, the key point is that Lakatos' approach allows an element of creativity in scientific search. The formation of a hypothesis or refinement in any sphere is considered not so much a necessary logical outcome (with no alternatives because of the universality of logical operations), but rather as one of the possible variations in the development of the scientific theory. The plasticity of theoretical knowledge, its modifiability, is the basis that determines the place of chance in scientific research. Lakatos sought a rational explanation of science, but his work contains the rationale for the existence of irrational procedures in scientific cognition. Consideration of such common scientific methods as criticism of falsifying experience, the formation of ad hoc hypotheses, the emergence of "deductive guess", testifies to the fact that in scientific discourse a firm place is occupied by irrational, creative thinking [2].

We have shown that the logic-only idea of scientific activity in science precludes arbitrary introduction of scientific principles, because the entire system of knowledge would follow from the initial premises of the theory. The development of the philosophy of science indicates consistent departure from this idea. This means that individual elements of scientific knowledge have an independent meaning and are caused not so much by logical necessity as by the explanatory potential of auxiliary assumptions. Thus, the development of science includes the creative formation of ideas and hypotheses.

Study of scientific creativity is a promising direction in the philosophy of science, It contributes to the clarification of historically given development of knowledge, and to the development of methodological guidelines for the development of modern science. The attempts made in the philosophy of science to explain the ways of forming hypotheses and cognitive attitudes, for the most part, are oriented toward revealing the role of sociological and cultural context, as well as the personal qualities of researchers. In our opinion, whilst this approach has a number of positive aspects, its explanatory potential is limited.

The study of the irrational aspect of scientific activity is an attempt to rationalize its irrational aspect, which in itself is paradoxical. The majority of attempted explanations are connected with ascertaining the fact of the arbitrariness of the formation of the prerequisites for cognition and the external explanation of this or that choice. At the same time, it seems promising to consider the creative process in science from the point of view of disclosing its structure, which can have a significant practical application in the future. In this sense, the hypothesis proposed by J. Holton on the existence of invariant theoretical constructions, with the help of which the surrounding reality is described, is of extreme interest. According to Holton, any theory is a combination of thematic bases of scientific knowledge, which in their totality are explicated when considering an object [5].

In addition to the theory of topical analysis, there are a number of theories and methodological systems that reflect the process of forming new knowledge, including the use of arbitrary procedures. For example, the theory of solving inventive problems (TRIZ), which is actively developing at present, is of considerable interest. In our opinion, the disclosure of the principles of creative thinking and, in particular, its optimization, represent one of the priority tasks in the modern philosophy of science, and in this respect it is expedient to form successive developments in the problem of mechanisms for the formation of arbitrary solutions in science.

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