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# THE UNCERTAINTY OF TRUTH IN THE DEBATE BETWEEN REALISM AND INSTRUMENTALISM

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***Abstract :***

*The debate between realism and instrumentalism in the philosophy of science has become one of the central topics concerning the nature of scientific truth and the relationship between scientific theories and reality. These two approaches offer contrasting perspectives on the role of scientific theories: realism views scientific theories as accurate representations of an objective world, while instrumentalism regards them merely as tools for predicting phenomena without making ontological claims about their truth. This study employs a literature review and conceptual analysis to compare the realist and instrumentalist viewpoints in the philosophy of science and to identify the uncertainty of truth that arises between them. The aim of this research is to understand the uncertainty of truth within the debate between realism and instrumentalism and its relevance to the development of contemporary science. The findings suggest that the uncertainty of truth is not a weakness of science, but rather an essential feature that allows for the growth and revision of theories. This article aims to contribute to a deeper understanding of the dynamics of the philosophy of science and its implications for scientific practice in the modern era.*

***Keywords :*** *Uncertainty of Truth, Realism, Instrumentalism.*

## INTRODUCTION

Truth plays a vital role in communal life, as it serves as the foundation for a just and rational social order. To attain truth, one must engage in proper thinking critical and systematic reasoning aimed at discovering knowledge that can be accounted for. However, what is considered true by one individual may not necessarily be seen as true by another. Therefore, thinking becomes a means to arrive at valid knowledge by considering the applicable criteria of truth. These criteria are not uniform but vary according to the nature and type of knowledge itself. Knowledge in the natural sciences, for instance, has different standards of truth compared to that in metaphysics. Even within the realm of natural sciences, the criteria for truth can differ depending on the specific branch or approach. Thus, it can be concluded that each field of knowledge has its own standard for determining truth (Nurdin, 2014).

However, in the process of pursuing truth, it often resides in a realm of uncertainty. This uncertainty is not absolute in the theological sense, but rather a form of scientific uncertainty that is probabilistic in nature. Such uncertainty is evident, for example, in defining what constitutes truth within the humanities, where truth is often contextual and open to interpretation. To reduce this uncertainty, scientific approaches that employ systematic methods and frameworks become essential. In this context, understanding and managing the uncertainty of truth becomes an intriguing challenge for thinkers and scholars, as they are not only tasked with discovering truth, but also with recognizing its limitations and the potential for plurality within truth itself (Djauhari, 2007).

This uncertainty is an integral part of the epistemic process. Indirectly, it can act as a catalyst for the emergence of critical and emancipatory knowledge. Uncertainty encourages individuals to reflect on their fate by contemplating the past, relating it to the present situation, and using it as a foundation to plan for the future. This epistemic process aims to reduce ontological uncertainty, especially in the context of the debate between realism and anti-realism. The next step is to develop further research that highlights the systematics of knowledge regarding uncertainty, involving epistemological aspects that can comprehensively represent this discourse (M. Rodinal Khair Khasir, Aldy Pradhana, 2023).

There is a problematic issue regarding the relationship between scientific theories and the reality to which they are applied. On one hand, scientific theories are human creations that are dynamic, always subject to change and development over time. On the other hand, there is the real world in which these theories are applied, and its behavior, at least in the context of physics, is stable and unchanging. The question is, how can the relationship between these two seemingly different aspects be explained? (Chalmers, 1983).

In the realm of the philosophy of science, there are two main schools of thought that significantly influence the debate about the nature of scientific knowledge: realism and instrumentalism. These two perspectives offer different understandings of the function of scientific theories and the meaning of truth in the context of science (Tarumingkeng, 2016). The realist view asserts that scientific theories, such as the kinetic theory of gases and electromagnetic theory, represent actual reality, where entities like molecules, electric fields, and magnets truly exist. In contrast, according to instrumentalism, these theories are merely tools for explaining and predicting observable phenomena, without considering the theoretical entities to be truly real (Chalmers, 1983).

Realism generally involves a specific understanding of truth. For realists, science aims to provide a true explanation of how the world actually is. A theory is considered true if it accurately describes certain aspects of the world and its behavior, whereas a theory that is not accurate is deemed false. In the typical realist view, as explained, the world exists independently, without relying on our awareness or theoretical knowledge of it. A true theory is one that reflects the objective world as it is. Meanwhile, instrumentalism also adopts an understanding of truth, but with a more limited approach. Explanations of the observable world are judged true or false based on the accuracy of their descriptions. However, theoretical constructs designed to provide instrumental control over the observable world are not judged in terms of truth or falsehood, but rather based on their usefulness as tools or instruments (Chalmers, 1983).

Based on the explanation above, it can be concluded that the debate between realism and instrumentalism centers on the perspective of truth and the relationship between scientific theories and reality. Realism asserts that scientific theories aim to describe the world as it is, objectively and independently of human consciousness. In contrast, instrumentalism emphasizes the functional aspect of theory, viewing it as a tool to explain and predict observable phenomena without claiming absolute accuracy in relation to reality. The uncertainty of truth arises as a consequence of these fundamental differences, especially when measuring the extent to which scientific theories can represent the objective world. Therefore, this article aims to examine how the concept of the uncertainty of truth becomes both a point of convergence and a challenge in the debate between realism and instrumentalism. As such, the author believes that research is needed to explore how the debate between realism and instrumentalism theories contributes to the pursuit and validation of truth.

## RESEARCH METHOD

The research method used in this paper is a literature study with a qualitative-descriptive approach. This research is conducted by collecting and analyzing various library sources that discuss the debate between realism and instrumentalism in the philosophy of science. The data are analyzed to describe each approach's perspective on the concept of scientific truth and to show how uncertainty is an integral part of the dynamics of scientific development. Through this method, the paper aims to provide a clear and straightforward overview of the issue of truth uncertainty within the debate.

## FINDINGS AND DISCUSSION

### The Uncertainty of Truth

The concept of truth begins with humanity's desire to understand everything until the ultimate revelation is reached. Aristotle, in his discussion of Metaphysica, states that knowledge leading to truth has two fundamental forms. First, knowledge for the sake of knowledge itself, where humans seek to understand and enjoy knowledge as intellectual and emotional fulfillment. Second, knowledge with the aim of application, such as in protecting oneself, making tasks easier, or improving health. In both forms, it is impossible to clearly separate the subject as the knower and the object as what is known. They are interrelated and form a fundamental unity, making them two inseparable elements of the same phenomenon (Salam, 2024).

Uncertainty is generally understood as a condition in which various possible events may occur, but the likelihood of each event cannot be measured quantitatively. Simply put, uncertainty reflects a state of doubt a condition in which the outcome or truth of something is still questionable in terms of its accuracy. This arises from the limitations of human knowledge, which remains imperfect. Therefore, uncertainty can also be interpreted as the human inability to accurately predict future events. In this context, uncertainty about the future encourages younger generations to develop more thorough and adaptive planning in order to face the various possibilities that may arise (Agustiyarini, 2023).

Truth, although often regarded as possessing a high degree of certainty, also contains elements of uncertainty that reveal its limitations. This uncertainty can be divided into two main types: methodological uncertainty and intrinsic uncertainty. Methodological uncertainty arises from two primary factors: errors in the process of investigation and the method of confirmation. These errors often occur due to the limitations of human senses during observation and measurement, which may be influenced by fatigue or inattentiveness. Even with the use of advanced instruments designed to improve precision, observational errors are still not entirely avoidable, thereby affecting the laws or theories built upon such data.

Furthermore, the process of confirming scientific theories is itself a source of uncertainty. In the scientific method, theories generate predictions through deduction, which are then confirmed through experiments and observations. However, critiques of inductive reasoning point out that such confirmation only applies to a limited number of observed cases, leaving many phenomena unexplored. To address this limitation, the assumption of the uniformity of nature is employed asserting that the properties of observed phenomena remain consistent across time and space.

Intrinsic uncertainty, on the other hand, originates from the structure and use of scientific ideas themselves. Most scientific knowledge is statistical in nature, such as the law of half-life in physics and chemistry, which describes the decay rate of radioactive elements on a large scale but cannot predict the exact decay of an individual atom. Another example is statistical averages, which, although offering a general overview, do not always correspond to individual cases. The Heisenberg Uncertainty Principle also illustrates intrinsic uncertainty in science. This principle shows that it is impossible to know both the momentum and the position of an electron simultaneously with high precision. If the momentum of an electron is known with certainty, its position becomes uncertain, and vice versa. Consequently, the location of an electron in an atom can only be predicted as a probability around the nucleus, not as an exact position. This principle serves as the foundation for understanding the behavior of subatomic particles such as electrons (Firman, 2019).

**What is Realism?**

Realism, as a philosophical school of thought, emerged as a synthesis between Immanuel Kant's idealism and John Locke's empiricism. Locke emphasized that truth can only be determined through sensory experience, rejecting the existence of metaphysical and universal truths. Realism, also referred to as neorationalism, has its roots in the classical thought of Aristotle, who viewed the world as something to be understood in a material and tangible way. According to Aristotle, reality cannot be separated from the realm of thought, even though our thinking is shaped by experiences that are selected and utilized. Reality is regarded as something that exists naturally and continuously develops in different forms within nature (Yuliyanti, Evi Damayanti, Soleh Hidayat, 2023).

Scientific realism is the view that scientific theories, in many cases, accurately reflect reality. This perspective is rooted in the belief that the external world exists independently of human perception, and that the task of science is to describe and explain that world as accurately as possible. In this context, scientific realism has several key characteristics. First, there is an objective correspondence between scientific theories and the structure of the real world. Second, truth in realism is defined as the correspondence between scientific theories and the reality they aim to describe. Third, scientific progress is understood as a process in which theories increasingly approach a more accurate description of reality (Tarumingkeng, 2016).

Realism is the view that the world and all its aspects have an objective existence independent of human thought. Truth is understood as the correspondence between statements and observable reality, with knowledge being obtained through empirical and inductive approaches. Realism believes that the world exists independently of human perception and views knowledge as an effort to understand the objective reality that is independent (Yuliyanti, Evi Damayanti, Soleh Hidayat, 2023).

Realism can be understood in various contexts, such as paradigm, theory, political philosophy, or philosophy of science, depending on its application. As a paradigm, realism views the world as full of conflict, while as a theory, it emphasizes that international stability is achieved through a balance of power. In the context of political philosophy, realism argues that power justifies all means. Meanwhile, in the philosophy of science, realism acknowledges the existence of an independent, invisible reality. Thus, realism is not only viewed as a perspective on the world but also as a broad approach applied across various disciplines, according to its goals and context of use (Rosyidin, 2022).

As a paradigm, realism is based on three main assumptions that form the foundation of its thinking. First, realism argues that actors in international relations are unitary and rational, operating in a world that is anarchic. Two key concepts in this assumption are "rationality" and "anarchy." Rationality is understood as the tendency of actors to prioritize their own interests or pursue individual goals within existing constraints. Second, realism views international relations as inherently conflictual. This perspective is inspired by economic theory, which assumes that actors compete for limited resources. Third, realism emphasizes that the international structure is determined by material capabilities. From this perspective, the behavior of states is entirely shaped by the material structure of the international system, which is the primary factor in the dynamics of inter-state relations (Rosyidin, 2022).

**What is Instrumentalism?**

It is called instrumentalism because human intelligence is seen as the primary tool (instrument) used to respond to various challenges and problems faced (Jaya, 2023). Instrumentalism views scientific theories as tools or instruments for explaining and predicting phenomena, rather than as literal descriptions of reality. In this perspective, the emphasis is more on the practical usefulness of a theory, rather than its ontological truth. Key characteristics of instrumentalism include pragmatism and utility, where a theory is evaluated based on its ability to explain, predict, and control phenomena, rather than its metaphysical truth. Additionally, theories are seen as human constructs designed to organize sensory experiences and phenomena, rather than to reveal objective reality. In this context, what matters more is the theory's ability to make accurate predictions, not whether the theory is true in an ontological sense (Tarumingkeng, 2016).

Instrumentalism, in its extreme form, separates the concepts applied to observable situations from abstract theoretical concepts. The goal of science, in this view, is to produce theories that serve as tools for connecting observable phenomena. Theoretical concepts are considered useful fictions that simplify scientific calculations, while observable phenomena are believed to reflect reality. For example, in Newtonian mechanics, the theory is used to predict the movement of billiard balls, but elements such as push force and friction are not regarded as reality, but only as tools for calculation. In kinetic gas theory, atoms and molecules are seen as theoretical fictions used to link observed phenomena, such as changes in manometers or thermometers. For the instrumentalist, science is not aimed at determining the existence of unobservable entities but rather at providing a practical framework for observation and prediction (Chalmers, 1983).

The naive instrumentalist approach faces a major criticism regarding the sharp distinction it makes between observable entities and theoretical entities. In reality, the entire process of observation heavily relies on theory, and many concepts, including objects that appear to be real, such as planets or billiard balls, are actually representations of more complex theoretical concepts. This criticism also highlights the difficulty in explaining how a theory, viewed solely as a tool for calculation, can lead to new discoveries. For example, molecular structures in organic chemistry, initially considered theoretical fictions, were later proven to be real through microscopic observation, challenging the naive instrumentalist view that strictly separates theory from reality (Chalmers, 1983).

**The Debate Between Realism and Instrumentalism**

If someone is asked about the statement "water boils at 100°C at sea level," they should provide an explanation of it (unless I refuse to answer). My response would be that "water boils at 100°C at sea level" aligns with the fact that, under standard atmospheric pressure, water does indeed exhibit the boiling phenomenon at that temperature. However, critics of this view might argue that the answer only describes the relationship between one statement and another, not with the real world. This criticism can be countered through an analogy. For example, if someone has a map of Indonesia and is asked what the map represents, my answer would be "Indonesia." In this case, I am not saying that the map represents the word "Indonesia," but rather the fact about Indonesia as a geographical region. Similarly, if someone is asked what the map shows, the answer must be a verbal explanation. In both the case of the boiling point of water and the map, the response is not merely a reference to a verbal statement, but to an actual fact. Thus, the statement "water boils at 100°C at sea level" logically refers to the fact that water indeed exhibits this property under certain conditions, and this can be reasonably understood within the framework of common sense.

After discussing the misguided criticisms of the correspondence theory, it is important to emphasize several key points related to this theory. Within the framework of the "truth as correspondence" theory, we must be able, in meta-language, to refer to sentences within a language system or theory, as well as to the relevant facts, to assess whether those sentences correspond to the facts. However, we can only talk about the facts intended by a sentence using the same concepts that are used in the sentence itself. For example, in the statement "water boils at 100°C," which refers to the fact of water's boiling point, we use the concepts of "water," "boiling," and "temperature" both in the object language and in the meta-language to explain the fact. The facts intended by a theory, which are to be shown to correspond with reality, can only be discussed using concepts from that theory itself. These facts cannot be separated or discussed outside the framework of the theory. This contrasts significantly with the discussion of factual correspondence in physical theories, which are more complex than simple examples like the boiling point of water (Chalmers, 1983).

This view, which emphasizes the connection between theory and facts, is well explained in Roy Bhaskar's "A Realist Theory of Science". Bhaskar shows that scientific laws and theories cannot be understood merely as descriptions of the relationships between sequences of events, as the empiricists' view suggests. According to Bhaskar, scientific laws cannot be adequately interpreted as statements such as "events of type A are consistently followed by events of type B." This view is based on the fact that physics involves experiments that are directly influenced by human involvement.

Experiments in physics are designed and conducted by humans. Humans plan experimental programs and create structured systems to test scientific laws and theories. The events that occur during experiments, such as data recorded by sensors, graphical displays, and so on, happen because of human intervention. Without human involvement, these sequences of events would not take place. However, even though experiments are influenced by humans, the natural laws tested through the experiments are not created by humans. Inappropriate intervention or negligence in an experiment can disrupt the testing process, but it will not invalidate the existence of the natural laws themselves. Therefore, Bhaskar emphasizes the need to distinguish between physical laws and the sequence of events typically produced during experiments as evidence for these laws.

If physics is viewed as an effort to seek truth, then the fundamental characteristics of physical laws are very different from simple descriptions such as "water boils at 100°C." In general, physical laws select specific properties of objects or systems in the real world (such as mass, force, energy) and describe how those objects or systems are likely to behave based on those properties (as in the law of inertia). Real-world systems typically have many other properties beyond those considered by a particular law, and their behavior is influenced by a combination of tendencies that operate simultaneously.

For example, a sheet of paper dropped from a certain height is not only subject to the law of gravity but is also influenced by air resistance, humidity, surface shape, and so on. Natural laws do not describe the direct relationship between local events such as "the paper falls to the ground," but rather describe tendencies that go beyond individual facts and are more fundamental in nature (Chalmers, 1983).

Newton's First Law of Motion, which Alexander Koyre referred to as "explaining something real with something impossible," is an interesting example. In fact, no one can provide a perfect example to illustrate this law because, in the real world, there are always frictional forces. However, if the law is true, then all phenomena would comply with it, even though the opportunity to demonstrate it in real life is rare. Experiments are designed to provide opportunities for proving such laws. If Newton's law is true, then its truth is universal and not limited to controlled experimental conditions. Therefore, it is not accurate to restrict the application of this law to experimental conditions alone. Newton's law remains true, but its application is usually influenced by other tendencies that work simultaneously. The correspondence of these laws is not with individual, local facts, such as the example of boiling water or falling paper, but with more fundamental and universal trans-factual tendencies.

In the discussion regarding the types of correspondence that may exist in physics, doubts arise about whether physics can be fully understood as the pursuit of absolute truth. This issue, as highlighted by Thomas Kuhn, relates to the history of physics, which shows a lack of attention to the fundamental nature of phenomena and their natural tendencies. For example, in the history of optics, views on the nature of light have changed significantly. Light was initially thought of as a stream of particles, then as a wave, and finally as an entity that cannot fully be classified as either a particle or a wave. The shift in these theories raises the question: how can these successive theories be considered to bring us closer to the truth about the reality of the world? This problem arises, although not always clearly visible, whenever a revolutionary change occurs in the development of physical science. It shows that scientific progress is not always linear and directly toward "truth," but is often a complex process that involves profound revisions of the way we understand the world (Chalmers, 1983).

Another problem in applying the correspondence theory of truth in physics is the existence of alternative formulations of the same theories. For example, classical electromagnetic theory has two different formulations: one based on electromagnetic fields that extend throughout space, and another based on the localization of charges and electric currents interacting at a distance. These interactions are explained through potentials that propagate at the speed of light. Similar situations are found in the formulations of classical mechanics and quantum mechanics. These alternative formulations often have equivalent predictive and explanatory power. If that is the case, a question arises for proponents of the correspondence theory: does the world truly contain electromagnetic fields, or only propagating potentials? The equivalence of these alternatives leaves proponents without a satisfactory answer, challenging the claim that a particular theory uniquely corresponds to reality.

Another difficulty for proponents of the correspondence theory arises from the nature of scientific theories themselves, which are human products and are subject to development and change. This stands in contrast to the physical world, which is the subject of those theories and whose behavior does not change over time. The view that the goal of science is absolute truth also faces significant challenges. Within the framework of the correspondence theory, the ideal goal of every scientific discipline is to arrive at "absolute" or objective truth that is, a correct explanation of the aspects of the world under investigation. However, the world possesses certain characteristics that existed before science came into being, so truth is not considered a social product but something that already existed independently. Therefore, if science were to ultimately achieve the goal of absolute truth, it would appear to transform from a human or social product into something entirely non-human. This transformation highlights the gap between the social nature of science and the absolute character of truth as its ideal, creating a conceptual dilemma that is difficult to resolve (Chalmers, 1983).

## CONCLUSION

The uncertainty of truth in science is a fundamental issue that revives philosophical reflection on the nature and purpose of scientific knowledge itself. Through the debate between realism and instrumentalism, it becomes evident that no single approach can fully capture the complexity of scientific dynamics. Realism maintains the belief that scientific theories represent objective reality, although it must contend with the revisability of theories and the limitations of scientific observation. On the other hand, instrumentalism offers a pragmatic approach but is often criticized for neglecting the ontological dimension of science. This debate illustrates that scientific truth is tentative, open to revision, and always in process. Uncertainty is not a weakness but an integral part of the evolving character of science. Therefore, our approach to scientific truth should not be absolute but rather open and reflective of the new possibilities that scientific development may offer.

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